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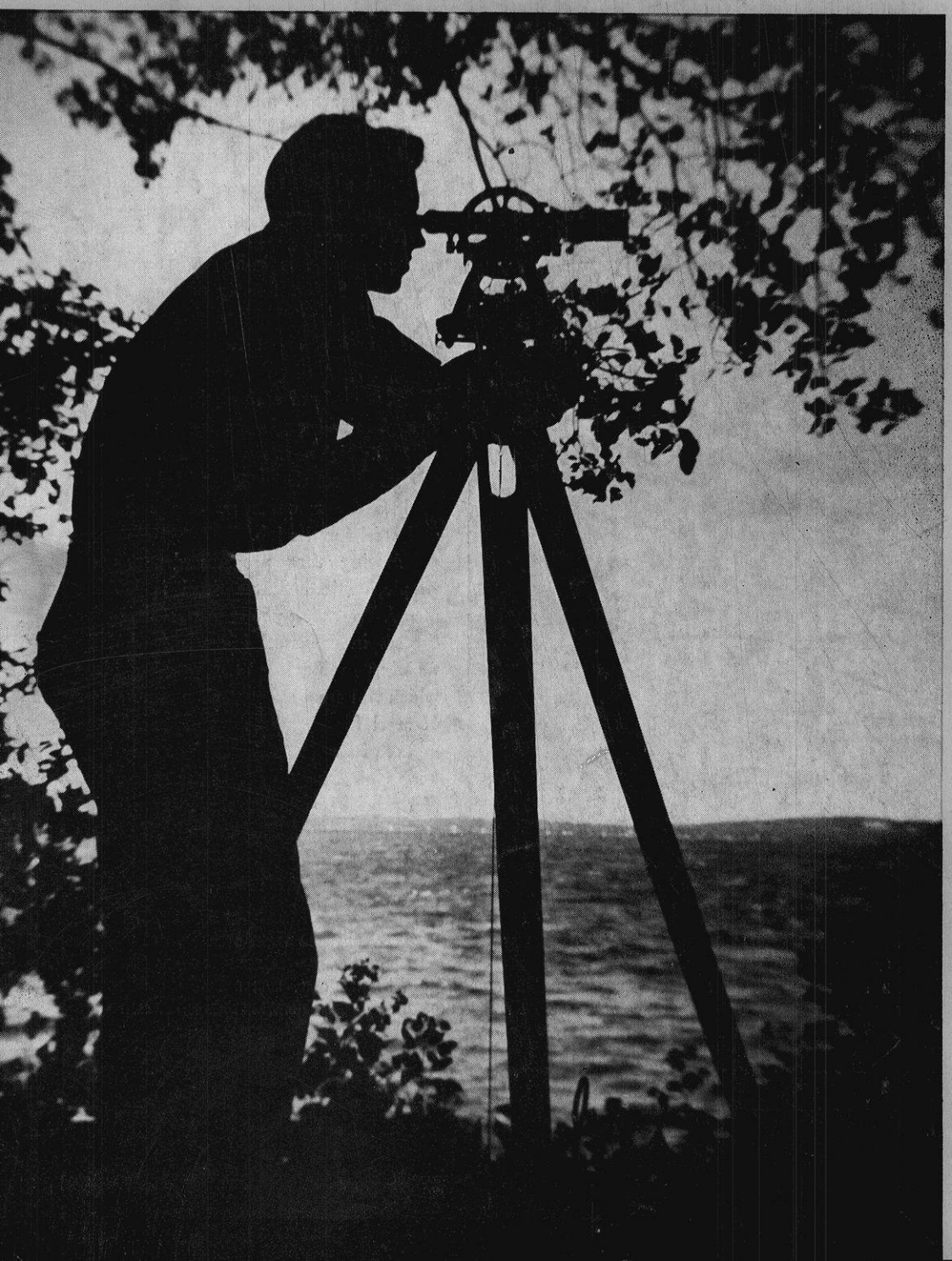
he Wisconsin

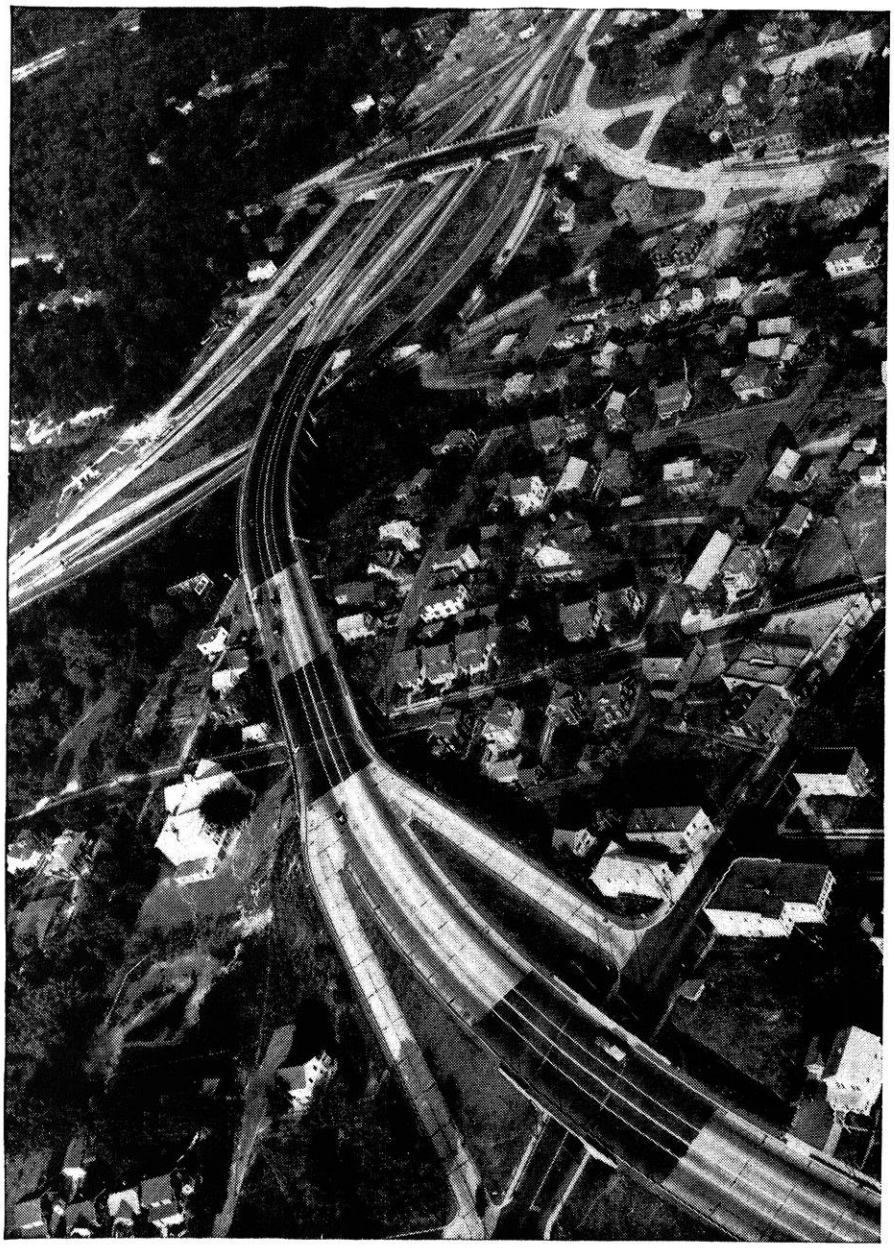
engineer

April, 1950



15¢

"...just drive straight ahead for 37,681 miles"



ALMOST everywhere you travel across this land of ours, you roll over beautiful wide, straight, smooth roads. A magnificent plan of interstate highways, the greatest road program in American history, is taking form at the rate of 700 million dollars worth of construction per year.

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It's a job that's far from finished, though. And it's going to call for an even greater supply of each of these commodities. Trained engineers must plan and build the highways of the future. And the talents of countless other skilled men will go into the manufacture of the cement and steel for the job.

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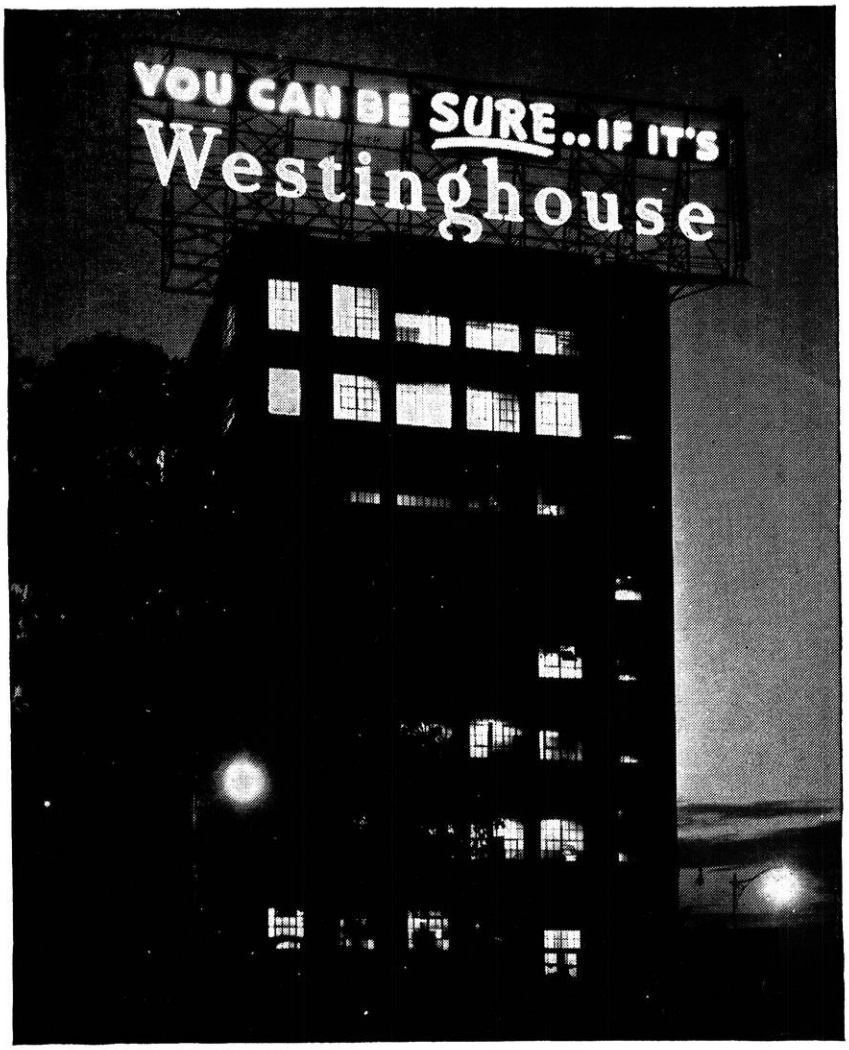

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IF HE COLLECTED SAMPLES

as he made his rounds

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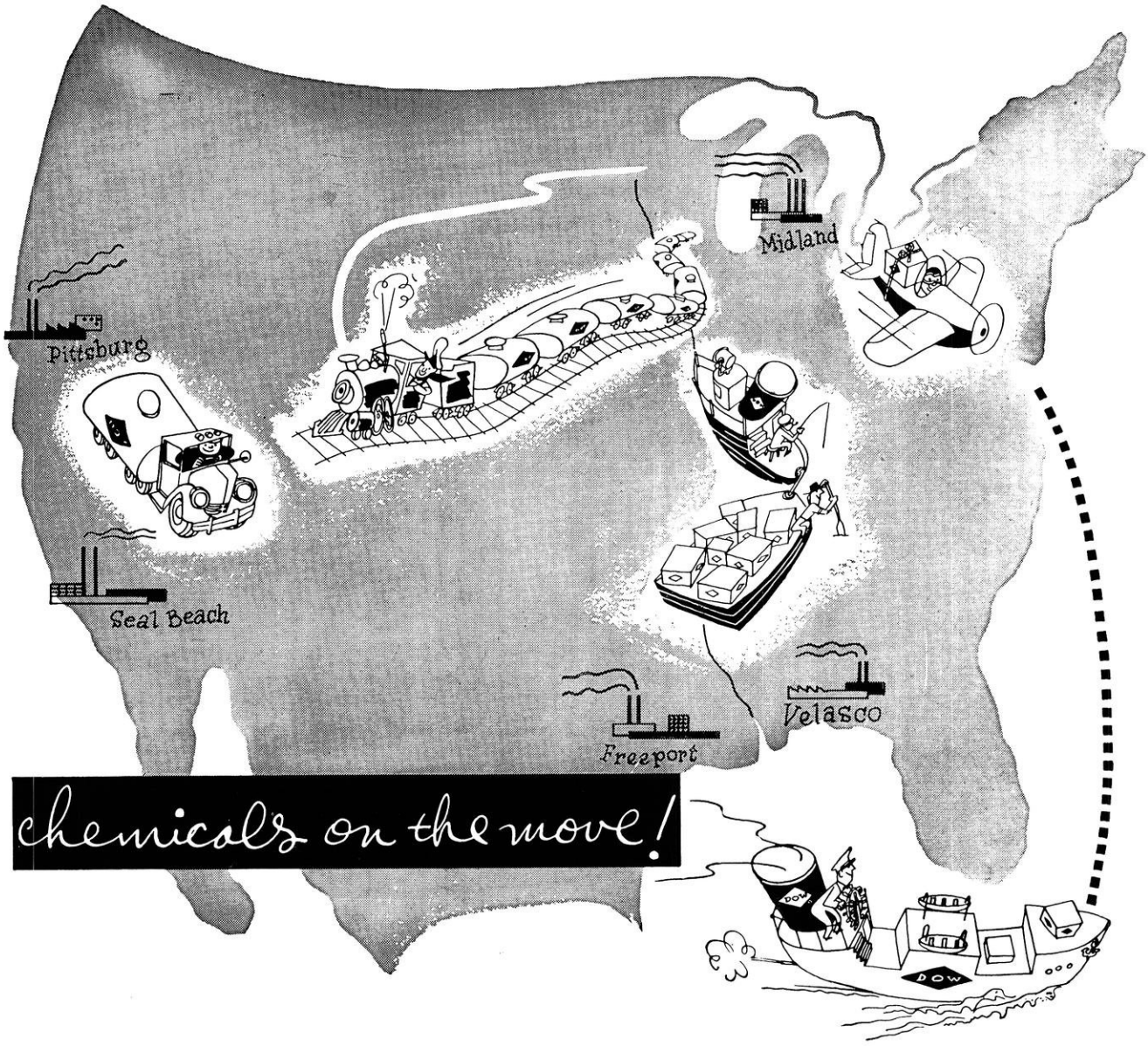

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WISCONSIN ENGINEER

Founded 1896

Volume 54 APRIL, 1950 *Number 7*

In This Issue . . .

Cover:

A Civil Engineer looks for signs of spring. (*Photo by Desens*)

Articles:

Departments:

THE WISCONSIN ENGINEER

— YOUR MAGAZINE —

Let's Read It!

Entered as second class matter September 26, 1910, at the Post Office at Madison, Wisconsin, under the Act of March 3, 1879. Acceptance for mailing at a special rate of postage provided for in Section 1103, Act of Oct. 3, 1917, authorized Oct. 21, 1918.

