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The Wisconsin Engineer

FEBRUARY **1936**

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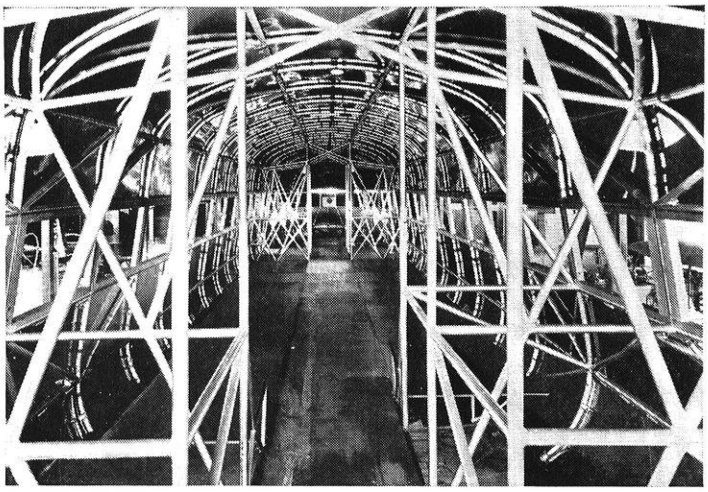


HERE'S HOW—the framework of the light weight, streamlined rail cars for high speed is Lindewelded from chrome-molybdenum steel tubing.

Mastery over all Metals

Welding Makes Jointless Structures Possible in Practically All Commercial Metals and Alloys

By A. B. KINZEL*

One great advantage of using welding is that practically every commercially available metal and alloy can be made by this means into a jointless assembly.

Contributes to Home Comforts

Numerous articles fabricated by welding are found in most homes. Familiar ones cover a wide range of metals—kitchen ware and furniture of aluminum, copper and stainless steel; copper tubing in refrigerators, sheet metal in refrigerator boxes; kitchen cabinets and gas ranges; water pipes of copper, brass, iron and steel; furnaces and hot water tanks of strong heat-resisting irons and steels. Even the tiny alloy wire elements in radio tubes are welded.

Simplifies Automobile Maintenance

Automobile manufacturers use welding for innumerable assemblies where your safety and comfort depend on permanent strength and tightness. The modern automobile repair man also uses welding. With welding he quickly restores broken parts to use again. Steel bumpers, fenders, frames are readily made jointless by welding—as strong as or stronger than the original piece. Cracked cylinder blocks and broken aluminum crank cases are welded. Valves and valve seats are made service free by welding a thin coating of Haynes Stellite to the wearing surfaces to give longer life and added thousands of low cost miles.

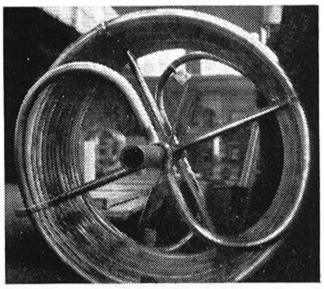
Aids Industrial Users

In industry—for tanks, containers, piping and a wide variety of other machinery and equipment of all sizes, shapes and metals—the use of welding is even more extensive.

Welding Marches Ahead

The wide-spread use of welding for various metals and alloys has been due largely to constant advances in technique and materials. Typical among these is the development of Lindewelding, a procedure for the rapid welding of steel pipe and plate. Speed increases of 50 to 65 per cent and material savings of 25 to 50 per cent over previous methods have been made.

Bronze-welding, welding with a bronze welding rod, is widely used for both repair and production. Smooth joining of metals or alloys of different compositions can be accomplished by bronze-welding. Steel can be bronze-welded to cast iron, bronze and copper can be joined, brass and steel plate can be united.



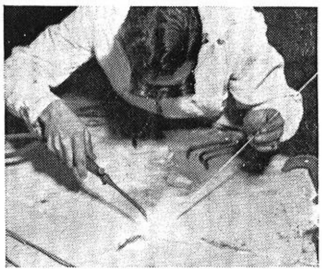
EVERY METAL—responds to the oxy-acetylene blowpipe. This stainless steel coil for cooling milk has welded joints.

Makes Modern Metal Designs Jointless

Exact procedures for the welding of corrosion-resistant steels and alloys have been developed. Welds so made are sound, strong and ductile. Resistance of the welded joint to corrosion makes it valuable also for use in joining special alloys such as Monel Metal and Everdur. Welded aluminum alloy chairs, tables and other furniture have been made possible through the development of special aluminum welding rods.

At Your Command

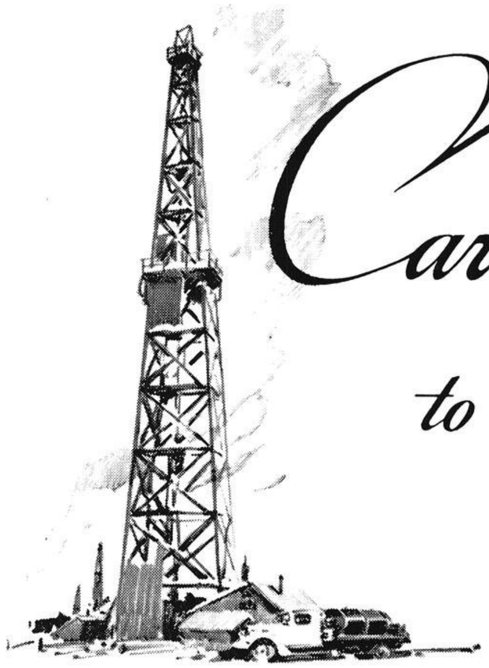
Modern welding technique, plus the great variety of metals and alloys on the market today provide many new possibilities for your products. Information and data which will help you use welding to wider advantage may be had from the nearest Sales Office of The Linde Air Products Company, a unit of Union Carbide and Carbon Corporation. These are located at Atlanta—Baltimore, Birmingham, Boston, Buffalo, Butte—Chicago, Cleveland—Dallas, Denver, Detroit—El Paso—Houston—Indianapolis—Kansas City—Los Angeles—Memphis, Milwaukee, Minneapolis—New Orleans, New York—Philadelphia, Phoenix, Pittsburgh, Portland, Ore.—St. Louis, Salt Lake City, San Francisco, Seattle, Spokane and Tulsa.



WELDING ALUMINUM—an architectural plaque, modern in design, is repaired by a modern method.

Everything for oxy-acetylene welding and cutting—including Linde Oxygen, Prest-O-Lite Acetylene, Union Carbide and Oxweld Apparatus and Supplies—is available from Linde through producing plants and warehouse stocks in all industrial centers.

*Chief Metallurgist, Union Carbide and Carbon Research Laboratories, Inc., Unit of Union Carbide and Carbon Corporation.



Carrying CHEMISTRY *to* OIL PRODUCTION

ANY development that materializes from a laboratory problem to a million dollar business in the short space of three years is, to be sure, of widespread importance.

That, in essence, is the history of Dowell Incorporated, through which as a subsidiary of The Dow Chemical Company, Dow is bringing chemistry to the aid of oil production.

Ever since old "Colonel" Drake sank the first oil well of commercial importance in 1859, oil producers have faced two basic obstacles in their efforts to drain nature's vast underground reservoirs of petroleum.

First, in many instances, greater production was possible if the producing formation could be opened up—creating fissures and channels from which oil could feed in to the "hole" and be pumped to the surface.

For years the only means of accomplishing this was to "shoot" the well—to lower a charge of explosives and blast. While reasonably effective, this method was hazardous to both life and the well itself. Frequently, in shattering the rock, subterranean water rushed in to ruin the oil. Often, the great heat glazed the surface of the rock, sealing its pores and defeating the purpose.

The second obstacle came with time. As the oil filtered through the porous rock it deposited gums, paraffin and resinous substances until the pores became clogged. The rich flow of oil dropped off until finally the well had to be abandoned.

Operating one hundred and thirty brine wells as the source of basic chemicals, The Dow Chemical Company faced similar problems. It turned its technicians' attention to finding the answers.

Starting with previous attempts to use hydrochloric acid as a dissolver of limestone—attempts that largely failed because the acid attacked metal tubing and equipment as well as the rock—they found the answer in an inhibitor. This ingredient added to the acid allowed it to be pumped down to the rock where it performed the necessary service of enlarging pores and opening channels or, in different dilution, to free clogged pores, thus reviving production.

To this basic development, Dowell Incorporated has added many other chemical applications that are overcoming specific difficulties in oil production.

Today Dowell Incorporated is a national organization. It has treated more than 6000 wells and has put more than 20,000,000 extra dollars into the pockets of oil producers in only three years.

Last year it applied over 3,350,000 gallons of its special inhibited acid to oil wells. Its trucks and cars traveled over 1,275,000 miles rendering this great service.

But, important as is this part Dow is playing in serving oil producers, it is only a segment of its contribution to American industry. As one of the world's foremost chemical companies, Dow produces over 250 products that literally find their way into practically every phase of industrial manufacturing, many pharmaceutical products, farming and fruit growing as well.

DOW

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With the Contributors . . .

△ Did you know that our college once had an Engineer's Minstrel Show as part of their year's activities? On his page, the editor brings you some interesting historical glimpses into the past life of *The Wisconsin Engineer.*

△ If you think the infirmary looks you over in their examination, you ought to watch Mr. Johnson put refrigerators through a real set of tests. He'll tell you all about it in his article.

△ There's no sentimentalism in the Mechanics Department. Professor Withey thinks nothing of smashing concrete that has been "babied" for 10 years. But he did find a lot of information that would be valuable to you and engineers in the field.

△ You'd better not plan using guns in your scheme for a perfect crime, until you've read what Carl Walter, c'38, has to say about Prof. Mathews' new comparison camera.

△ The last page has a message that every engineer should read.

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"All Life is a contest . . . if there is no contest, we make one." —E. J. Mehren

FORTY YEARS This year marks the fortieth in the life of the **Wisconsin Engineer**! For forty years this magazine has carried on . . . never faltering. It has weathered every depression, every adversity. It is a symbol of unflinching loyalty and support; the result of a wonderful spirit that has held the hearts of the hundreds of men who have served on its staff.