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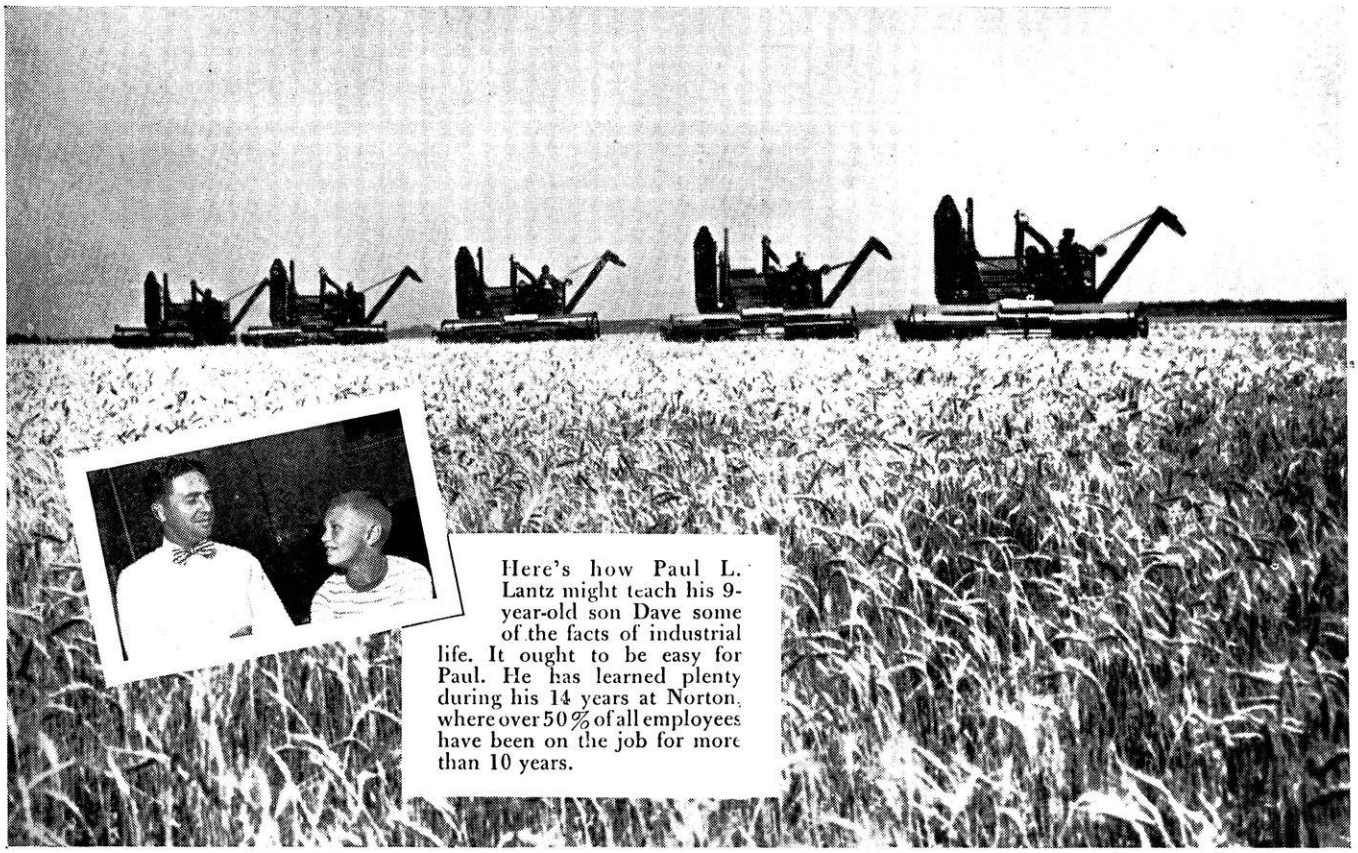

Here's how Paul L. Lantz might teach his 9-year-old son Dave some of the facts of industrial life. It ought to be easy for Paul. He has learned plenty during his 14 years at Norton, where over 50% of all employees have been on the job for more than 10 years.

A quintet of combines in action.

"IS FARMING AS EASY AS IT LOOKS, DAD?"

"No, son. It's just easier than it used to be, thanks to the farm equipment manufacturers who are always finding new and better ways to make farming more efficient."

"Diesel tractors give more power than 100 horses. Smooth, rugged power derived from accurate, close-fitting parts. Norton Lapping Machines finish these parts to closest tolerances possible in mass production.

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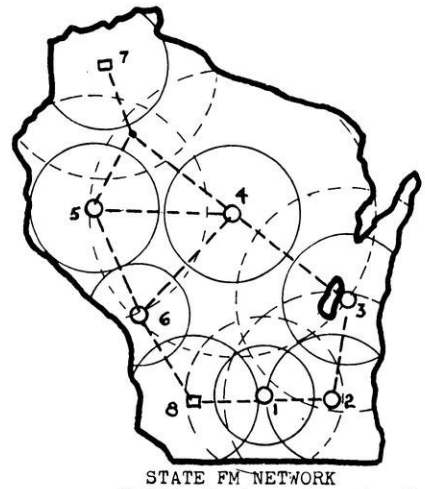
BEHR-MANNING, TROY, N. Y. IS A DIVISION OF NORTON COMPANY

(Photos by Mitchell)

Construction on new Recording Room — temporary recorders (left) to be installed in rack at right.



STATE FM NETWORK
Solid circle--city signal
Broken circle--rural signal

WHA

NO.	LOCATION	CALL	FREQ. MCS.	POWER INPUT WATTS	EFF. RADIATED WATTS
1	Madison	WHA-FM	88.7	3,000	9,350
2	Delafield	WHAD	90.7	10,000	51,700
3	Chilton	WHKW	89.3	10,000	51,500
4	Rib Mt.	WHRM	91.9	10,000	114,000
5	Colfax	WHWC	88.3	10,000	50,500
6	Holmen	WHLA	90.3	3,000	15,450
7 & 8 future stations					

"The Oldest Station . . ."

by Don Smithana e'50

When one looks today at the FM antenna for WHA — towering 297 feet above the campus — he might inquire as to the origin of this relative newcomer to the campus landmarks. It marks a new chapter in the development of the State Station. WHA has expanded from a humble one-room origin until today it embraces within its scope the entire state. It has fulfilled the motto, "The boundaries of the campus are the boundaries of the state".

The nerve center for the State Station is on the campus in Radio Hall. Located there are the three studios for "live" programs, and the basement houses the recording room and the FM transmitter. The amplitude modulated (AM) transmitter is located near the AM antenna tower just outside Madison. Both transmitters carry the same program except for station breaks at which time one transmitter is off the air while the other is being identified. In addition to these two transmitters the State Stations consist of five FM transmitters located throughout Wisconsin.

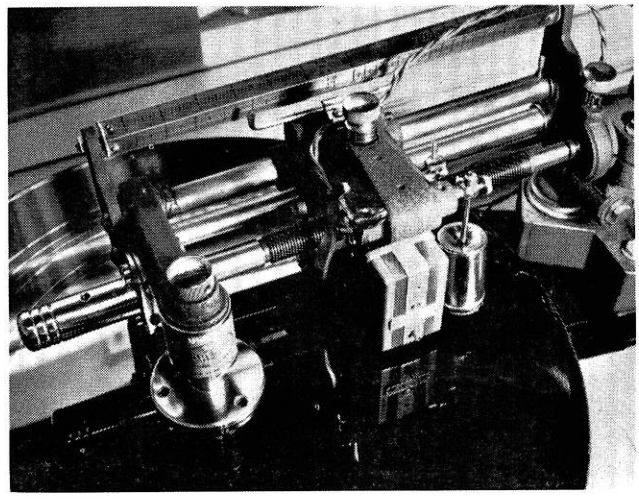
The history of WHA is as interesting as the history of broadcasting, for one parallels the other. It was around 1915 that the late Prof. Earle M. Terry set up a wireless station, W9XM, in Science Hall, which sent out weather and market reports. These were in telegraphic code, however, and it was not until 1917 that startled listeners heard words and music coming from their crystal sets. Unfortunately, work at the station was frequently interrupted by tube breakdowns. Because it was one of the first stations to discard the spark-gap in favor of the newly developed vacuum triode, all tubes had to be handmade.

In the summer of 1919, while radio telephony was entirely experimental to most, Terry was regularly broadcasting speech and Hawaiian music to an audience consisting mostly of experimenters. Hawaiian music was received best because its "tinny" quality lent itself quite well to the limited capabilities of the modulation equipment. It was these broadcasts that laid the groundwork upon which the present claim is made—"WHA, the oldest station in the nation". Radio station KDKA, usually recognized as the oldest, was not heard until the fall of 1920.

For these first broadcasts, the station was located in

(Photos by Mitchell)

Main control studio.



Precision disc-recorder.

a basement room of Sterling Hall. As the space requirements of the station grew, it was moved in 1934 to its present location, Radio Hall. This building, originally a heating station, had been occupied by the Mining and Metallurgy department. By this time, the station had long ago left the experimental stage and was now devoting itself quite professionally to public service. The School of the Air and College of the Air programs were inaugurated to extend radio education to the classroom and the home.

The status of the State Stations seems confusing to those accustomed to thinking in commercial terms. The stations are owned by the state and operated by the State Radio Council (created by the Wisconsin Legislature) with the aid and cooperation of the University. They accept no advertising, so that the time during station breaks, usually filled with "commercials", is occupied only by a short silence. The frequencies used by the stations are those set aside in the FM band expressly for educational use. The State Stations do not compete with private stations for material since their programs are of a type and length not attractive to commercial stations. They do not necessarily compete for listeners either, since other stations may rebroadcast without charge such State Station features as they feel would be attractive to their listeners.

WHA employs a number of student announcers and engineers, offering them experience that is difficult to obtain elsewhere. News writing and editing experience is also extended to those students properly qualified.

Student engineer Phil Farley at FM transmitter controls.

The large expansion of WHA has taken place in the field of frequency modulation (FM). On March 30, 1947, WHA-FM went on the air, making it the first FM transmitter in the Madison area. WHA-FM, no less a pioneer than W9XM of three decades before, was a result of the foresight of those associated with radio education and public service. The primary motive for expanding in FM was to better serve the people of Wisconsin.

Because further frequency allocations in the AM band were unavailable, AM transmitters to serve the people in the northern part of the state were impossible. Also, because of interference at night, the AM stations are limited to daylight hours, resulting in many of their programs being missed by those who are only able to listen at night. Further, since many of the programs at WHA include fine musical recordings, it was noted that only FM with its ability to reproduce faithfully a wide range of musical frequencies would be able to do them justice.

All of these handicaps were overcome by establishing an FM network. This network consists of the master station WHA-FM and five sub-stations strategically located throughout the state. Most of the programs heard on the network originate at the campus station. These programs are picked up off the air by a special receiver at the Delafield station (2 on map) where they are retransmitted on a slightly different frequency to serve the southeastern section of the state. Again the signals are picked up at Chilton (#3), rebroadcast and received at station four, WHRM, located high on Rib Mountain. In this way, a program originating at WHA-FM is heard throughout almost the entire state without recourse to expensive (and distortion-producing) telephone connecting cable.

Now in the process of completion at Radio Hall is a completely new recording control room and soundproof studio. This is a result of the realization of the flexibility afforded by the use of transcriptions. The recording room will contain eight magnetic tape recorders in addition to

(please turn to page 32)

PRECISE TRANSITS

by James Ringenoldus c'50

"Wild" is a name that is sure to make engineering history by revolutionizing the science of measuring the surface of the earth. With war-born advances in optics and precision machining, the Henry Wild company of Heerbrugg, Switzerland, has completely eclipsed American manufacturers of surveying equipment.

Disadvantages of weight, clumsiness, instability and difficulty in reading and setting up have been almost completely eliminated in the new instruments. Compactness and ease of handling are probably the most striking features of the Swiss line of levels, transits and theodolites. The "T-O" theodolite, comparable in accuracy and use to the American surveyors' transit, weighs only six pounds —less than one half the weight of the American instrument.

Convenience in operation and handling characterize all the new instruments. Now all readings and adjustments can be made from one position without the necessity of having the surveyor move around the transit or level to check the bubble centering or read verniers on the opposite side of the instrument. Wind blown plumb bobs need no longer plague the transitman since the instrument is centered over stations through the use of an optical plumbing device which is used from a standing position.

Measurement of angles has been made easier by the use of internal scales and simplified systems of calibration. Eyestrain and magnifying glasses have been done away with in the optical vernier which reads seconds direct with the ease of reading a speedometer. Level bubbles are centered by the coincidence method in which the image of the bubble is split by a prism and both ends are adjusted to coincide—a feature formerly found on only the most expensive precise levels. Level readings can be taken with the bubble in full view of the observer at all times. This means speed and accuracy.

Typical of the new Swiss line is the "T-2" theodolite which is owned by the University of Wisconsin Civil Engineering Department. On first glance the observer is impressed by the ridiculously small size of the instrument, but only on closer inspection can the capabilities and advantages of this precision tool be appreciated. Although the telescope is only 5.7 inches long it has a magnification power of 28 diameters. Instead of the old style spider web or platinum wire cross hairs, the new telescope has simplified markings etched on a glass disc. This new method eliminates errors arising from using the wrong cross hair and is far more durable than web or wire.

Angles are read by looking into a small auxiliary telescope placed along side the main telescope. A turn of a knob selects the desired scale for either vertical or horizontal angles. Since diametrically opposite points on the scale are seen at the same time, errors of eccentricity are completely eliminated. The interior scales are illuminated by mirrors adjusted to reflect daylight through a series of prisms. For night or underground work, the mirrors are replaced by small electric lights whose current is furnished by a battery box clamped on a tripod leg. Targets are lighted by a similar system.

A new system of measuring distances which is faster, more accurate, and more versatile than the stadia method, can be used with the T-2. An invar "subtense" bar with targets at each end is set up on a tripod over a distant point so that the bar is horizontal. The angle between targets, measured to seconds with the transit, is converted to feet by a table of angle to distance relations. Since the length of the bar is constant and no vertical angle correction has to be made, there is less chance of error than with the stadia rod. Under conditions of rough and hilly terrain, this system of measuring horizontal distances is considered as accurate as chaining. Probably the main drawback to the use of the subtense bar is its price of $261.

Wild levels also bring new precision and ease to the fundamental operation of differential leveling. Only one fourth the weight of an ordinary level, the Swiss instrument's versatility has been increased by the addition of a horizontal circle for measuring angles and a simplified cross hair pattern. After the level has been set up and roughly leveled with a spherical bubble, all adjustments can be made with the observer's right hand and the internal telescope bubble can be checked at the same instant that a sight is made.

Other optical tools for the aid of surveyors have been developed by the inventive Swiss. Almost unbelievable is the tetrahedron prism. Basically a piece of optical glass cut in the form of an equal sided pyramid, this prism will reflect light directly back to its source if the angle of incidence to the face of the prism is less than 60 degrees. The tetrahedron prism finds its best use in precise triangulation. Sights of 15 miles between towers and mountaintops are common and all work is done at night. Formerly a man with a signal light had to be at each station to be sighted but now a prism can be left at the station and a spotlight directed to it. So accurate are these prisms in reflecting a beam of light straight back to its source that the theodolite must be within a foot of the spotlight or no reflection can be seen.

Although prices of these foreign-made instruments are kept in line by excessive tariffs, they are sure to make a lasting impression on American engineering. If surveying can be made simple, the Swiss will do it.

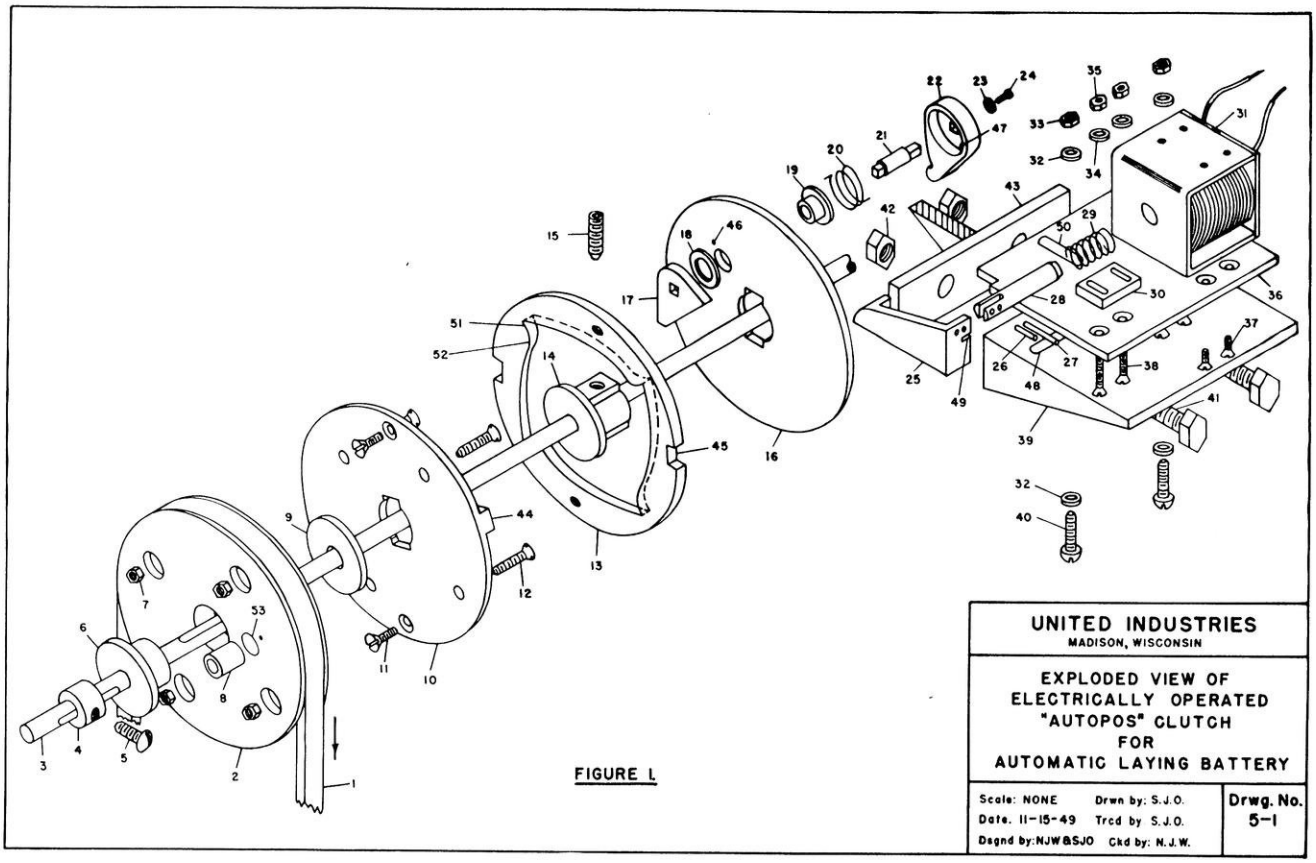


FIGURE I.