At forty, a man is in his prime. At forty, he has the keen edges of his talents, wit, and powers sharpest. At forty, he makes or breaks himself.

But at forty **The Wisconsin Engineer** has just begun. Let us see what has gone on in the past years of its existence.

In 1896, the magazine started as a quarterly publication of 160 page, 6½ inches by 9¾ inches, under the editorship of E. C. Bebb, '96. Paging through it, we find the frontispiece a picture of the main library, "The new library building for the State Historical Society and University of Wisconsin." Further on is a view of Lincoln Terrace . . . Bascom Hall has a dome but no wings. There are many advertisements, one of which is "The Monarch, King of Bicycles . . . . Ride a Monarch and keep in front." Near the back of the magazine is a picture of the old machine shop which "can also be lighted by arc lights, a dynamo being provided for this purpose."

The year 1906 saw little or no change in the general make-up of the magazine. It now came under the editorship of E. T. Howson, '06. We read that "the minstrel show is progressing nicely and is now an assured thing . . . . Let the audience be strictly an engineering audience, and limit the admission to engineers and their lady friends."

Another decade, and 1916 finds **The Wisconsin Engineer** now a monthly issue of 48 pages, 6½ inches by 9¾ inches, under the editor John E. Wise. On the editorial pages are remarks about having "the Engineer's Minstrels again this year." There are also some interesting histories of men in the Steam and Gas Department—especially one about "Associate Prof. G. L. Larson . . . . graduate of Electrical Engineering, University of Idaho, 1907." There is, too, a note concerning "Another smoker for the students and faculty being arranged by the Engineer's Club for a date early in the second semester."

Ten more years pass, and we find the **Engineer** grown to a 9 inch by 12 inch, 40 page issue of February 1926, one very similar to the one now before you. H. C. Wolfe, e'26, was the editor. This is an issue that would interest every student in the school. One article, profusely dotted with pictures, begins like this: "After a period of building inactivity, the campus is about to welcome some long needed structures. There are being constructed at the present time an addition to Bascom Hall, the Memorial Union Building, the men's dormitories, an almost completed nurses' home, and numerous smaller projects." Other articles tell of how Polygon elected R. E. Zinn, Ch'27, president; how the new officers were installed at an A.S.C.E. meeting; and of the plans being laid for St. Pat's Parade, "To insure his getting a real honest-to-goodness reception, and to forestall any possible machinations of our legal adjuncts."

Another ten years brings us to the magazine you now have in your hands. It piques the curiosity to think about what our **Engineer** will be like forty years from today.

But what of our present magazine? Today we join hands with Polygon to help sponsor the smokers, dances, and St. Pat's Parades. In collaboration with Alpha Tau Sigma, we run the Freshman Drawing contest. Because of the financial arrangement, Polygon, **The Wisconsin Engineer,** and the student societies combine their forces to give every possible advantage to the students in our engineering college. Years ago, when this magazine was an enterprise distinct from other organizations amongst the engineers, it gave wholehearted backing to every good thing presented the engineering students. Its entire career is colored with kindness and helpfulness.

And we should keep our magazine this way! Everyone should help boost it on the way—surely for those who are to follow us, if not for our personal gain. For, after all, is anything you do worthwhile, if it cannot be passed on for the enjoyment and convenience of those to come after you?

A Good Man Gone

THE staff of THE WISCONSIN ENGINEER selfishly regrets its loss of Mr. George H. Cook, Ch.E. Feb. '36, editor last semester. But we are happy to find him with his newly won degree and a position with the Standard Oil Company at Baton Rouge, Louisiana.

Cook possessed unusual ability and range. The magazines that grace your library of last semester are the excellent results of but one of his many interests. He was an Alpha Kappa Lambda; president of Alpha Tau Sigma, the National Honorary Engineering Journalism fraternity; and, with all those activities, he yet maintained a high scholastic standing.

One of Cook's pet subjects was what he called "Social Engineering." He aimed to excel academically, yet have a variety of interests. Such an ideal gave him a cheerful and active mind in an energetic and healthy body. Everyone has seen him smile; few have seen him frown.

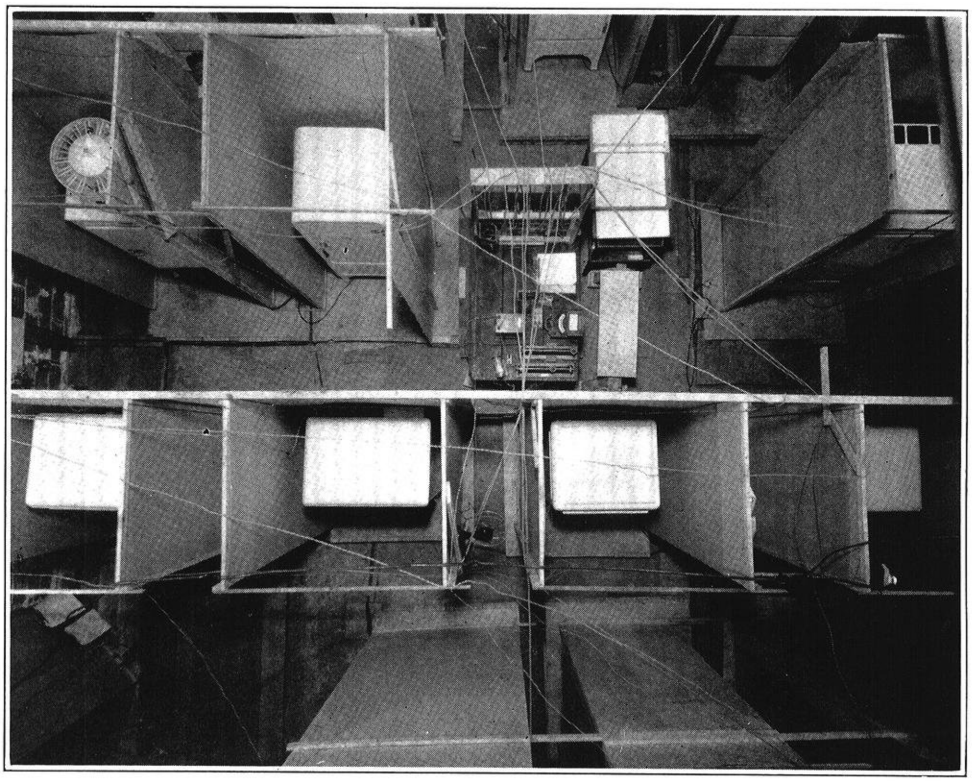
We wish to thank and wish good fortune also to Mr. Tom J. Williams, former business manager of our magazine. His was a praiseworthy and unsung work, the result of striving for a cause and an ideal, not for personal gain.

It is our earnest hope to, in some measure, carry on the fine work these men have left to us.

—Leo S. Nikora

HOUSEHOLD REFRIGER

IN A mechanism as complicated as the common household refrigerator it would seem logical to expect that there would be considerable difference in performance of machines of various makes. That there are definite differences was shown by a test of several months' duration which was completed within the past year by the Electrical Standards Laboratory. The test was made to determine over-all performance, rather than component part performance, inasmuch as the user is generally interested in the complete machine, its initial and maintained efficiency and its refrigerating capacity.



Bird's-eye view of refrigerator test room

Considering the magnitude of the investment in refrigerators and annual energy consumption of the approximately 7,250,000 household refrigerators in use in this country, it is rather surprising that practically no tests have been conducted for public or semi-public information. It is still more surprising that little has been done to establish definite standards for test conditions and procedure which adequately determine refrigerator performance under service conditions both when new and after several years of service.

Since there were no officially approved standards for testing the complete household refrigerators, various tentative and suggested test specifications were analyzed and correlated to serve as standards of procedure for the test.

Refrigerator performance depends so much on loading and ambient conditions that a statement of results only might well be misleading. For that reason, and also to indicate the rigidity of conditions necessary to secure results which can be checked with reasonable accuracy, the test conditions and measuring methods are briefly described.

Test Conditions and Measuring Methods

1. Ambient temperature variations did not exceed plus or minus 0.5°F. during a test run.

2. Vertical temperature gradients less than 0.5°F. per foot.

3. Temperature differences in various parts of the room at 3 feet above floor within plus or minus 1°F.

4. No drafts on refrigerators exceeding 25 feet per minute air velocity.

5. Each refrigerator placed in its own 7-foot high booth with adequate separation between booths, hollow tiles beneath booths and 10 feet clearance between top of booths and ceiling for air circulation. Refrigerator was placed 3 inches from the back of booth and 6 inches from sides.

6. Test room (hollow tile walls and concrete floor) was surrounded on all sides by spaces at approximately 10° below ambient temperature to absorb the heat from the refrigerators and still have no cold surfaces in the test room.

7. Temperatures were measured in the refrigerators with thermocouples calibrated before and checked after the test. Sensitivities were 0.2°F. A special potentiometer circuit in which stray contact and thermal e.m.f.'s were minimized was used for measuring thermocouple electromotive forces. Air temperatures in the refrigerators were measured with thermocouples imbeded in iron cubes having the heat capacity equivalent to 15 grams of water. Temperatures were measured in from 10 to 12 locations

...OR PERFORMANCE TEST

ROYCE E. JOHNSON, e'24

Assistant Professor of Electrical Engineering

Director of Electrical Standards Laboratory, University of Wisconsin

in each refrigerator, depending on its construction. Four air temperature thermocouples were used in each food space.

8. Energy measurements were made by watthour meters readable to at least 0.01 kwh.

9. Gas consumption was measured by a "wet meter" sensitive to 0.001 cubic foot, backed up by two ordinary gas meters for integrating purposes.

10. Operation records were obtained on a twenty pen strip-chart recorder.

11. Total running time was integrated by a synchronous motor-driven minute counter connected to each of the 15 electric refrigerators.

12. Humidity measurements were made with wet and dry bulb thermometers.

13. Ambient temperature measurements were made with mercury in glass thermometers at a number of places in the room. A Leeds and Northrup recording resistance thermometer, sensitive to 0.02°F., made a graphic record of the temperature at one location and functioned to maintain the ambient temperature constant.