The "Autopos" Clutch

by

John Warner m'50

THE PROBLEM:

To design a clutch with the following requirements:

1. **Positive action** must be assured, which is capable of transmitting heavy torque without slipping or releasing.
2. **Engagement** and disengagement must be supplied by power from the driving force.
3. **Actuation** must be accomplished electrically by remote control.
4. **Reversibility** with either component able to serve as driver or driven.

As if these requirements were not enough, in addition, the clutch must be simple, compact, dependable, long lived with minimum maintenance, and adaptable to various V belt drives. Sum up these requirements and a knotty problem is at hand.

The problem arose in the development of an automatic laying battery by Stanley J. Otis, a graduate of the university and now with United Industries, Madison. It was found necessary to operate 14 conveyor belts, of varying sizes, at slow speeds, but with reasonably heavy torques. Electric motors with speed reducers seemed an unnecessary extravagance from the standpoint of expense and complication.

It was desired to run the belts at different times, that is, not all of the belts would have to be run simultaneously. Thus, the most obvious solution was to design a clutch that could be used with each pulley, and actuate it electrically by a remote control program clock. In this way, a relatively small motor could be used, alternately operating the various pulleys.

The clutch that would most adequately serve the purpose proved a problem, as the requirements noted above indicate.

THE SOLUTION:

After considerable search and experimentation, the desired clutch principle was discovered in an old E. W. Bliss Co. punch press. It required considerable engineering and alteration in order to be adaptable to V belt drive. Much of this work was done by Norman J. Wedekind, a student here at the University. After much experimenta-

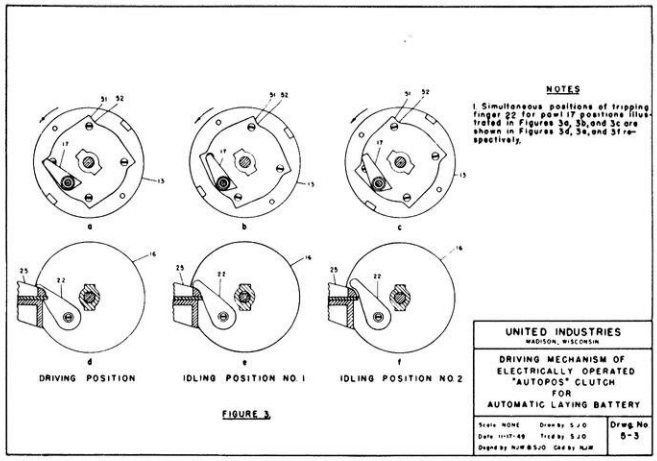


FIGURE 3.

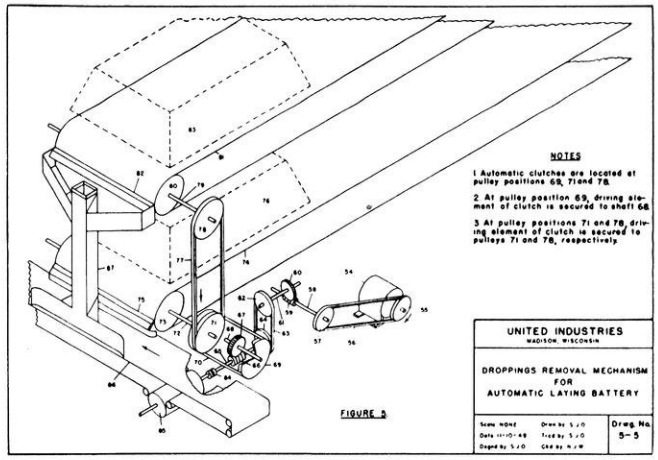


FIGURE 5.

tion the final form evolved, and it has proved itself admirably in actual service.

The operation of the clutch is as follows:

In the exploded view, Fig. 1, the pulley #2 is the driver and face plate #16 is the driven, however either can be the driver or driven member. Pulley-hub bushing #6 is press fit into the pulley #2. The pulley-hub bushing rotates on the shaft, there being no rigid connection between the two.

As the pulley is rotated, it in turn rotates cam plate #13. The pawl #17 is spring loaded, and follows the cam contour into one of the four valleys. This turns face plate #16 positively along with the driving pulley, and the clutch is engaged.

To disengage the clutch (see also Figs. 2 and 3), pawl #17 will have to be kept off of the cam face. This is accomplished by raising the tripping finger #22 as it comes in contact with the tripping arm #25. As the tripping finger is raised, pawl #17 is wedged away from the cam contour and the clutch idles.

An additional movement then occurs (see Figs. 3-c and 3-e). The shape of the pawl and cam contour causes the attached tripping finger #22 to clear the tripping arm #25 slightly. It can be seen that as the cam rotates, there is a periodic up and down movement of the tripping finger, #22, as the pawl #17 follows the cam contour. This is important because the solenoid will not pull back the tripping arm, while held down by the tripping finger. This is one of the unique characteristics of this particular clutch, in that it is able to actuate a heavy duty torque by the application of a relatively light solenoid. This type of mechnism does not cause large drains on the power supply. A pull of 6 oz. at ¼ in. was sufficient for this application.

It can be seen then, that to engage the clutch, the solenoid is energized, drawing the stripping arm #25 back. This allows the tripping finger #22 to remain forward and the pawl to remain in the valley of the cam contour. The clutch will continue to deliver as long as the solenoid is energized.

Fig. 5 shows how one drive can take care of a number of pulleys through the use of this type of clutch. The limited space taken by the clutches is evident.

It might be interesting at this point to see just how this clutch measures up to the requirements stated at the beginning of the article:

1. The cam and follower transmit positively, and the torque is limited only by the strength of the parts.

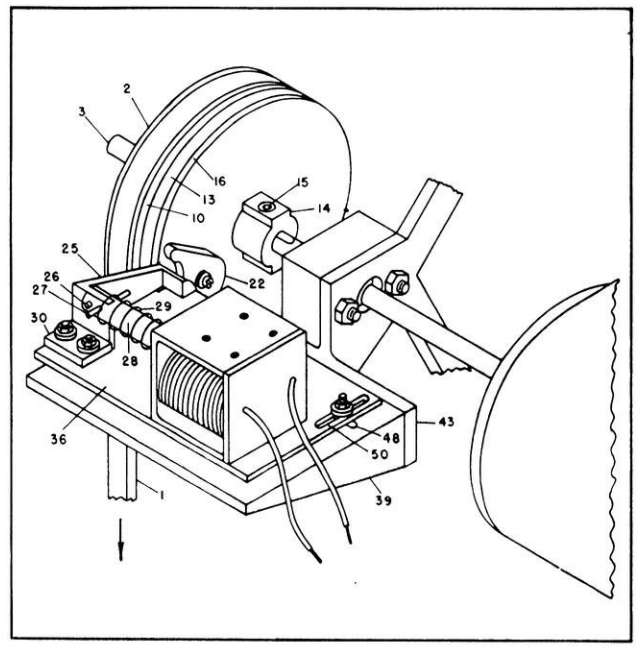
2. The driving force supplies the power to disengage the clutch.

3. A lighty duty solenoid is sufficient to actuate the clutch, and can be operated automatically by a program clock.

4. It is designed for easy reversal of the driver and driven elements, and the tripping arm.

It is also simple, compact, and has proved itself in service. There are only 4 parts, excluding the bearings, that are subject to wear. The clutch can be made in a number of sizes, and is adaptable to V belt drives. There are undoubtedly a number of industrial uses for a clutch of this type, because of its diversity of design and interchangeability.

Thus, the solution of another challenging problem is achieved through the use of imagination, experience, and creative engineering.



A Wisconsin Engineer In The Army

by Alfred B. Plaenert c'26

This article briefly outlines what one Wisconsin engineer accomplished in the Army because of his engineering and ROTC background. My commission in the Army Reserve Corps was originally granted because of my four years of ROTC at the University of Wisconsin, which proved invaluable in later years.

On 1 August 1937 I was ordered to active duty and assigned to CCC camp administration. This, on a smaller scale, is typical of my later Army duties. In a CCC camp I was responsible for the maintenance of the buildings, grounds, utilities, etc. A knowledge of water supply, sewage disposal, electricity, and general construction was essential as all these problems were continually encountered. In addition, the CCC duty was an excellent background for Army paper work such as supply, administration and mess.

On 29 October 1940 I was ordered to military construction duty which, at that time, was still a function of the Quartermaster Corps. I was assigned as Constructing Quartermaster, Ft. Custer and vicinity for my first project, replacming a West Point Colonel who had been on the job for only two months. The Constructing Quartermaster was one of the most independent officers in the Army. He was responsible directly to the Quartermaster General in Washington, and the only control over him by the Post Commander was for police, discipline, and sanitation. Army regulations strictly prohibit any person in the military service from influencing or interferring in any way with the Constructing Quartermaster. This clause is vital to keep ranking unit commanders, who are poorly acquainted with construction, from demanding a lot of ill-advised changes. Effective 1 December 1941 military construction was assumed by the Corps of Engineers, and my title then became Area Engineer. Previous to that date, Engineers were responsible for rivers, harbors, and fortifications only.

The Area Engineer is the liaison officer between the Government and that part of the public interested in construction. He prepares plans and specifications for bids, and opens the bids. The abstract of bids and bids are then forwarded to Washington for approval of the award after the Area Engineer makes his recommendations. Some revisions in this method have since been made. On Ft. Custer, because of the urgency, approvals of the award were secured by phone. In addition to the contract section, the following sections were also organized in my office: property records; personnel; auditing; cost control; engineering; inspection; reproduction of plans and specifications; material and labor expediting; public relations; and photography.

A brief history of the project is as follows: On 17 August 1940 the first contract was let for construction at Ft. Custer. In all about two hundred construction contracts were let there, including those for utilities. The total obligations incurred while I was in charge was about $12,000,000.00, while $15,000,000.00 was allotted by Washington for this work. The saving of $3,000,000.00 was returned for use on other jobs. Ft. Custer is the only Army camp in the United States which was built under the estimates. The construction of Ft. Custer was the subject of commendation by the Senate Investigation Committee headed by President Truman while he was a Senator.

The short time allotted for the completion, namely 90 days in each contract, called for the use of the latest methods for producing speed. Hand sawing was replaced by a battery of 7 electric saws, each capable of doing the work of 50 carpenters. The lumber was unloaded from freight cars into saw sheds, where it was cut into the proper dimensions and carried to the building site, where nothing further was needed except to nail together the parts which had been carefully matchmarked at the sawing sheds. Building parts, such as window frames, door frames, ventilation doors, brackets, and trusses were fabricated in assembly lines in the best tradition of the automobile business.

The entire project was machine constructed; water mains and sewer ditches were dug by machine, while other machines dug holes for foundation posts. However, the human element was present to run the machines. Some 5000 men were needed to run the machines and do the odd jubs for which the machines were not feasible.

The water supply for the camp reached about 3,000,000 gallons per day. We had to construct an entire system of wells, water towers, and distribution lines. The sewage was lifted by a series of pumping stations to flow through the sewage system of Battle Creek to its disposal plant.

Utilities were problems for immediate consideration when work started, and among early contracts were those for water mains, tanks for water storage, the electrical distribution system, sewer lines and pumping stations, gasoline stations, and railroad tracks. Added to this later were storm sewers, parking areas, and roads. For example, there are 24 miles of water lines on the post, 32 miles of electric service lines, and 24 miles of sewer lines. The road program called for surfacing 58 miles of streets and roads in the cantonn ment and maneuver area; storage has been provided for 279,000 gallons of gasoline, 1,700,000 gallons of water; parking areas surfaced for military vehicles total 437,000 square yards, and storm sewers total 21,000 feet.

(*please turn to page* 28)

PART III
LAY THAT SLIDERULE DOWN!

by

Paul Grogan, me instr.

Knowledge of the familiar 3-4-5 right-angle triangle dates back through the ancient civilizations of the Egyptians and the Chinese. It has served the purpose through untold centuries of helping man lay out squarely his plots and tracts of land, his villages and towns, his highways and canals, and his buildings and monuments.

Although these ancient men commonly employed the 3-4-5 principle for the construction of a right angle, it is believed they were satisfied with the results so obtained and considered not why they were so. The knowledge was simply handed down along with the other arts and crafts necessary for the survival of their civilization.

Pythagoras, a frequent visitor to Egypt in the Sixth Century B.C., picked up much of the learning of that country and was the first man history records as stating the proof which has become a classic in Euclidian geometry.

We recall a simple proof with the right-angle triangle, abc, appearing Figure 1.

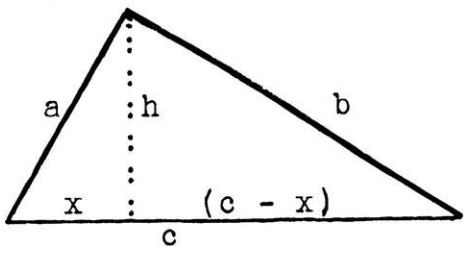


Figure 1.

$$(1) \quad \frac{a}{x} = \frac{c}{a}, \text{ or } a^2 = cx$$

$$(2) \quad \frac{b}{c-x} = \frac{c}{b}, \text{ or } b^2 = c(c-x)$$

Adding (1) and (2),

$$(3) \quad a^2 + b^2 = cx + c(c-x) = c^2$$

Thus we have a general expression involving the three sides, a, b, and c, of a right-angle triangle, but what other such triangles are there with integer sides? 6-8-10 and 9-12-15 are simply the same old familiar 3-4-5 triangle under a slight disguise.

Quite by accident, we may have chanced upon 5-12-13 and/or 7-24-25 as other integer combinations which form right-angle triangles, and we should begin to suspect there are a great many more which can be formed.

From a table of squares appearing in Part I, we recall:

$26^2 = 24^2 + 100 = 24^2 + 10^2$; Or,
10-24-26 is a combination.

$29^2 = 21^2 + 400 = 21^2 + 20^2$; Or,
20-21-29 is a combination.

$34^2 = 16^2 + 900 = 16^2 + 30^2$; Or,
16-30-34 is a combination.

$41^2 = 9^2 + 1600 = 9^2 + 40^2$; Or,
9-40-41 is a combination.

At the expense of some repetition, we may soon establish a particular right-angle combination to fit every small integer larger than two.

Odd Numbers	Even Numbers
3. 3 - 4 - 5	4. 4 - 3 - 5
5. 5-12-13	6. 6 - 8-10
7. 7-24-25	8. 8-15-17
9. 9-40-41	10. 10-24-25

These, in turn, may eventually be reduced to the form of identities:

Odd Numbers: $a = (2n - 1)$, $b = \frac{(2n-1)^2 - 1}{2}$, $c = \frac{(2n-1)^2 + 1}{2}$

Even Numbers: $a = 2n$, $b = n^2 - 1$, $c = n^2 + 1$

The reader may verify the identities by adding the squares of a and b to obtain the square of c.

Continuing the tabular information above with the aid of the identities, new combinations may be found with relative ease:

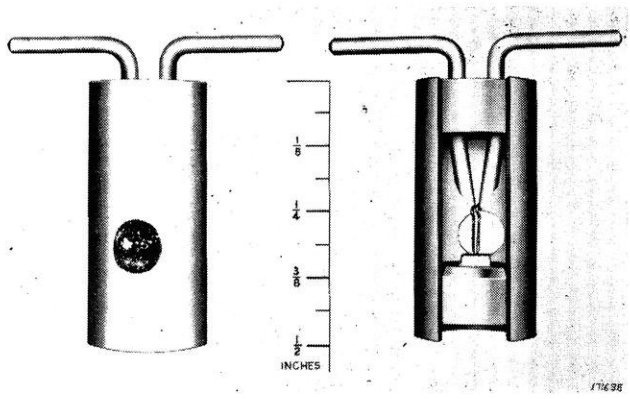
11. 11 - 60 - 61	12. 12 - 35 - 37
13. 13 - 84 - 85	14. 14 - 43 - 45
15. 15-112-113	16. 16 - 63 - 65
17. 17-144-145	18. 18 - 80 - 82
19. 19-180 181	20. 20 - 99-101

(*please turn to page* 36)

THE MIGHTY MITE

by Hank Williams e'50

New developments in design and an ever-increasing knowledge of its behavior, have made the Transistor a device that can no longer be ignored. The transistor was virtually unknown as late as 1947, but since its discovery Bell Laboratories have progressed rapidly in explaining its hidden possibilities. The transistor's development has been a direct result of research on germanium and silicon point-contact rectifiers for radar. Key investigations which brought the transistor to reality were carried out by Dr. John Bardeen and Dr. Walter H. Brattain. The general research program leading to the transistor was initiated and directed by Dr. William Shockley. From the work of these men came a device which had the properties of a vacuum tube, yet needed no vacuum and was lighter and smaller than commercial tubes.



Type A transistor.