14. Ambient temperatures of 70, 90, 100, 110, 115, and 120°F. were used.

15. Relative humidity generally was kept above 75 per cent and frequently was above 85 per cent.

16. Loads for which energy requirements were obtained are designated below as A, B, C, and D. The C and D runs or loads are based on a 24 hour cycle. A and B loadings generally were for a longer period.

The loads were:

A. No food or other load, refrigerator running with door closed.

B. Fifty b.t.u. per hour heat load in food space of regular refrigerators: 25 b.t.u. in chests. Heat was turned on at 12 hours before taking data. Heat was supplied by 8 feet of asbestos insulated heater wire spread around on the lower food shelf.

C. Door opening and ice making in addition to B load above. Door opened for 15 seconds every five minutes from 8-9 a. m., 11-12 a. m. and 3-4 p. m., plus one opening at 12:15 p. m. for charging with 4 pounds (only 2 pounds in chests) of water, making a total of 40 openings in the run (24 hours).

The ice was removed about 11:20 a. m. during one of the regular 15 second openings: the trays emptied and charged with water at 70°F. ± 4°F. just before they were replaced at about 12:15 p. m.

The trays of the standard types of refrigerators contained a total of 4 pounds of ice at the beginning of each run. The chests had only 2 pounds of ice.

Refrigerators Tested

The refrigerators were selected at random from dealers' or jobbers' stocks. In general, only one machine of each make and model was tested. It was not believed necessary to test a number of refrigerators of each kind because with any degree of adequate factory inspection there should not be much difference between cabinets, compressors or other parts in a given line of machines. Furthermore, if inspection standards in a factory are so poor that occasionally a sub-standard machine costing a hundred dollars or more is passed, the whole line could reasonably be regarded with suspicion, if not condemned.

Some of the important features of the various refrigerators tested are listed in Table I. Refrigerators of one make are designated by the same number, a letter being affixed to identify other machines of the same make.

TABLE I

Construction Features

No.	Nominal Vol.	Year Model	Type	Insulation Material	Wall Thickness—In.	Type of Unit	Refrigerant
1	6	1934	Cabinet	Dry Zero	3.4	Conventional	SO_2
1A	6	1934	Cabinet	Dry Zero	3.4	Conventional	SO_2
2	5.5	1934	Cabinet	Dry Zero	2.1	Conventional	SO_2
3	6.1	1934	Cabinet	Alfol	2.25	Sealed	$C_2Cl_2F_4$
4	6.5	1934	Cabinet	Corru. Paper	2.75	Conventional	SO_2
5	7	1934	Cabinet	Corru. Paper	2.9	Sealed	$HCOOCH_3$
5A*	7	1935	Cabinet	Corru. Paper	2.9	Sealed	SO_2
5B	2	1934	Chest	Corru. Paper	2.6	Sealed	SO_2
6	5.5	1934	Cabinet	Balsam Wool	3.5	Conventional	SO_2
7	6.2	1934	Cabinet	Balsam Wool**	3.4	Sealed	SO_2
7A*	6.2	1935	Cabinet	Balsam Wool**	3.4	Sealed	$C\,Cl_2F_2$
8	6	1934	Cabinet	Balsam Wool	3.4	Conventional	CH_3Cl
9	5.3	1934	Cabinet	Corru. Paper	2.9	Conventional	SO_2
9A	2	1934	Chest	Corru. Paper	2.0	Conventional	SO_2
10	5.4	1934	Cabinet	Dry Zero	2.75	Sealed	CH_2Cl_2
11	6	1934	Cabinet	Temlock	3.25	Sealed	NH_3

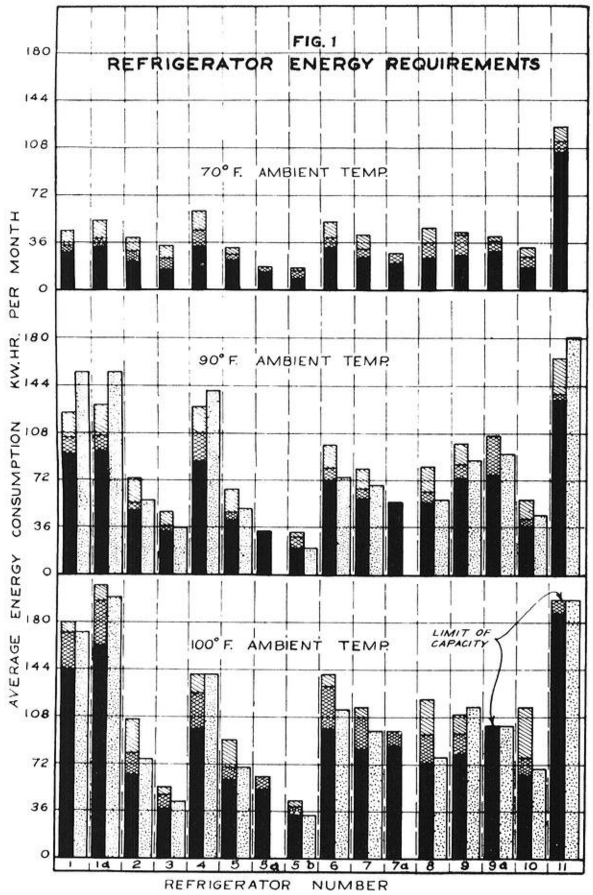
*1935 unit in the old cabinet.