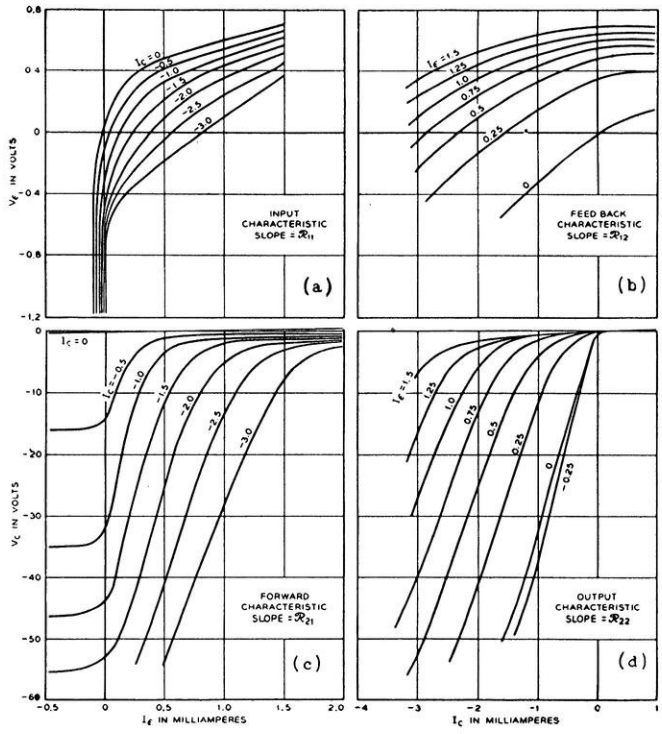
Since the first announcement of the invention of the transistor by Bell Labs, a form named the Type-A has been developed and is being made in considerable numbers. The Type-A consists of a small germanium wafer 1/8 inch in diameter and 1/32 inch thick which is soldered to a metal base. Germanium is a semi-conductor, a material whose electrical properties are intermediate between those of metals and insulators. The current flowing through germanium can be controlled by changing the electronic structure of the material. In metals there is a ratio of approximately one current-carrying election to every atom. In insulators there are practically no such electrons and therefore little conductivity. In semi-conductors, such as germanium, there may be as few as one current-carrying electron for every million atoms, but this number may be varied 1,000-fold or more.

Two electrodes or "Cat's Whiskers" make point contact on one side of the germanium wafer. These electrodes, called the emitter and collector, are placed in close proximity (0.005 to 0.025 cm.) on the upper surface. The third electrode is a large area low resistance contact on the base.

The contact assembly is made by molding the two support pins into a cylindrical plug of insulating material. The 0.005-inch phosphor bronze wires, which previously have been pointed at one end by bevel-grinding and polishing, are spot-welded to the ends of these pins. After welding the wires are bent in cantilever form and a final manual adjustment of the points is made. The electrode's polarities are selected and the pins are bent to distinguish between the two. The assembly is then forced into the other end of the cartridge until contact is made between the points and the germanium surface. The cartridge is then filled with wax to improve its mechanical stability. The entire assembly of electrodes, base, case and wax filling weighs 1.3 grams.

When the emitter and collector points are spaced far apart the emitter currents and voltages do not affect the collector currents and voltages. However, Figures 2a to 2d show the effects on the collector current vs. voltage relationship when the two contacts are placed near each other.

Because of the differences between electron tubes and transistors, the methods of presenting the static characteristics for the two are different. Tubes usually are operated with fixed bias voltages and voltages are plotted as the independent variable. For transistors, current is chosen as the independent variable because such a choice simplifies the physical interpretation of the actions in the transistor. Also, transistors may oscillate when measured in the vacuum tube manner. The voltages are measured



relative to the base and usually vary with the collector and emitter currents. In most transistors made at the present time E_1, V_1, and I_1 are positive, while E_2, V_2, and I_2 are negative when the transistor is operated as a class-A amplifier. Figure 4 shows a schematic diagram of a transistor circuit in which the arrows indicate positive directions of current and voltage.

For large signal applications, the static characteristics can be used to find the operating point in a manner similar to that used in vacuum tube operation for class-A.

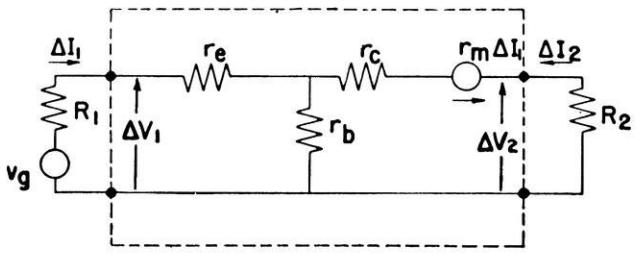


Figure 4.

A load line is drawn across the curves of Figure 5d with the voltage intercept equal to the electromotive force in the collector circuit and the negative slope equal to the load resistance. Draw a similar load line across the curves of Figure 2a corresponding to the values of the electromotive force in the emitter circuit and the external resistance. Replot this emitter load line on the collector characteristics of Figure 2d. The point of its intersection with the collector load line will be an operating point of the transistor.

For small-signal applications it is much easier to use the characteristics in differential form and find an equivalent circuit valid for small signals. From the equivalent circuit the a-c behavior of the transistor can be calculated for any input and output conditions. Equations can be derived for input and output impedances and power gain.

Well-known linear network theory leads to a number of possible equivalent circuits containing resistances and internal generators. A particularly useful form of equivalent circuit is shown inside the dashed box in Figure 3. In this circuit there are three resistances: r_1 associated with the emitter contact, r_2 with the collector contact, and rb with the base contact. The active property of the network is described by the inclusion of an internal generator $r_m \triangle I_1$ whose electromotive force is the product of the mutual transfer resistance rm and the variation of the input current $\triangle I_1$. The convention for positive currents and voltages is as shown by the arrows in Figure 3. The quantities $\triangle I_1$ and $\triangle I_2$ can be replaced by alternating currents i_1 and i_2 whose value is small compared with the bias currents I_1 and I_2. The figure does not show the external batteries and bias currents. vg is an alternating voltage signal generator in the input circuit.

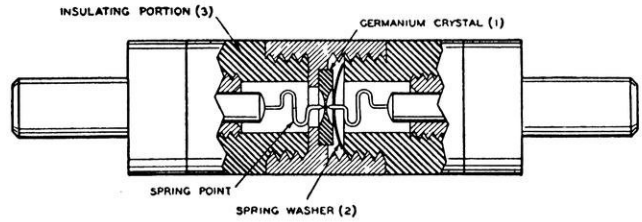
From Figures 2a to 2d it follows that the open-circuit resistances and hence the parameters in the equivalent circuit will depend on the values of the bias currents I_1 and I_2. They also will vary from one unit to the next. For a representative type-A transistor in a good operating region the equivalent circuit resistances might be: r_1 = 250 ohms; rb = 250 ohms; r_2 = 20,000 ohms; rm = 40,000 ohms. Since transistors are in an early stage of development, appreciable variations from unit to unit are to be expected. As the transistor art develops these variations undoubtedly will be reduced.

Shortly after the discovery of the transistor, J. N. Shive of the Bell Telephone Laboratories observed that amplification could be obtained if instead of having both collector and emitter on one side of the germanium wedge, they were placed on opposite surfaces. The germanium crystal is narrowed down and the point contacts are placed at a point where the crystal is only a few thousandths of an inch thick. Instead of obeying to the theory of surface current flow that explains the action of the Type-A transistor, investigation seems to indicate that the current passes through the semi-conductor. The great advantage of this new arrangement of the electrodes is the complete shielding between emitter and collector points.

The germanium is 1/8 inch in diameter and 20 mils trick. Two dish-shaped depressions are lapped into the faces of the wafer. Figure 4 shows the wafer held in place by spring pressure. In the experimental models, the insulating portions were made of lucite for ease of fabrication.

All three parts—emitter point, collector point, and germanium disk—are seen to be coaxial.

High polish of the active surfaces of the germanium allows the passage of higher collector currents before



Coaxial transistor.

burnout occurs. The surfaces are polished with a fine grade of diamond lapping compound and followed with an electropolish operation.

A large part of the useful gain is voltage gain resulting from the introduction of current from the emitter at low impedance and the withdrawal by the collector at comparatively high impedance. A large construction advantage of the coaxial transistor is the avoidance of the problem of placing two spring contacts within a few thousandths of an inch of one another. The highly polished surface also improves the stability of the points.

The idea that vacuum tubes are on their way out of the electronic picture is, of course, ridiculous. Nevertheless, one must admit that the special features incorporated in the transistor make it much more desirable than the vacuum tube for certain types of equipment. Its application will probably first be tested in telephone work. The saving of space would be a great advantage in circuits which sometimes contain over a thousand tubes. All of us have laughed at comic strips which depict wrist radios and portable television sets, but the joke may soon be a reality.

Science Highlights

by Donald Miller m'50 and Donald Smithana e'50

FLIGHT TEST CALCULATOR

A calculating machine designed to flight test a new airplane before it is constructed has been built for the Navy by engineers at the Massachusetts Institute of Technology.

With the machine, test engineers are able to set up an electrical model of any aircraft or guided missile in the advanced stage of design, and then apply an autopilot to "fly" the theoretical craft. Defects in the design can thereby be disclosed without the cost of actual construction.

Known as a flight simulator, the machine is a combination of intricate electronic and mechanical equipment. With its control equipment, it takes up most of a large room at the laboratory.

The fundamental purpose of this machine is to permit the development of high speed aircraft with a reduction in time, expense and number of conventional flight tests. The flight simulator involves the use of intricate computing machines and a "flight table" on which actual problems relating to flight stability are worked out. The table is an arrangement of gimbals, a mounting permitting a rotation in any direction such as used on shipboard to permit a compass to remain level when the vessel moves. The gimbal frame, operated by very high speed servomechanisms which automatically control instruments that carry out the motions in accordance with electrically transmitted commands, is used to orient the automatic control system of a theoretical plane or missile just as it would be tested in actual flight. The gimbal frame rolls, pitches and goes through all the motions the plans would make in the air under the stated conditions. The motions of the gimbal are recorded on charts where they may be visually studied.

The problem is worked out on the machine by setting electronic computer dials that represent the characteristics of the aircraft to be studied — weight, velocity, altitude, wing span, and many others.

The question is then fed into the simulator by applying appropriate electrical signals through a control board. The answer is returned on a chart in a few seconds.

(Photo courtesy Dept. of Defense)
Gimbal table and controls for flight test computer.

TURBO-HEARTH STEEL

It is possible to make steel in 12 minutes by a process which has just been developed. It now takes from eight to twelve hours to make a batch of open-hearth steel.

The new method uses what is called a turbo-hearth. Molten pig iron from the blast furnaces is poured in and blasts of air are shot in from the sides to blow over the molten iron. The pig iron cooks itself to become steel. Carbon and other impurities in the pig iron supply the heat as they oxidize in the air stream. This process differs from the Bessemer process in that the air is blown over, not through the molten iron.

A thirty-ton turbo-hearth could make three times as much high-quality steel in a day as could a 150-ton open-hearth.

Other advantages of the turbo-hearth are its flexibility, savings in cost of fuel and the fact that it is cheaper to build.

RADIO DISTURBANCE WARNINGS

In addition to standard frequency and time signals, radio station WWV of the National Bureau of Standards also regularly broadcast radio propagation disturbance warnings. These are based on observations of radio, ionospheric, solar, and geomagnetic phenomena at stations throughout the world. They apply especially to transmissions over the North Atlantic. The warnings are given in code at 19 and 49

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Alumni Notes

by Hank Williams e'50

E.E.

Karl Guthe Jansky, 44, radio research engineer with Bell Telephone Laboratories and world-famed for his discovery of radio waves from inter-stellar space, died Tuesday, Feb. 14, in Riverview Hospital, Red Bank, N. J., where he had been under treatment for a heart ailment. Mr. Jansky lived at 57 Silverton Ave., Little Silver, N. J.

An expert on radio transmission phenomena and on "atmospherics" and other types of radio interference, Mr. Jansky is credited with several basic discoveries, and was recently awarded an Army - Navy Certificate of Appreciation for his work during World War II on radio direction finders. For several years after joining Bell Laboratories in 1928, his research was concentrated on short-wave radiotelephone transmission. He guided the development of special recorders and directional antennas with which his most significant discovery, that of radio waves of extraterrestrial origin, was made in 1933.

Mr. Jansky was also known for his studies of noise in amplifiers and receivers, and for the design of several types of wide-band amplifiers. His work was done at the Holmdel, N. J., installation of Bell Laboratories.

The son of a professor of electrical engineering, Mr. Jansky was born Oct. 22, 1905, in Norman, Oklahoma. He was educated at the University of Wisconsin, from which he was graduated in 1927 with a bachelor of science degree in physics. He received his master of arts degree from the same institution in 193.

His father is Cyril M. Jansky, professor emeritus of electrical engineering at the University of Wisconsin.

Mr. Jansky was active in professional societies and was the author of numerous technical papers. He was a fellow of the Institute of Radio Engineers, and recently served as chairman of its Monmouth County sub-section. He was a member of Phi Beta Kappa, Phi Kappa Phi, and Phi Sigma Phi.

Besides his wife, Alice K. Jansky, and his father, Mr. Jansky is survived by his mother, Nellie Moreau Jansky of Madison, Wis.; by a son, David Burdick Jansky; a daughter, Ann Moreau Jansky; and by three brothers and two sisters. They are Cyril M. Jansky, Jr., and Maurice M. Jansky of Washington, D. C.; Nelson M. Jansky of Malden, Mass.; Mrs. I. A. Striffler of Marysville, Ohio; and Miss Helen A. Jansky of Madison.

C.E.

Ralph Gribble, ('43), is an engineer in the Planning Department of Oscar Mayer Company located in Madison.

David J. Welch, ('47), is an engineer with the consulting firm of Howard, Needles, Tammer, and Burgendorf and is engaged on field studies and supervision of foundation work on the Delaware River Memorial Bridge near Wilmington, Delaware.

Volney N. Moote, ('47), is at present employed with the Bridge Division of the Wayne County Road Commission of Michigan and is working on a system of depressed expressways for the Detroit area.

Vaso Bjelajac, ('38, MS'50), has been appointed City Engineer of Watertown.

Jane M. Strosina, ('46), and **Arthur J. Schallock, Jr.,** ('49) were married on February 25.

Spalding A. Norris, ('37), has been appointed Sales Manager of the Pump Division of Teomans Brothers Company, Chicago manufacturer of pumps and sewage treatment equipment.

M. & M.E.

Harry Niedzweicki, (Min'50), is at present working in Peru, South America as a Mining Engineer for the Braden Copper Company.

Harry Raschke, (Min'49), is on the training program with Bethlehem Steel Company of Ellsworth, Penn. He is with the division of Coal mining.

William Bauman, (Min'50), is employed as a mining engineer for the Ray Consolidated Copper Company of Ray, Arizona.

Gus E. Archie, (Min'31, MS Min '33), is an Exploitation research engineer of the Shell Oil Company of Houston, Texas. He visited the University of Wisconsin March 20-21 interviewing students in Physics and Electrical, Mechanical, Chemical and Mining Engineering for employment with the firm he represents.

E.E.

Mr. Bernon W. Schmidt, (e'33, MS'35), is now Sales Engineer with the Louis A. Allis Co., Rockford, Ill. He visited Madison March 23 to inspect the Gisholt Machine Co. with a group of "Tool Engineers" from the Rockford Area.

Samson G. Sargis, ('24), one of the top geophysicists in the country, is on a leave of absence from the Geneva Steel Company, of Salt Lake City to explore the resources of "Cerro Bolivar", believed to be the largest deposit of iron ore in the world.

ON the Campus

by Fritz Kohli e'50

STUDENT PLACEMENT MEETING

An important meeting for all engineering students who will graduate in 1951 will be held on May 2, at 7:00 P.M. in temporary building 16.

Prof. H. M. Goehring, head of the Engineering Placement Office, will outline the procedure of the placement program. He will explain how the interview schedules are made up, and how the interviews themselves are handled. A vital topic to be covered will be the interviewing companies' viewpoints pertaining to their own interviewing techniques and their attitudes toward the records and interviewing techniques of the student applicants.

The use of the printed personal data sheets will be explained. Prof. Goehring states that these data sheets have proved to be exceptionally successful this past year, creating an extremely favorable impression with the interviewing companies.

The meeting is scheduled to last approximately one hour, after which there will be a session devoted to questions and answers.

All students expecting to graduate in 1951 are strongly urged to attend this meeting.

PI TAU SIGMA

Pi Tau Sigma, honorary mechanical engineering fraternity, held an informal initiation for the spring semester on March 22 at the Esquire Club.

The entertainment for the evening was furnished by the initiates: James C. Burton, John L. Flitz, Carl E. Frank, Howard B. Kast and James Y. Yerges.

The arrangements and program were under the direction of Ralph Hauser, Jim Coonen and Joe Velguth. Refreshments and a social hour followed the initiation ceremonies.

A.S.M.E.

A talk entitled "Engineering Responsibilities and Organization" was presented by Mr. F. N. Sanders, Mfg. Engineering Superintendent of Western Electric Co., on March 30. Candidates for next year's offices were nominated, and information about the Student Paper contest was given out.

The Student Paper contest, which began April 1, is sponsored by the Rock River Section of A.S.M.E. First prize is $25 and second prize is $10.

The Student Branch Regional Meeting was held at South Dakota State College at Brookings, S. D., on May 1 and 2.

ENGINEERING LECTURE

Another of the series of engineering lectures was presented on May 3. Mr. Donald S. Roberts, Assistant Manager of Training for the General Electric Co., presented a talk entitled "Let's Not Worry About Statistics."

A.I.E.E.

A speaker from Dow Corning Silicon Electrical Insulation Corp. will be the main feature of the A.I.E.E. meeting to be held Wednesday, April 26. He will present a talk with slides on the newly developed silicone insulation which has a very high heat resistivity.

Mr. S. K. Guth, head of lighting research at the Nela Park Division of General Electric Company, presented a talk with slides entitled "Light, Vision and Sight" on March 22. Mr. Guth was a former engineering student here at the University, graduating in 1930.

A special meeting was held April 5 at which time the student papers were presented to the society. Papers were read by Donald A. Barber, EE4; Edward A. Ohm, EE4; George J. Weinfurter, Jr., EE3; and a graduate paper was submitted by Richard C. Lathrop.

A.I.Ch.E.

The latest in a series of A.I.Ch.E. meetings was held April 6, featuring Dr. Harris of the Forest Products Laboratory who spoke on the subject "Molasses from Wood Waste." The society is planning to make a field trip through the Forest Products Lab in the near future.

At a meeting on February 16, Dr. Carl Smith of the University psychology department presented a talk entitled "Psychology for Engineers".

Another meeting was held on March 1, at which time Dr. Belknap, associate professor of medicine at Marquette, talked on the effects of toxic fumes, vapors, gases and dusts on industrial workers. Dr. Belknap acts as a consultant on industrial toxicology.

Plans are being made for an election meeting to be held in May. A picnic for the members is also being planned for the same month.

A.S.C.E.

"Research in Cement and Concrete" was the subject of a talk presented to the members of A.S.C.E. on March 30 by Dr. A. Allen Bates, Vice-President in charge of Re-

(please turn to page 26)

ON THE AIR FOR PASTIME!

by Cecil Royce e'50

As an institution of higher learning, the University of Wisconsin cannot be expected to play along completely with the statement, "NEVER let your schoolwork interfere with your education." But "the powers that be" have recognized the necessity of other forms of education besides the purely academic studies, and have added bits to the school for the purpose of enabling students to develop broader interests than just their studies. We have the Union, the Pine Room, and the Truax Service Club to provide meeting places for sexes, and "wreck" rooms and gyms in the dormitories.

For those with electro-technical interests, the University, in conjunction with the armed forces, has provided three amateur radio stations for properly qualified personnel. One station is at the men's dorms, one at Truax, and one at the armory.

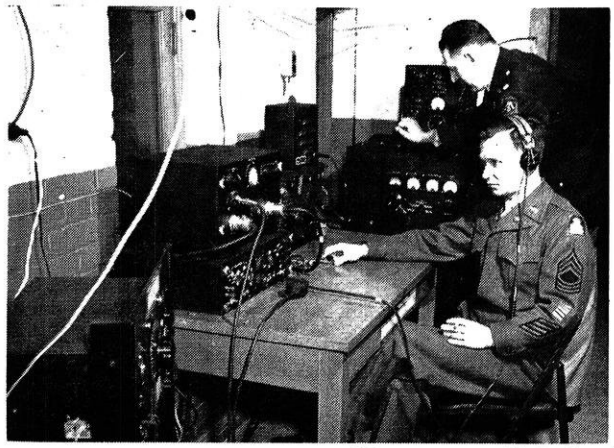
The station at Truax was about to be moved to another location at the time of writing, due to the face that the building was to be closed. The whole project at Truax is to be closed at the end of the spring semester, and the station will be closed with it. The assigned call letters are W9PNE. The antenna system, when the station was visited, consisted of a 28 mc. rotatable doublet, a V antenna for the lower frequencies, and a doublet for 7 mc. The final stage on 7 and 14 mc. is a single 211 using plug-in-coils, and having about 100 watts output. Two exciters are available to drive this stage, and two smaller transmitters provide about 35 watts on 28 and 3.5 mc. All four units are built into tuning unit boxes from a BC 191 transmitter.

Dorm Station

The station at the dorms, with membership restricted to dorm inhabitants, is operating under the call of W9GOC. This unit is sponsored by the Men'es Halls Association, which provides the funds for its operation. The station has been given enough money to get a rather complete set of test equipment. A Channalyst, VTVM, oscilloscope, tube checker, signal tracer, rf. generator, and a BC 221 frequency meter are available. The receiver is a Hammurlund HQ 129, using the same antenna as the transmitter. Break-in operation is not possible. The antenna is an end-fed 270 ft. wire. The present transmitter is an 807 final using plug-in coils, and driven by a Sonar exciter. The final is constructed in a tuning unit box from the BC 375. Plans have been made for a final stage of about 500 watts, using an 813, as soon as someone gets enough ambition to build it. The parts are available and the power supply has already been constructed. The 500 watt unit will be modulated by a paid of 811's. The scope could provide a means of monitoring the phone signals, and the code oscillator provide monitoring for the cw. unit.

ROTC Station

On the top floor of the armory, in the corner devoted to the signal-corp section of the ROTC, is the third of the amateur stations available to students. The station is part of the MARS (Military Amateur Radio System) and has the expressed intention of training amateur operators in military procedure. Designed primarily for "hams" in the reserves of the Armed Forces, the station is available to other amateurs also. In the MARS work, additional frequencies are available outside, but adjacent to the regular "ham" bands. This station is at present available for use by ny amateur during certin hours. There is someone there from 8:30 to 4:30 Monday through Friday, Saturday mornings, and Thursday evenings after 7:30.



(Photo courtesy U. S. Army)

The ROTC station.

The antenna system is a doublet for 8 mc., with a long wire for use on the other frequencies. The transmitters that may be used are a BC 10 for either phone or cw. up to 8 mc. with 500 watts output, a B C 191, and a wideband fm transmitter and receiver. There are 3 receivers for am. reception; a HRO, a BC 342, and a BC 312. The test equipment includes a couple of VOM's, an oscilloscope, and a BC 211 frequency meter. One of the things available at this station, which is not available at the others, is a code machine with an automatic keyer and some tapes, so code practice is possible without someone sending. The tape-code speeds vary from 5 to 20 words per minute. This machine provides a means to learn code for those who are interested, and who have been unable to get adequate assistance.

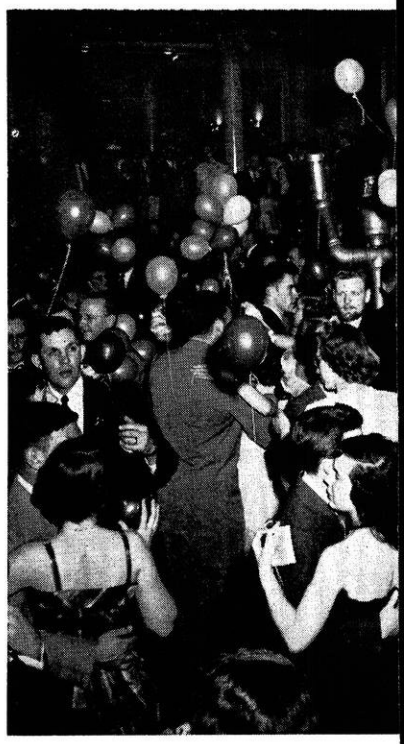
If you are interested in becoming an amateur radio operator and need a higher code speed, come over to the armory and the ROTC personnel will show you how to operate the machine to improve your code reception. If you're already an amateur, use one of the three stations to make new contacts, chew the fat with old contacts, or even, with a little special arrangement, call up home.

(Photo by C. Stapel - B. Krieger)

Above: Fritz Kohli, beard chairman, crowns winner Bob Claypool, St. Pat.

Below: Prizes awarded to beard finalist.

(Photo by Del Desens)



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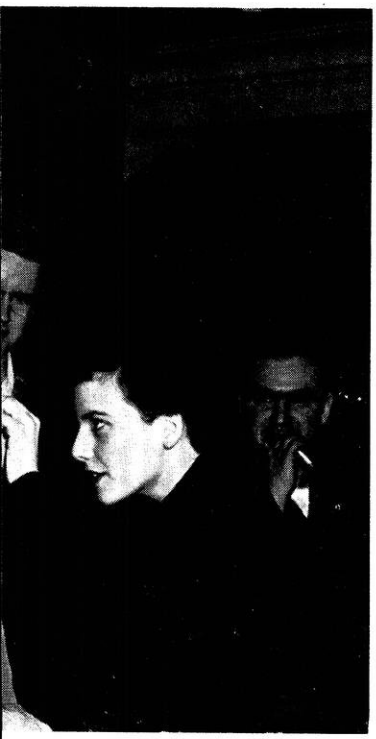
Badger beauty measu

(Photo by Del Desens)

ɔinners
shaved ! !

hopeful candidate.

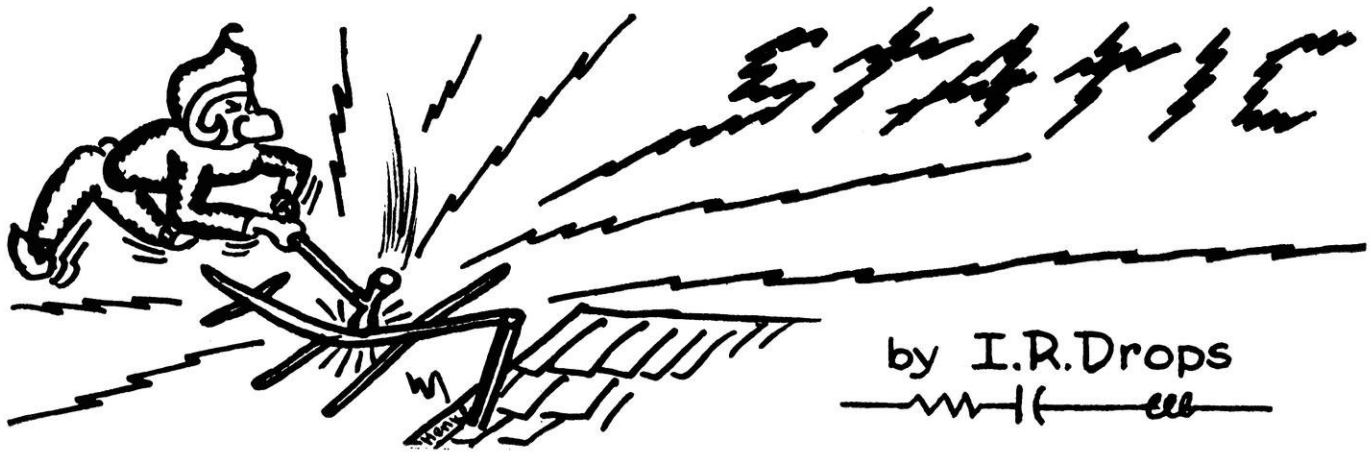


(Photo by Del Desens)

(Photo by C. Stapel - B. Krieger)

Above: Bob Wilson, ME '51, shows date Oscar the Iron Man.
Below: Beard winners.

(Photo by C. Stapel - B. Krieger)



At time T equals zero there lived in a small cavity in a dielectric a poor struggling dipole by the name of Eddy Current. He was deeply in love with a beautiful double layer by the name of Anne Ion, the daughter of an influential force in the town, Cation. Anne was the center of attraction of the young dipoles of the town. Her golden curls, her symmetric line integrals, and her simple harmonic m o t i o n affected the susceptibilities of all the gay sparks. However her father, rich magnet and power factor, had laid down a strict set of boundry conditions for her future husband. Eddy's first contact with her came at the time T equals A. As he passed by a beauty parlor on his periodic orbit, he saw her having a standing wave induced in her filaments. He made a fine sight in his beautiful doublet and it was a case of mutual polarization.

By a coincidence they met at a dissipation function the following night. After a few oscillations to the strains of a number (N) by Mo Mentum and His Incandescent Tuning Forks, the couple diffused into the field outside. There on the Wheatstone bridge the young dipole felt that his big moment had come. "Gauss, Anne, you are acute angle! I am determined that U shall marry me for I sphere I will never be happy without you."

"Oh Eddy, don't be obtuse," said Anne. "Integrate out of here!"

"Anne, are you trying to damp my oscillations? Can't you see I am in a state of hysteresis over you?"

"Now Eddy, be a discreet particle. What will Father say?"

Eddy did not allow her reluctance to phase him, for he knew it was only a surface charge. "I admit I only get paid a low calorie in my present position, but I have potentialities, and I am sure that money cannot B T U of any importance compared to my love."

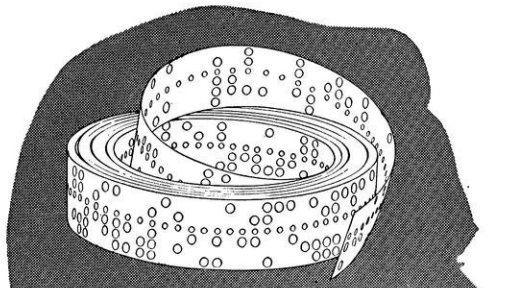
Alas, there was also in this cavity a mean dipole who was resolved to marry the beauteous Anne, using coercive force if necessary. Hearing these murmurings of love he went Pi-ied with fury, and crept stealthily upon the couple with velocity V, his joules drooling with the bestial erg that moved him. "LC Schmidt!" cried Anne.

"What the infra red are you doing here, you flat-bottomed vial villain?" demanded Eddy. The situation grew tensor.

Schmidt advanced to choke the beautiful coil; Eddy offered resistance (R) and his capacity (C) for absorbing the charge (Q) but Schmidt suffered little lost work content in knocking him out to infinity with a severe blow on his negative charge. Eddy made a quick comeback with acceleration A. Stripping off Schmidt's outer electrons, Eddy so upset the villain's equilibrium that he was converted into

(*please turn to page* 24)

Newsworthy Notes for Engineers



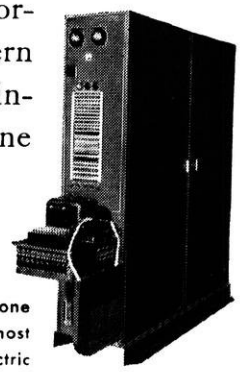
This "Brain" helps make better telephone apparatus

To improve the accuracy of testing Bell telephone switching equipment and to speed up tests during manufacture, Western Electric engineers designed and built a unique test set—known as the Tape-O-Matic—which has a paper tape "brain."

Controlled by a narrow paper tape, punched with coded information, the machine *automatically* performs complicated series of tests. If there is a fault in the equipment under test, the Tape-O-Matic stops, rings a bell and indicates the source of trouble on a lighted panel.

Some 1200 different tapes, varying in length from one to thirty feet, are used for testing various assemblies. Formerly an operator, in testing an average size assembly, had to make 41 individual connections. With the Tape-O-Matic, one multiple plug connection does the job. And 28 preliminary tests, 81 lamp observations and 71 key operations are replaced by one tape insertion and the push of a button.

The Tape-O-Matic can cut testing time as much as 80%—practically eliminates the possibility of human error—and helps to assure equipment of highest quality. It is a good example of the ingenuity, skill and thoroughness which Western Electric engineers put into making Bell telephone equipment.



The 1500-pound Tape-O-Matic is one of the largest, most complex and most versatile test sets that Western Electric engineers have ever devised.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

Engineering problems are many and varied at Western Electric, where manufacturing telephone equipment for the Bell System is the primary job. Engineers of many kinds—electrical, mechanical, industrial, chemical, metallurgical—are constantly working to devise and improve machines and processes for production of highest quality communications equipment.

Static . . .

(*continued from page* 22)

cosmic radiation and vanished in the realms of space, leaving Eddy the resultant vector in the combat.

Old Cation, attracted to the spot by Schmidt's oxidation, beamed upon the young dipole. "Brave young lad," he emitted. "You have satisfied the boundary conditions and by the theorem of uniqueness you are the only one for my daughter."

"Our love will not be transient," said Eddy as he formed a closed circuit about her. "Darling we will raise a one parameter family of second order infinitestimals," murmured Anne happily, as time T approached e . . .

* * *

A lady called the doctor: "My husband has swallowed a mouse!"

"Get back to him," said the doctor, "and try waving a piece of cheese in front of his mouth. I'll come right over."

When the doctor arrived, the man was lying flat on the floor while his hysterical wife was waving a piece of salmon close to his mouth.

"I told you to try cheese," cried the doctor.

"I know that," shrilled the woman, "but I've got to get the cat out first!"

* * *

The young man finally redeemed his best suit of clothes — bringing them home from the pawnshop in a suitcase and promptly forgot about it. When his mother unpacked the suitcase and found a tag on the coat, she called "Bill, what is this ticket on your coat?"

He called back, "Oh, I was at a dance last night and checked my coat."

A moment later mother found his pants tagged the same way. "Bill," she exclaimed, "what kind of a dance did you attend?"