**Celotex and Temlock used in addition to Balsam Wool.

Before beginning the test the refrigerators were operated for two weeks during which thermostat settings were adjusted and the measuring and recording devices tested out. At the end of the first week of operation service men from the various dealers were called in to check the operation of their respective machines. In a case where the refrigerator did not seem to perform as it should, the service man made subsequent adjustments until he thought it was operating satisfactorily.

Test Results

Refrigerator power requirements appear to be of more concern to most householders than any other factor, judging by requests for information. The average kilowatt-hours per month required by the refrigerators for several degrees of loading are shown in Fig. 1. Note that refrigerator No. 11 used gas and that the kwh. ordinates in Fig. 1 must be multiplied by 20 to obtain the cubic feet per month of 520 b.t.u. per cubic foot gas for this refrigerator.



SYMBOL	LOAD	KIND OF LOAD	DATE OF RUN		
			70° AMB.	90° AMB.	100° AMB.
	A	NO LOAD	11/22/34	11/8/34	10/15/34
	B	INCREMENT DUE TO HEAT LOAD	11/27/34	11/10/34	10/29/34
	C	DOOR OPENING + ICE MAKING	11/24/34	11/11/34	10/27/34
	A'	LATER, NO LOAD	NONE	1/24/35	1/6/35

NOTES: 1. REFRIGERATORS NOS. 5A AND 7A TESTED IN APRIL, 1935.
2. REFRIGERATOR NO. 11 OPERATED ON 520 B.T.U. GAS. TO OBTAIN CU.FT. OF GAS PER MONTH, MULTIPLY KW.HR. SCALE BY 20.

Thermostats were set to produce an average food space temperature of between 43° and 45°F. in each refrigerator (with a few exceptions as noted below) with A loading at each ambient temperature. The settings were not changed for other loads at the same ambient temperature, although the average food space temperatures increased due to the heat load, opening load and the ambient temperature. In normal usage thermostats are not set in the daytime for lower temperatures than are desired during the night after the contents are cooled. An average food space temperature of 43°-45°F. during this period—corresponding to load "A" conditions during the test—generally keeps the contents cool enough during the day. At this point it may be well to recall that the temperature sensitive element of a thermostat is located on the evaporator or cooling coil, generally in such a position that it is not greatly influenced by air temperature. It follows that in hot weather it will be necessary to use a colder thermostat setting than in cold weather for the same food temperatures. For example, decreasing the ambient temperature from 90° to 70°F. lowered the food space temperatures over a range 3° to 9°F. with A loading and no thermostat change.

Referring again to Fig. 1, the exceptions previously mentioned parenthetically were for load A runs at 100°F. ambient. Refrigerator No. 11 could not be cooled below 47°F. on the initial or final load A run. Refrigerators No. 9 and 9A had an average food space temperature of 47°-49°F. on the final load A run, No. 9 because the thermostat could not be set lower and No. 9A because it had insufficient capacity. On account of insufficient capacity, several refrigerators after 2.5 months showed less increase in energy requirements at 100°F. ambient than at 90°F. The increase in energy requirements at 90°F. ambient would have been somewhat greater for some machines had the first 90°F. run been made three weeks earlier. The humidity was high during most of the 3-week period following the first 100°F. ambient run.

TABLE II

Energy, Running Time, and Interior Temperatures With High Ambient Temperatures

(All data taken under no load conditions)

Thermostats set to produce an average of 45°F in food space at 100°F. ambient (if there was sufficient capacity) for the 110°F. ambient temperature run. Thermostats in coldest position for 115° and 120°F. ambient runs

Ref. No.	110°F. Ambient 2/3/35 *Food Space Temp. (°F.)* *Top*	*Bottom*	*Running Time (%)*	*KWH* per mo.*	115 & 120° Ambient, Mar.-Apr. '35 *Food Space Temp. (°F.)* *Top*	*Bottom*	*Running Time (%)*	*KWH* per mo.*	*Amb. Temp. (°F.)*
1	65	53	100	209	----	----	------	------	------
1A	62	52	100	234	----	----	------	------	------
2	51	46	49	107	40	34	100	192	115
3	48	49	100	62	----	----	------	------	------
4	63	60	100	149	----	----	------	------	------
5	52	44	62	78	46.5	40	100	132	115
5A	----	----	------	------	51	44	100	105	120
5B	50	46	40	44	----	----	------	------	------
6	55	44	100	146	----	----	------	------	------
7	50	52	100	125	----	----	------	------	------
7A	----	----	------	------	46	48	100	158	120
8	52	45	73	103	51	42.5	100	159	115
9	60	54	100	132	----	----	------	------	------
9A	65	53	100	107	----	----	------	------	------
10	45	49	61	127	44	47	100	220	115
10	----	----	------	------	49	54	100	224	120
11	62	57	100	4150 cu.ft.	----	----	------	------	------

*Based on 720 hours per month.

An idea of the relative reserve capacity of the machines tested can be obtained from Fig. 2, in which are shown the per cent running times corresponding to the energy requirements shown graphically in Fig. 1.

Additional data throwing light on relative refrigerating capacity are included in Table II, in which data are summarized for high ambient temperature conditions. For the 115° and 120°F. ambient temperature conditions, the motors were caused to run continuously, the food space temperatures serving to compare refrigerating ability. Only those refrigerators (exclusive of one chest) which had sufficient capacity at 110°F. were run at 115° or 120°F. ambient.

Two factors which make for a permanently efficient household refrigerator, but whose importance is too frequently overlooked, are a well sealed food space and either a non-hygroscopic insulation or a well-sealed insulation. Waxed or otherwise impregnated paper, commonly called waterproof, is far from being impermeable to moisture. Refrigerators No. 4 and 9, for example, were "waterproofed" with impregnated paper covering over the insulation material. There is an easily noticeable relationship in Table III between maintenance of efficiency and moisture absorption by the insulation.

Table III also contains data on frost accumulation on the evaporators. The doors were opened only twice in the ten day period covered. During this time two 30 gram hamburger samples and one 50 gram water sample were kept refrigerated for 96 hours with nearly the same amount of dehydration (about 45 per cent weight loss from the hamburger and 30 per cent from the water) in each refrigerator. This accounts for about 45 grams of the frost melted off at the end of the ten day period. Incidentally, all hamburger specimens were refused by a dog after the four day storage period. There is a general relationship between refrigerator energy requirments as given in Fig. 1 and the amount of frost accumulation. It happens also that the refrigerators having the greatest increase in energy requirements over a period of time accumulated considerable frost on their evaporators. The large frost accumulations indicate that the food space is not well sealed.

TABLE III

Frost Accumulation, Moisture Absorption, and Increase in Energy Requirements

Refrigerator No.	Frost Accumulation, 10 days, 100°F. Ambient grams*	Moisture Absorption Initial Weight lbs.	Increase in 5 months lb. — oz.	Increase in Energy Requirements Load A Over 2.5 mo. Period 90° Amb. (%)	100° Amb. (%)
1	1700	238	6 — 0	68	20**
1A	1300	233	6 — 8	64	22**
2	300	254	3 — 14	16	19
3	65	221	0 — 0	11	18
4	570	285	7 — 3	61	42**
5	195	320	1 — 5	16	16
5B	50	142	0 — 4	4	–2†
6	480	266	2 — 8	3***	14
7	320	306	3 — 10	17	17
8	280	289	2 — 11	4	7
9	1220	278	9 — 15.5	17***	45
9A	170	160	2 — 6	21	1**
10	340	310	0 — 12	26	26
11	540	421	4 — 10	40	0**

*Includes about 45 grams from dehydration test. Door opened twice in this period. Ambient humidity high. Food space at about 45°F.

**Refrigerators ran nearly 100% of the time initially and had insufficient capacity on final run at 100°F. ambient.

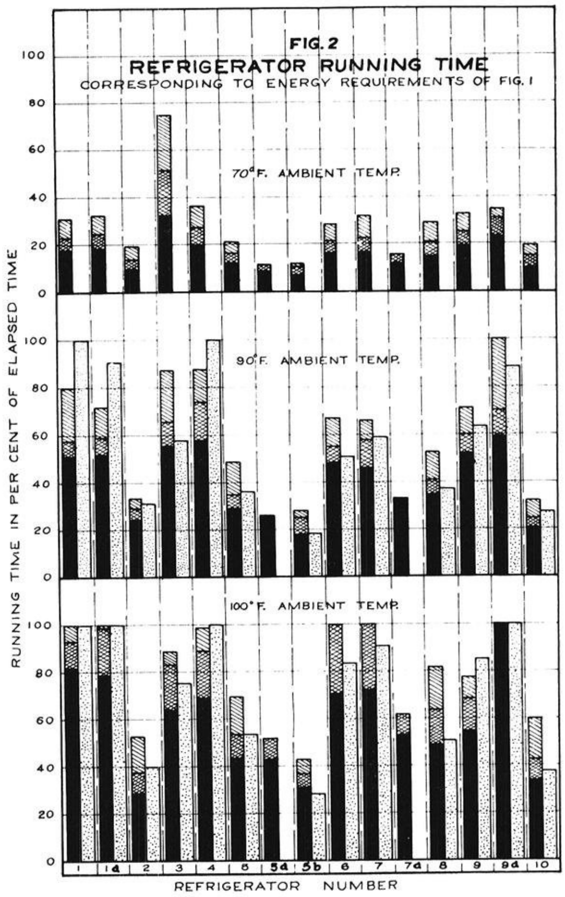
***Probably had become partly saturated before initial 90°F. run, but not before first run at 100°F. ambient.

†Thermostat setting probably not exactly the same for initial and final runs.