* * *

A young lady, with a touch of hay fever, took with her to a dinner party two handkerchiefs, one of which she stuck in her bosom. At dinner she began rummaging to the right and left in her bosom for the fresh handkerchief. Engrossed in her search, she suddenly realized that conversation had ceased and people were watching her fascinatedly.

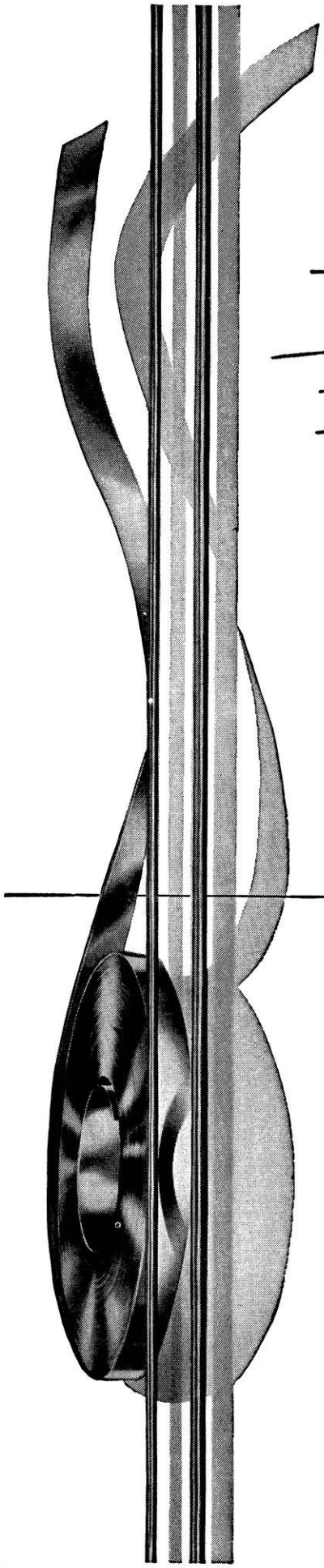
In confusion she murmured, "I know I had two when I came!"

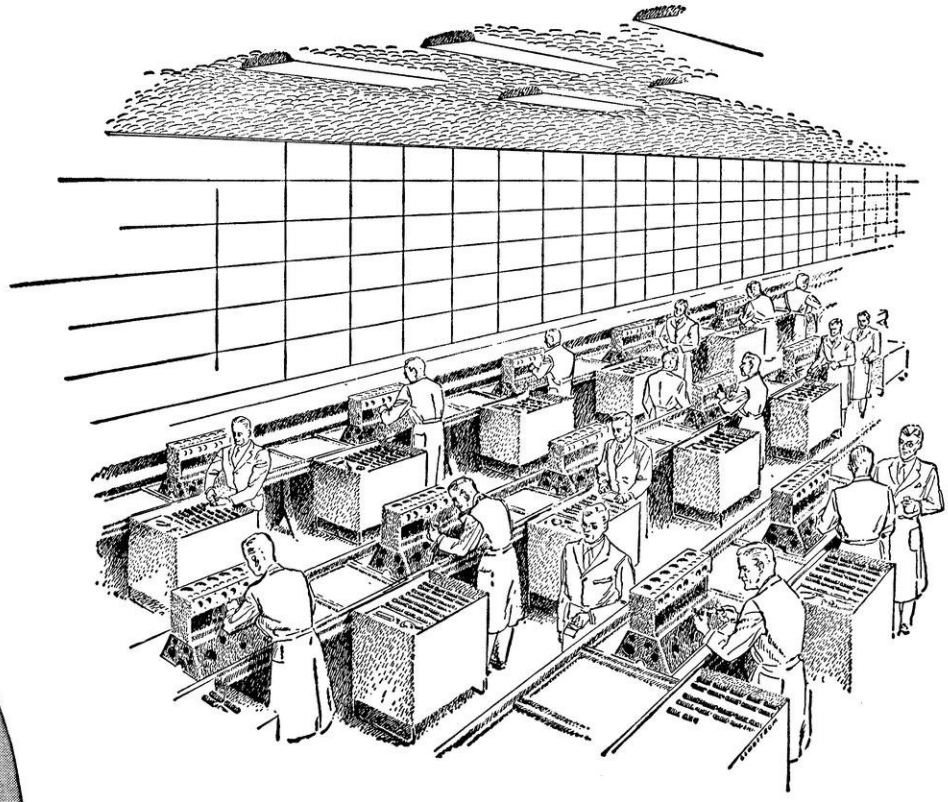
* * *

Deciding to teach her drunken husband a lesson, his wife dressed up in a devil's costume. That night when he came staggering home, all lushed up, she met him at the front door. Through his bleary, blood-shot eyes, he looked her over and said, "Who are you?"

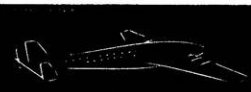
"I'm the devil."

"Well, I'm sure glad to know you. I married your sister."





Better product . . . better production



Roebling Aircord contributes importantly to safe, sure "control in the air".

Roebling Oil-Tempered Spring Wire leads for automotive springs.

Roevar Magnet Wire insulation is 10 to 40 times tougher than other types.

WHEREVER HIGH CARBON WIRE can improve the quality of a manufactured product, Roebling wire can be adopted with complete confidence in results. Roebling is one of the world's largest producers of quality Oil-Tempered Spring Wires and Cold Rolled Spring Steels . . . furnishes wire with physical properties and finishes for almost every purpose under the sun.

But besides bettering your product, Roebling round, flat and shaped wires, bring you better production, too. Every inch of these wires is identical in gauge, grain and finish. Your machine preparation time is lowered; machine stoppages and rejects cut way down . . . Roebling research, special techniques and modern, precision equipment assure wires with definite *plus* values for every user.

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A CENTURY OF CONFIDENCE

Campus - - -

(continued from page 18)

search and Development for the Portland Cement Association.

A lecture of importance to all engineering students entitled "Registration of Professional Engineers" was given by Mr. W. A. Piper at a meeting on April 4.

The A.S.C.E. student papers must be submitted to the national committee by September 10, 1950. The papers may be on technical or popular subjects or may be based on personal experience. The first prize is $50 cash and expenses up to $50 to the annual meeting of the parent society at Chicago on October 11, 12, and 13. Second prize is $15 cash and third prize is $10 cash.

All entries should be mailed to Mr. J. C. Chaderton, University of Illinois, Navy Pier, Chicago 11, Ill.

TRIANGLE

Members of Triangle fraternity went all out in the celebration of St. Patrick's Day. They brought Oscar the Iron Man all the way from the South to help celebrate the occasion. He was displayed in the window of Wagner's Flower Shop during the week before the dance. He presided over the dance from the center of Great Hall, holding an enormous cluster of balloons arising from his upraised hand.

The Blarney Stone, which was displayed in the window of the House of Flowers, was stolen by a group of "shysters" on the morning of St. Pat's Day. Ross Lovington, Triangle house fellow, arriving on the scene, offered to "help" take the Stone in his car. Returning with the car and several engineers, he relieved the "shysters" of the Stone and returned it to its rightful place.

I.R.E.

Four movies — "Coaxial and Radio Standing Waves on Transmission Lines," "Modern Aladdin's Lamp," "Introduction to Radar," and "Operation Cross Roads" — were presented to the members of I.R.E. at a meeting on March 30.

Another meeting is planned for the week of April 24. Mr. John Biggs of Collins Aircraft Co. will give a talk on aircraft instruments. I.R.E. has invited the members of A.I.E.E. to attend this joint meeting. Refreshments will be served.

KAPPA ETA KAPPA

Kappa Eta Kappa will join with Theta Tau fraternity in a Spring Semiformal Dance at the K.C. Hall on April 22.

KHK held two smokers for electrical engineering students. The first was held on March 6, at which time several movies were shown and refreshments served. The second was held on March 30 featuring an evening of refreshments and cards.

JOB OPPORTUNITIES CONFERENCE

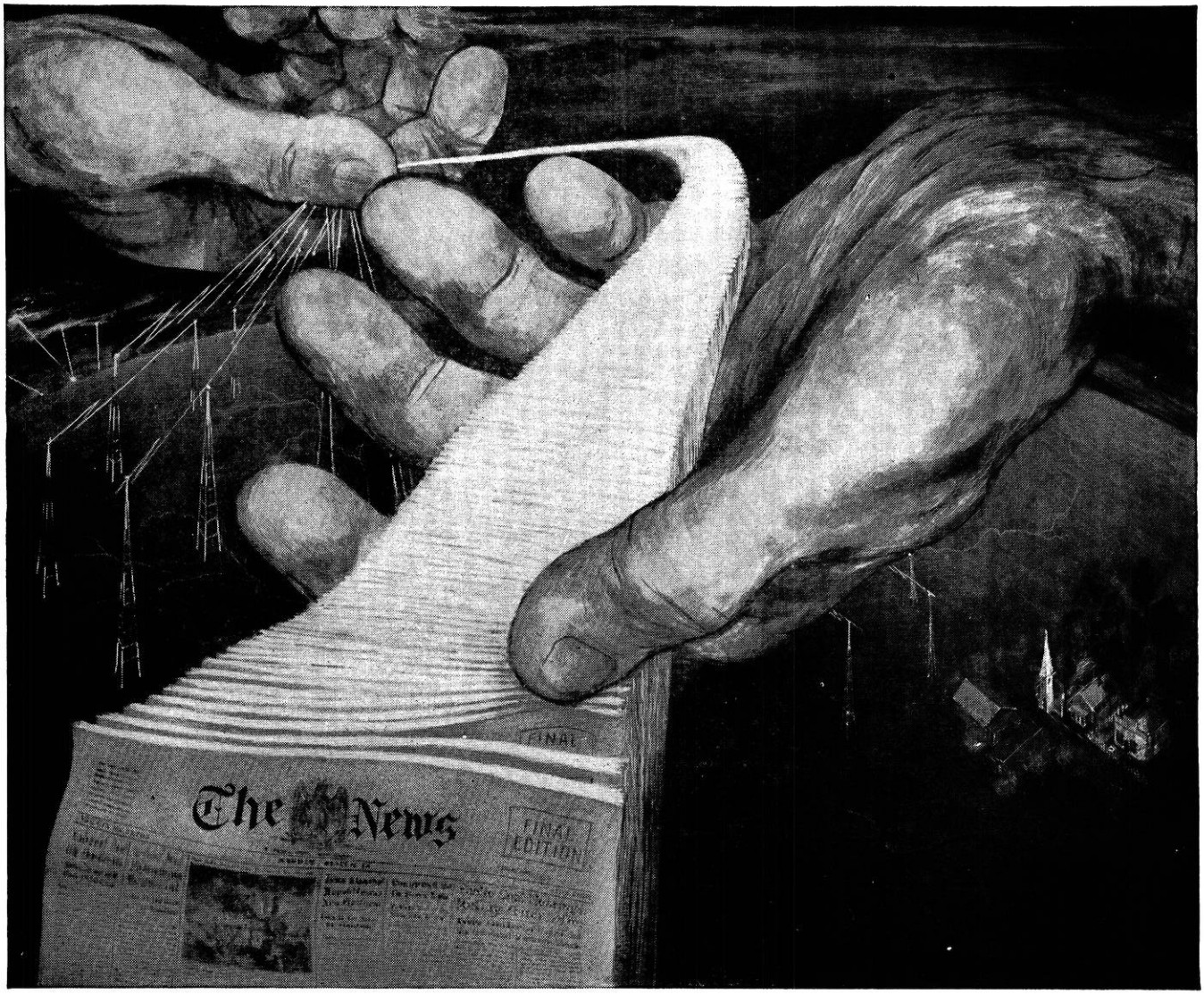
The annual all-university Job Opportunities Conference was held in the Memorial Union on March 28, 29 and 30. The conference began with a general session in Great Hall. The lead-off speaker was Mr. David C. Everest, President and General Manager of Marathon Paper Corporation. The subject of his talk was "Your Job Future."

Topics of interest to engineering students were "Scientific Research," "Personal Management," "Radio," "Engineering Production," "Civil Service," "Industrial Management," and "Engineering Sales."

FINANCIAL STATEMENT OF POLYGON BOARD

July 1, 1949 to December 31, 1949

Cash Balance, July 1, 1949		$653.93
Cash Receipts		
Deposit	$28.75	
		$28.75
Total Cash Available		$682.68
Cash Disbursements		
Activities Circus:		
Pamphlet	$65.50	
Supplies	10.20	
Other Expenses	3.65	
	$79.35	
Presidents Dinner	30.00	
Fall Smoker	26.58	
Campus Chest:		
Supplies	5.00	
Contribution	9.00	
Job Forum	38.35	
Badger Pictures	6.50	
Keys	54.60	
Total Cash Disbursements		249.38
CASH BALANCE, Dec. 31, 1949		$433.30



Today's News—Today!

THE AMAZING SPEED and accuracy with which news comes to us are genuine tributes to the great newspapers, and the news services, to radio and television—and the people who staff them.

It's a story of communications. Radio flashes words—by voice or teletype—across continents and seas with lightning speed. Pictures move as fast. And today television and photography are used in a method to transmit instantaneously and reproduce full pages of printed, written, or illustrated matter in the *original form!*

Electronics is the basis of such speed. Special metals are required for the tube electrodes. Plastic insulations keep high frequency current in right circuits. Carbon's unique electrical and mechanical value is used to control power.

In supplying these materials, and many needed chemicals, UCC has a hand in getting the news swiftly to you. The people of Union Carbide also produce hundreds of other basic materials for the use of science and industry.

FREE: *If you would like to know more about many of the things you use every day, send for the illustrated booklet "Products and Processes." It tells how science and industry use UCC's Alloys, Chemicals, Carbons, Gases, and Plastics. Write for free Booklet B.*

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Army - - -

(*continued from page* 12)

Special buildings constructed included theaters, chapels, service clubs, guest houses, radio station, incinerator, bakery, post office, telephone office, fire stations, cold storage building, and a laundry. The laundry was the most expensive building on the post, and cost nearly one-half million for building and equipment.

Approximately 35,000 troops and officers were to be quartered at this post. Some idea of the magnitude of the housing problem may be gained by reading the following list of buildings constructed as of January 1942. This is not the completed total.

314 Barracks (63 men each)
44 Barracks (45 men each)
21 40-man officers quarters
9 Commanding officers quarters
13 Hospital barracks
112 Enlisted man mess halls
12 Officers messes
1 1000 man cafeteria mess
5 Hospital messes
111 Company recreation rooms
16 Regimental recreation rooms
12 Post exchanges
3 Theaters
23 Administration buildings
64 Company storehouses
25 Warehouses
2 Quartermaster utility shops
15 Motor repair shops
11 Infirmaries
5 Clinics
27 Hospital wards
1 Morgue
1 Post office
1 Telephone and telegraph building
1 Radio transmitter building
11 Guard houses
9 Gas stations
4 Fire stations
1 Guest house
1 Service club
1 Cold Storage Building (28,000 man capacity)
1 A.C. hangar
1 Laundry (40,000 man)
2 Magazines powder
1 Ordnance shop
3 Boiler houses
Extensive railroad facilities
Coal trestle
Bridge across Kalamazoo River

Additional work to be completed included grading and road construction. In addition, the entire post was land-

(*please turn to page* 30)

New scintillation counter, using electron tube developed at RCA Laboratories, gives faster, more accurate measurements of atomic radiations.

What can you hear through an ***ear of grain*** *?*

When agriculturists want to learn what nourishment a plant is getting, they inject radioactive materials into the soil and trace their absorption with sensitive instruments. Industry and medicine also use this ingenious technique to gain needed knowledge.

Until recently, scientists literally *heard* what was happening, for they followed the passage of atomic materials through plants or machines, or even the human body, with a clicking Geiger counter. Now a more sensitive instrument—*a new scintillation counter* made possible by a development of RCA Laboratories—can do the job more efficiently.

Heart of this counter is a new multiplier phototube, so sensitive that it can react to the light of a firefly 250 feet away! In the scintillation counter, tiny flashes, set off by the impact of atomic particles on a fluorescent crystal, are converted into pulses of electrical current and multiplied as much as a million times by this tube.

* * *

See the newest advances in radio, television, and electronic science at RCA Exhibition Hall, 36 West 49th Street, New York. Admission is free. Radio Corporation of America, Radio City, N. Y.

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.

RADIO CORPORATION of AMERICA

World Leader in Radio — First in Television

Army - - -

(continued from page 28)

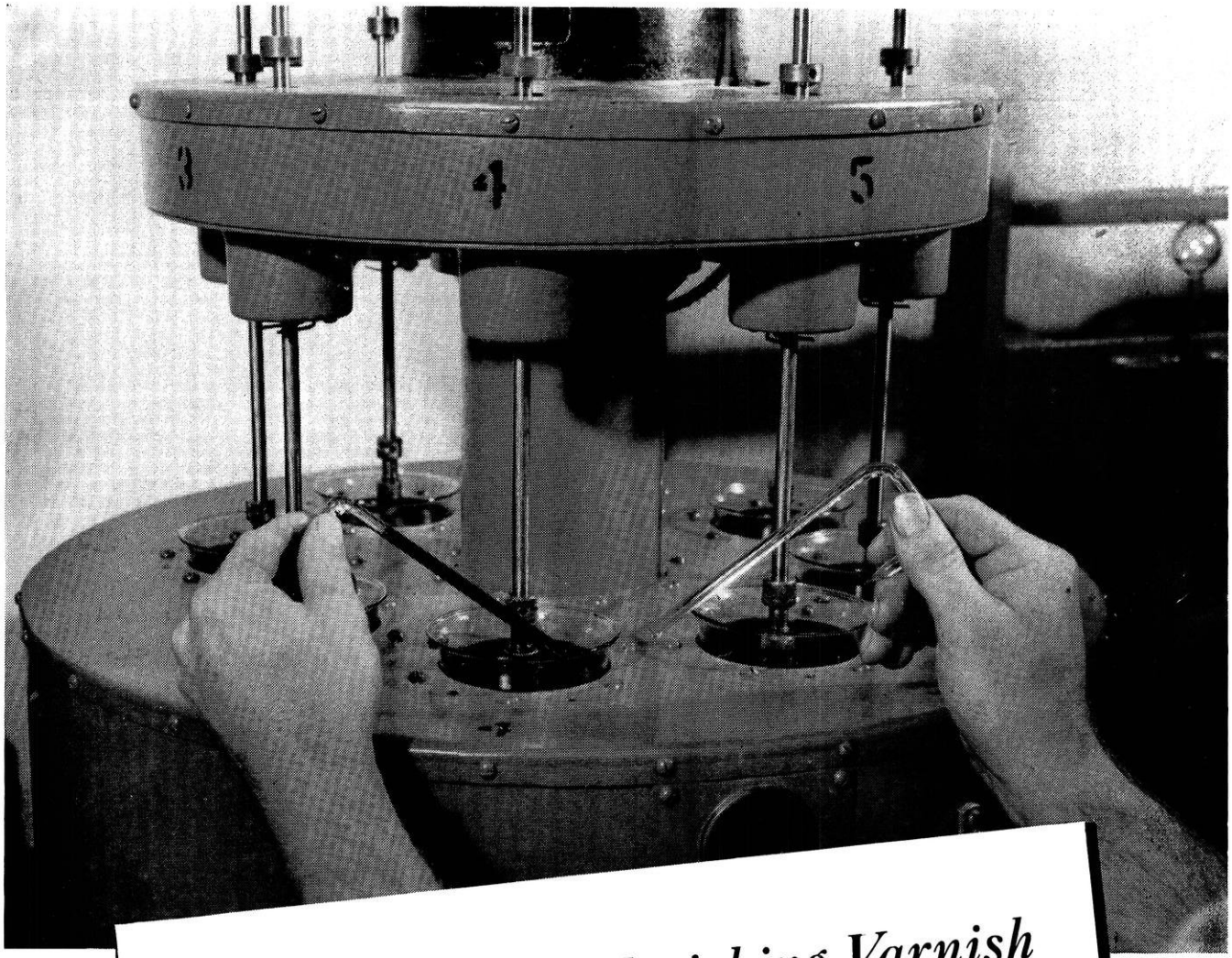
scaped, and provisions were made to prevent soil erosion.

This project was constructed under what is known as the "Lump-Sum" contract system. Under this system, the contractors are awarded contracts either by competitive bidding or by negotiation. This lump-sum includes all fees and amounts due the contractor, and the only amounts paid additional are those determined by an approved change order. The negotiation system is used only when time is insufficient for normally advertised bidding.

On 15 January 1942 I left Ft. Custer and was sent to Pine Camp, New York, to complete that project. Instead of being a lump-sum project, this was a cost-plus fixed fee project. This type of contract is often used where plans and specifications are incomplete, and insufficient time or information is available for normal bidding. Here a contract is negotiated with a contractor, or group of contractors, to do the work, and he is guaranteed a fixed fee above his cost to do the work regardless of how the cost goes. Comparing this project to Fort Custer, the typical barracks at Pine Camp cost double those at Custer. Another difference on this project was the fact that the architect-engineers for the project were hired under contract, instead of being a part of my own organization as at Custer.

My next assignment was the construction of a large ordnance plant, the Symington-Gould ordnance plant at DePew, New York. This plant was erected to provide cast steel armor plate for tanks, and is one of the most modern foundries in the nation. It is entirely artificially lighted and ventilated. This plant was built two and one-half months ahead of schedule and 30% below estimates. It is noteworthy that a Wisconsin firm, the Trane Company of LaCrosse, furnished the ventilation equipment. About 15 unit ventilators, each with a capacity of about 135000 CFM, were mounted under the roof of the main building. Another Wisconsin firm, the Harnischfeger Corporation of Milwaukee, furnished a large number of various sizes of electric traveling cranes on this project. Many new problems arose on this project, as it was an addition to an existing plant. The historical records were inaccurate, and so no one knew the exact location of all the underground utilities, of which there were many types, air, water, gas, etc. Several types of electricity were used, 220 volt dc on the cranes, 60 cycle and 25 cycle ac, and various voltages and phases.

While stationed at Seoul, Korea, I was post engineer for Camps Seoul and Sobingo. Here I was responsible for the maintenance and repair of all military facilities in the area. These included hotels, apartments, office buildings, public buildings, residences for dependents, refrigeration plants, ice plants, sewage disposal, fuel supply, utilities, and water supply.



The Case of the Vanishing Varnish

VARNISH PAINTS a grim picture inside an engine. Oxidation of motor oil under operating conditions is largely responsible for varnish accumulations which result in sticking rings and valves, sluggish pistons, loss of power.

The varnish problem, however, has been all but conquered by Standard Oil lubricants. Today our heavy-duty and premium-type oils contain additives—oxidation inhibitors plus detergents that keep engines cleaner, keep them running longer and enable them to deliver more power.

We learn about these additives and what they will do by subjecting our oils to a variety of tests. For example, we devised the Indiana Stirring Oxidation Test (which is performed on the machine in the picture) to provide data that would help solve the varnish problem. It is helping solve that problem. Other tests are leading to other improvements.

• • •

Behind all the tests are the men of Standard Oil. It is their obligation never to be satisfied —to believe that improvements are not only possible but necessary. Thus they maintain this company's leadership in research, and help provide our customers with products that steadily increase in quality and usefulness.

Standard Oil Company

(INDIANA)

STANDARD

WHA - - -

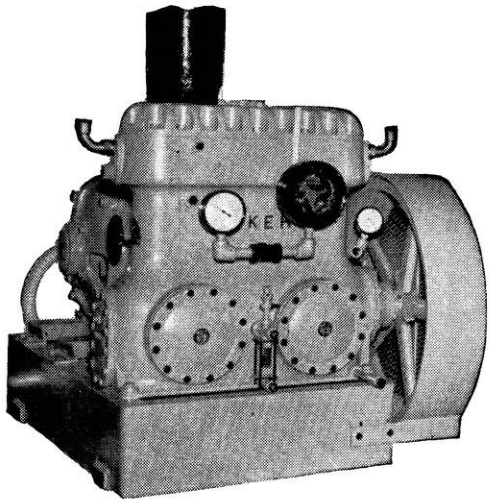
(*continued from page 8*)

disc recorders. Because of the greater fidelity, portability, and economy of magnetic tape recordings, their use at the station has greatly increased. The recorders can provide continuous transcriptions of programs up to one hour in length. In addition, if the one-hour tapes are run twice as fast, greater fidelity is obtained for half-hour programs.

Present telephone lines from all over the campus will enter the recording room switching panel. From here they may be connected to any of the recorders, to the transmitter, or both. The amplitude response of the lines is approximately "flat" to 15,000 cps (as are the tape recordings) so that no distortion is introduced in the remote pick-up program before it is put on the air. This is necessary if the full advantages of FM fidelity are to be obtained.

In tracing the growth of the State Stations from the original WHA to the present WHA-FM and the FM network, one is amazed at the great strides taken in radio as well as radio education. It certainly seems that Prof. Terry was more than accurate when, after World War I, he predicted that some day wireless sets would be as common in homes as bathtubs.

Another page for **YOUR BEARING NOTEBOOK**



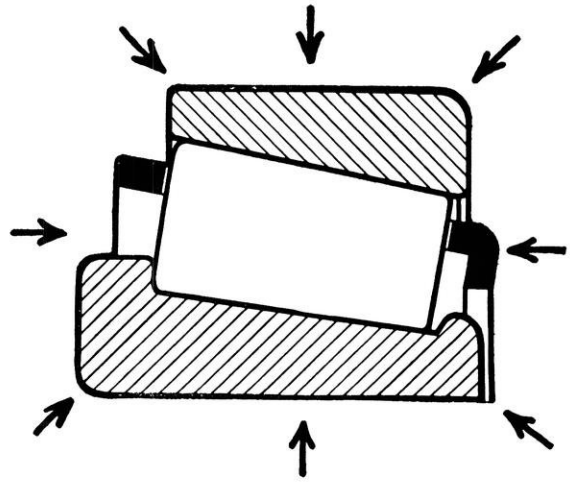
Crankshafts stay rigid ... foods stay frigid

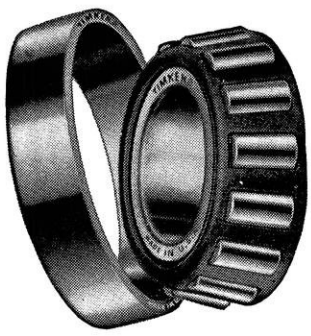
Designers of a compressor for refrigeration plants were looking for a way to insure smooth, dependable crankshaft operation. They couldn't risk the chance of breakdowns—and the food spoilage that might result.

They stopped possible trouble at the design stage —by mounting the crankshafts on Timken® tapered roller bearings. Timken bearings take the heavy radial, thrust and combination loads, prevent shaft wobble, insure trouble-free service with minimum maintenance.

Q: Short on space? A: TIMKEN® bearings!

Because Timken bearings have a *tapered* design, they carry loads from all directions. No separate thrust devices needed. Also, Timken bearings have *line* contact between rolls and races. This gives them greater load capacity, permits use of smaller bearings. The space-saving feature is another reason why 9 out of 10 bearing applications can be handled more efficiently by Timken bearings.





TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Want to learn more about bearings?

Some of the important engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For additional information about Timken bearings and how engineers use them, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION

Science - - -

(*continued from page* 16)

minutes past each hour. They consist of the letters W, U, or N, indicating warning, unstable conditions, or normal, respectively.

Controlled measurements of the ionosphere itself are essential to the warning service. The most important single aid is the magnetograph which measures the variations of the horizontal component of the earth's field. Radio disturbances have been found to be closely related to abnormal activity of the earth's magnetic field. Although years of study have shown a very close association between solar activity and terrestrial disturbances, it is not certain that activity seen on the sun has anything directly to do with radio propagation storms.

Magnetic storms have been found to affect the higher frequencies of radio transmission more than the low. The high frequencies rely on an ionized reflecting layer and during a radio storm, it has been found that this upper (F2) reflecting layer has an abnormally great height. Given a forewarning of a propagation disturbance, a radio operator can take steps to minimize its effect by changing to lower frequencies or rushing priority messages.

SYNTHETIC MICA

Synthetic mica, very similar to natural mica, but able to withstand even higher temperatures, has been crystallized successfully by scientists at the government Bureau of Standards. This work is part of a research program being carried out on fluorine-type artificial minerals.

Rather than try to crystallize mica under high temperature and pressure as it naturally is, the scientists are using fluorine as a crystallizing agent. Because fluorine is poisonous and difficult to control, synthetic fluorine compounds, fluorosilicates, provide a convenient way of introducing fluorine into mica synthesis.

The raw materials for making mica are quartz, magnesite, bauxite and a fluorosilicate compound. These are placed in a platinum-lined crucible and melted at a temperature of 1400 degrees C. As the mixture cools, mica crystals grow from a tiny seed at the bottom of the crucible. The most satisfactory synthetic mica developed has the chemical formula $K_4Mg_{12}Al_8Si_{12}O_{10}F_8$.

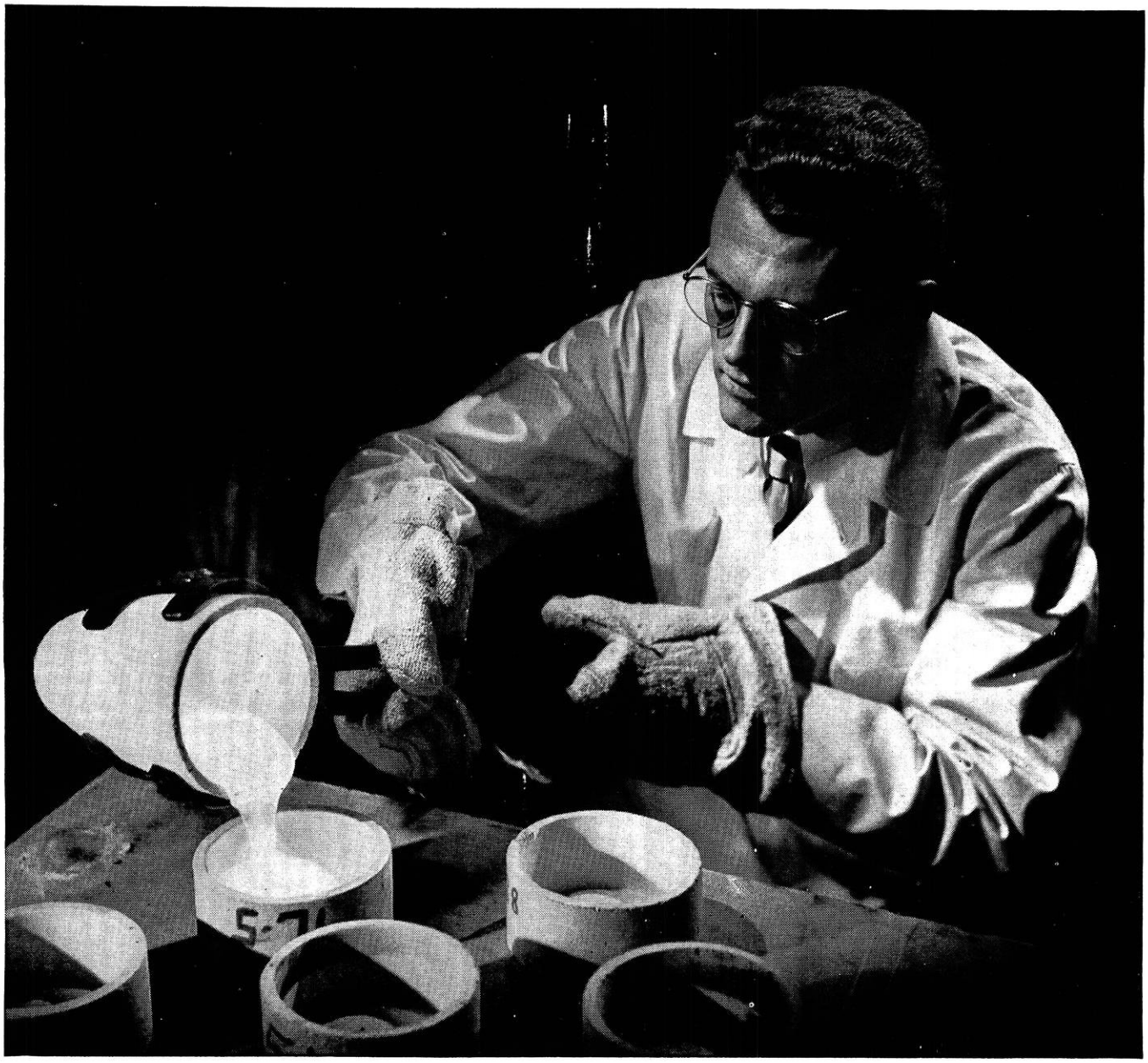
Impurities may occur in the synthetic mica causing milky films in the sheetlike structure, however its physical properties compare favorably with natural mica. Mica is a particularly good insulator in the electronics industry and the United States produces only one-third of its consumption.

ALKALIES IN PORTLAND CEMENT

The content of sodium and potassium oxides in portland cement sets an important limitation on its use for many applications. When the cement is mixed with crushed rock or gravel to make concrete, for example, the alkalies may sometimes react with soluble silica present in the aggregates. This causes expansion of the concrete, resulting in cracks and a weakened structure.

Gravimetric determination of these alkali oxides in cement is time-consuming and expensive. As an alternate method, the Bureau of Standards has devised a method of photometric determination.

The solution to be analyzed is atomized into a flame and the intensity of its spectrum is compared to that of standard solutions of known alkali concentration. For accurate results, the standard solution should produce a similar excitation condition as that produced by the cement solution. This means proportions in both known and unknown solutions should be about the same. Therefore, a series of standard solutions containing CaO and HCl were prepared by the Bureau so that the flame photometry tests might be made with closer to ideal conditions.



He uses 7/8 of the earth's elements in his cooking

If you've always thought of glass simply as a substance made of sand, soda, and lime, we believe this will surprise you:

Corning scientists, such as the one you see here cooking up a batch of experimental glass, *have actually made glass using 84 of the earth's presently known 96 elements.*

Nearly 3000 of these experimental glass compositions are turned out every year, as Corning scientists search for new and useful ways to combine nature's elements.

Already Corning has developed more than 50,000 formulas for glass. Just as alloys make metals more useful, these 50,000 formulas make glass more useful—enlarging its applications in untold and sometimes surprising ways.

Corning makes glass so strong that it can be used as piping in a steel mill. Corning makes glass so soft that it can be melted with a match—and glass so resistant to thermal shock that it can be heated to a cherry red, then plunged into ice water without its breaking.

Today, throughout industry, *Corning means research in glass*—research which, along with a multitude of other developments, has made glass one of today's most versatile engineering materials.

Corning is constantly turning up new kinds of glass, new uses for existing ones. So when you're out of college, and concerned with product or process improvement, it will pay you to call on Corning before your planning reaches the blueprint stage. *Corning Glass Works, Corning, New York.*

CORNING
means research in glass

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Possibly we should stop searching for anv more of these special triangles now that it has been established there is one which fits every positive integer larger than two. There are, in fact, limiting cases of 1-0-1 and 2-0-2 for the integers one and two when the identities are applied. Yet we sometimes happen across an example which cannot be classified according to either of the two groups established heretofore. The single integer, 20, is a part of no fewer than five different configurations, 12-16-20, 15-20-25, 20-21-29, 20-48-52, and 20-99-101, two of which may be applied to no integer smaller than 20. Furthermore one lies outside our defining identities. We are forced to look for a new defining relation.

There happens to be just such a relation which arises in the most round-about way. Going back to the double-angle formula from trigonometry, we recall:

$$\tan 2\theta = \frac{2 \tan \theta}{1 - \tan^2\theta}$$

Now, if $\tan \theta = a/b$, an integer fraction, then

$$\tan 2\theta = \frac{2a/b}{1 - a^2/b^2} = \frac{2a/b}{1 - a^2/b^2} \cdot \frac{b^2}{b^2} = \frac{2ab}{b^2 - a^2}$$

Thus, $\tan 2\theta$ is still an integer fraction, and 2ab along with $(b^2 - a^2)$ may be used to form the two legs of a right-angle triangle. Further, obtaining the square root of the sum of their squares reveals the third side, or hypotenuse, to be $(b^2 + a^2)$. Therefore, the three sides of the triangle so formed are all integer values. Given any integer fraction, a/b, less than unity, a right-angle triangle follows.

The following form, with a few examples, is suggested for the mass production of these oddities. It is further suggested that the investigation proceed systematically with integer fractions such as 1/2, 1/3, 1/4, 1/5, 1/6, etc., until it becomes evident just what type triangles will appear later. Then, begin with 2/3, 2/4, 2/5, 2/6, 2/7, etc., until a new series unfolds. Each numerator, when used in combination with the successive integers as a denominator, will produce a series of triangles which may be formed by inspection after the first four or five examples.

a	b	a^2	b^2	2ab	$b^2 - a^2$	$b^2 + a^2$	Triangle
1	2	1	4	4	3	5	3 - 4 - 5
2	7	4	49	28	45	53	28-45-53
3	8	9	64	48	55	73	48-55-73

The preceding discussion is largely purely theoretical and may appear to have little practical application. Yet, it

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has been presented to spur an interest in these phenomena and has been presented with the hope the reader will come into closer working contact with the readily available network of facts and data which are number theory.

Probably no shoe fits like an old shoe. Likewise, we must get some wear on the information presented in this and the preceding parts through everyday practice or we will become little accustomed to its use.

There are problems everywhere throughout engineering curricula which involve the addition of vector quantities in a two-dimensional system. Every one of these problems can be reduced to the mere solution of a right-angle triangle. Given the X and Y components of two or more vector quantities, the situation often arises that the sum of the vector components along one of the axes will predominate. An example is an alternating-current electrical circuit analysis with some reactance, but largely resistance prevailing. Another problem is a turbine stage velocity diagram where either the X or the Y component may be small upon comparison with the other, depending whether inlet or exit velocities are in mind.

As an example, we will assume a resistance, $Rx = 110$ ohms, and the net reactance, $Ry = 15$ ohms. Applying methods which have been presented heretofore, we may reason $R^2y = 225$. We also know that the interval between 110^2 and 111^2 comprises some 221 units. We may simply state that if, $Z = \sqrt{R^2x + R^2y}$, then $Z \cong 110 + \frac{225}{220}$

$\cong 111 + \frac{4}{222} \cong 111.018$ ohms.

Three decimal places are determined easily in this instance from the knowledge that 1/111 is very nearly 0.009, and 4/222 is therefore nearly 0.018. The decimal places are not justified, however, if the accuracy of the electrical measurements does not include a corresponding number of significant figures.

Or, in a turbine problem, given an equation

$$V4 = \sqrt{V^2x + V^2y}$$

with the data, $Vv = 410$ feet per second, and $Vx = 50$ feet per second.

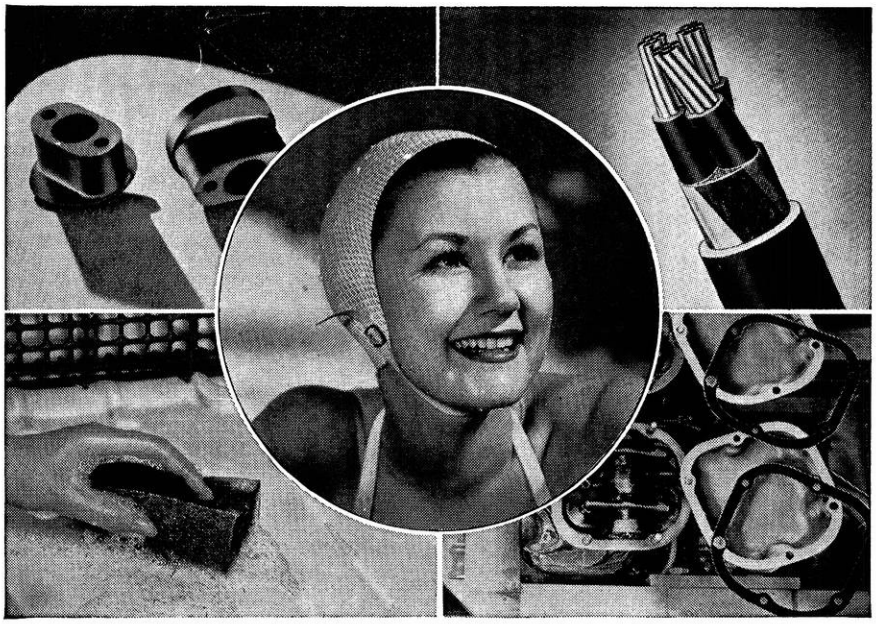
We ascertain $V^2x = 2500$ units. Applying these units to the task of increasing the square of Vy to include the square of the next and succeeding integers, we may decide that hardly more than three additional integers may be encompassed. It takes 821 units to get from 410^2 to 411^2, an additional 823 units are required to get from 411^2 to 412^2, and lastly 825 units are required to get from 412^2 to 413^2. Including three significant figures, our solution is, $V_4 = 413$ feet per second. By careful tabulation, however, we could easily establish that some 28 units re-

(please turn to page 40)

THE DU PONT DIGEST

With the development of Neoprene Type W

Science Again Outpoints Nature



Motor mountings, wire and cable, sponge, gaskets, swim caps are among possible uses for Du Pont's new Neoprene Type W.

NEOPRENE — the chloroprene rubber produced by Du Pont research—has long outpointed natural rubber on many counts. Because of its greater resistance to chemicals, flame, heat, sunlight, weathering, oxidation, oils, grease and abrasion, it is widely used in such products as industrial hose, conveyor and transmission belts, insulated wire and cable, hospital sheeting, gloves and automotive parts.

Until recently, however, certain natural rubber compositions couldn't be beaten when it came to "permanent set" characteristics. Released from the pressure of prolonged deformation, they returned more nearly to their original shape.

This recovery factor is important to some manufacturers, particularly the people who make gaskets, seals, diaphragms, sheet packing, soft rolls and vibration-dampening devices.

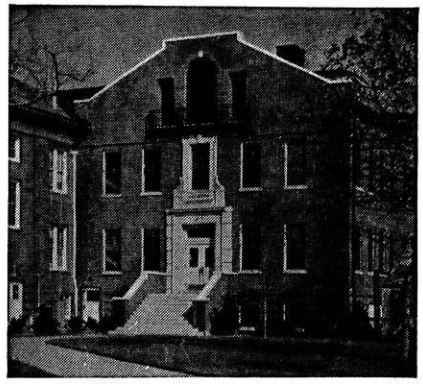
NEW PRODUCT NEEDED

Much as they wanted to use neoprene because of its other superiorities, they often needed more resistance to permanent deformation than it afforded. So they used natural rubber, but were never quite satisfied with the way it resisted deterioration in severe service.

Du Pont scientists went to work to solve the problem. Skilled research chemists, physicists, engineers and others pooled their efforts. The result was a new polymer named Neoprene Type W.

NEOPRENE TYPE W INTRODUCED

Chemically, the new neoprene is quite similar to previous types. But its molecular structure has been changed so that the mechanical properties of its compositions are more nearly like those of rubber. With Neoprene Type W, it is possible to producevibration-dampeningdevices that are not only highly resistant to oils, heat, grease and sunlight, but recover better than rubber from prolonged pressure.



Jackson Laboratory, Deepwater, N. J., one of Du Pont's laboratories which participated in the development of Neoprene Type W.

Neoprene Type W also provides the basis for compositions that have a low modulus of elasticity—are easy to stretch. More attractive colors are possible. Soon it may appear in such articles as swim caps, where bright colors and head comfort are important. The brighter-colored compositions should also appeal to makers of appliance cords, coasters, sink mats, stove mats and toys.

In developing the uses of Neoprene Type W, Du Pont is working with hundreds of manufacturers and distributors. Once again a "partnership" of big and small businesses will cooperate to give Americans the benefits of an advance in science.

★ ★ ★

SEND FOR "The Story of Coal, Air and Water," a 28-page illustrated booklet describing the chemical ingenuity behind the development of neoprene, nylon, and other products. For your free copy, write to the Du Pont Company, 2503 Nemours Bldg., Wilmington, Delaware.

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main as an additional increment beyond 413. These units comprise but 28/827 of the interval toward 414. If the additional accuracy is justified, we may state, $V_1 = 413.03$ feet per second.

Conversely, if the hypotenuse is known, along with a proportionately small side, the other side may be readily determined. For example, given: $F = \sqrt{F^2x + F^2y}$, where,

$$F = 2000 \text{ pounds, and } Fy = 600 \text{ pounds.}$$

Nearly 4000 units in terms of F^2y are required to give an Fx a single pound less than F, itself. As it happens, $F^2y = 360{,}000$ units, or enough for 90 such intervals. Now, we may state cautiously that $Fx = 1{,}910$ pounds, realizing at the same time that we have applied an approximation formula which is only nearly exact for the **first** interval through **89** additional increments. Yet, if we perform the actual solution by longhand methods, the four-place answer is, $Fx = 1{,}908$ pounds. The accuracy of the method is very closely 99.9% whereas the angle involved is the arcsin 0.300, or approximately 17.5°. We mention this because the accuracy depends upon the acute angle involved, and not the length of the sides. You may verify that the method is approximately 99% accurate where the angle is 30°. Since either one acute angle or the other, in a right-angle triangle, has a good chance of being smaller than 30°, the method may be employed over a wide range of applications.

In assuming $Fx = F - \frac{F^2y}{2F}$, we introduced an error of a single unit in the first application of the approximation, three units error in the second application, then 5, 7, 9, ..., 179 units error in the succeeding approximations. In all the accumulative error was:

$$1 + 3 + 5 + 7 + \ldots\ldots + (2n - 1), \text{ where } n = 90.$$

From our earlier discussion we should also recognize the sum of our accumulated error, the series above, as being the square of 90. Therefore, the accumulated error after 90 intervals is 8100 units. These, in turn, suggest that two more intervals may be included, or $Fx = 1908$ pounds.

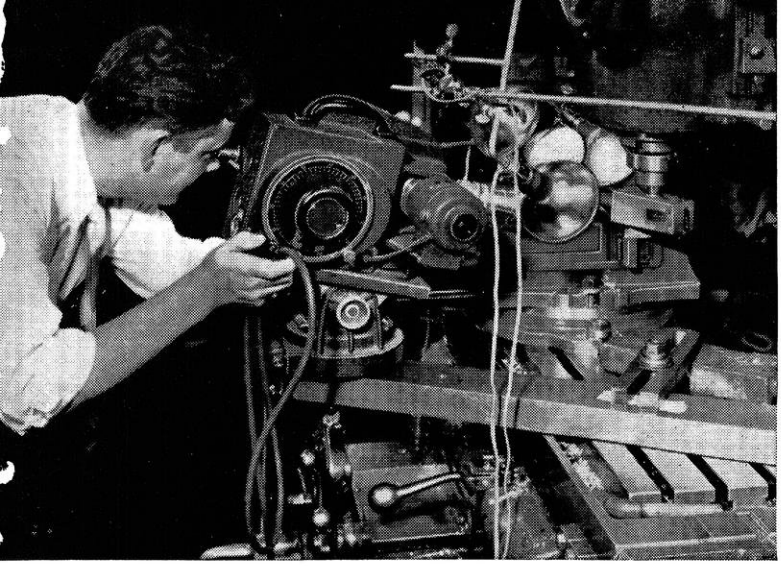
As a matter of fact, we may tabulate the problem as below and arrive at any desired degree of accuracy.

$$Fx = 1910 - 8100/(1910 + 1909)$$

$$= 1910 - \frac{3819}{3819} - \frac{4281}{3817}$$

$$= 1909 - \frac{3817}{3817} - \frac{464}{3817}$$

$$= 1908 - 0.12 = 1907.88$$



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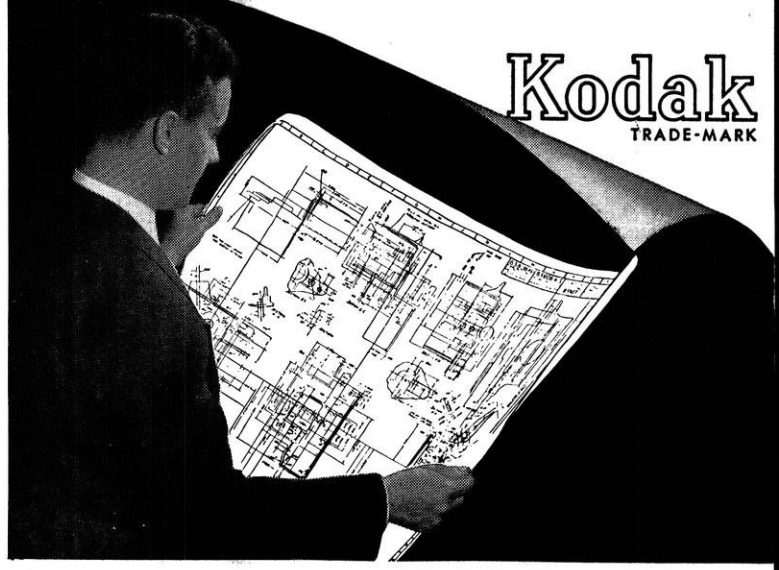

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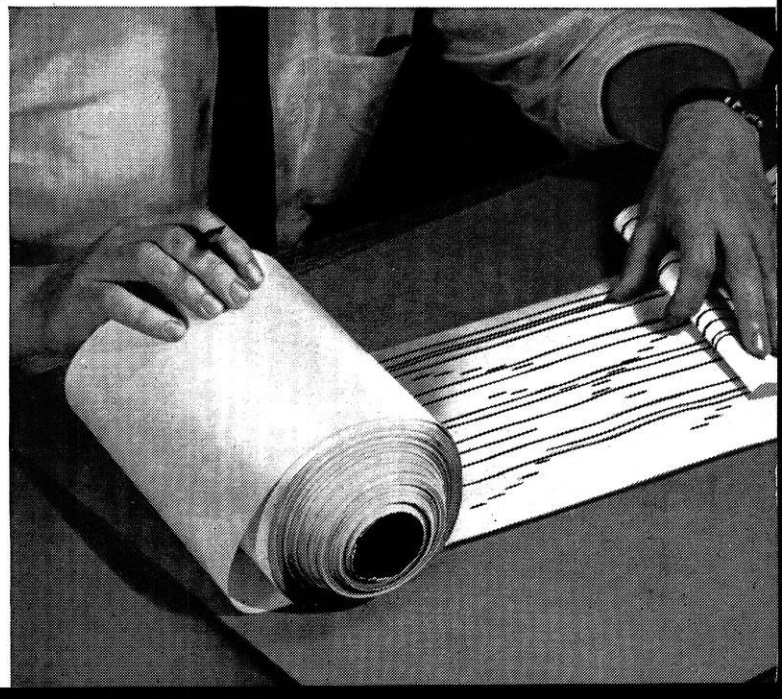

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