Poor sealing of the food space can easily be due to a poor fit around the door. This was checked by the service men in most cases after the first week of operation and rechecked after a month or so as part of the test procedure. What air circulation there may have been past the door of any refrigerator was unavoidable and due to construction rather than faulty adjustment of the door.

Miscellaneous Observations

Unusual ice making ability is sometimes an important item, although often overstressed. Observations on freezing speed were made at several ambient temperatures, but the results are not satisfactorily comparable in that tray dimensions are so different as to greatly affect freezing speeds. None of the refrigerators tested was found especially outstanding in freezing ability. Refrigerators with four shallow trays, all equipped with aluminum separators or partitions to make small ice cubes, will freeze a given quantity of water, other things being equal, much faster than one with only two deep trays making large cubes. Rubber cube partitions greatly increase freezing time but avoid considerable loss of ice in removing it. Aluminum ice cube partitions, constructed with the bottom of the partition thick enough to make tapered ice blocks, function to remove the heat rapidly and also to warm up readily when removing the ice. Refrigerated shelves in the evaporator greatly assist in promoting rapid freezing on the shelves. The thin aluminum shelves which sometimes are removable from the evaporator do not readily conduct heat from a tray of water to the evaporator and its refrigerant, but



are desirable in that they can be removed to make space for rapidly cooling a large piece of meat or several cans or bottles.

A convenient food space arrangement found in very few refrigerators is that which can be obtained by placing the drip tray far enough below the evaporator to provide a meat storage space in the tray. Cold air passes down into the tray providing a cold, or even freezing, location for food.

Noise from a refrigerator can be very annoying. With the gradual development of noise consciousness on the part of the public, this phase of appliances will receive more attention. Six observers were used to compare the amounts of noise produced by the refrigerators. Human observers were believed to be more reliable under the circumstances than acoustimeters, which have to be used with discretion. A summary of the noise observations is contained in Table IV, which also covers a few other observations. There were no great differences between the ratings made by the several observers, who worked independently of one another.

TABLE IV

Electrical Insulation Leakage, Noise, Exterior Finish

Ref. No.	*Leakage* Current Amperes*	*Average Noise Units***	*Exterior Finish****	*Condition of Finish at End of Test*
1	.0156	25	S.D.O.	Slightly yellow—O.K.
1A	.005	25	S.D.O.	Slightly yellow—O.K.
2	.008	41	Baked lacquer	Checked, discolored, rusted
3	.0912	27	S.D.O.	Slightly yellow—O.K.
4	.0132	37	Baked lacquer	Checked—rough spots
5	.0006	32	S.D.O.	Slightly yellow—O.K.
5B	.0007	19	S.D.O.	Slightly yellow—O.K.
6	.0057	80	S.D.O.	Slightly yellow—O.K.
7	.0018	50	S.D.O.	Slightly yellow—O.K.
8	.0014	49	S.D.O.	Slightly yellow—O.K.
9	.006	61	Lacquer	Rough spots
9A	.0057	76	....	Slightly yellow—O.K.
10	.0022	61	S.D.O.	Slightly yellow—O.K.
11	.0009	3	S.D.O.	Slightly yellow—O.K.

*With 110 volts impressed on the insulation.

**Noise units are arbitrary, No. 7 was taken at 50 units and the others compared to it.

***S.D.O. indicates a synthetic drying oil of which Dulux, Glyptal, and Porceloid are examples.

In humid climates, such as are present in the Gulf states and also existed in the test room (one's trousers stuck to the skin in about two minutes), electrical insulation resistance may become rather poor. To test this, the refrigerators were allowed to stand idle for ten days in a 90°F. room with about 80 per cent relative humidity. Leakage currents through the insulation to ground are tabulated in Table IV. This leakage occurs largely in the motor but all circuits in the refrigerator contribute to it. None of the leakage currents would ordinarily be fatal to a person, but there was sufficient leakage in Nos. 1, 2, 4, 6, 9 and 9A to be at least alarming. An advisable precaution would be to ground the motor frame and compressor.

Exterior finishes on refrigerators may be of several types. Porcelain enamel, if not chipped or cracked, should resist humidity better than the lacquers or synthetic drying oils. Type of finish and some idea of how they weathered the test are contained in Table IV. There is no question but what the synthetic drying oils, which are baked on, are considerably superior to lacquer.

Porcelain enamels are universally used for refrigerator interiors. Not all enamels are acid resisting. Some of them lose their glossy surface after a relatively short exposure to mild acids. Tests were made by pouring vinegar, grape juice and lemon juice on small areas in the bottom of each refrigerator. There was very little difference, after a few days, in the effect of these liquids upon the non-acid-resisting enamels. Refrigerators No. 6 and 11 were found to have that type of porcelain enamel. No. 2 was only slightly attacked, and the others were not attacked by the liquids used. These findings were not entirely in agreement with advertised claims.

Conclusions

"How much will it cost per month to run the X refrigerator?" and "Which is the best refrigerator to buy?" are frequent questions which, unfortunately, cannot usually be answered definitely. To answer them at all, information is needed concerning first cost, reliability of both the manufacturer and dealer, and the user's requirements for freezing and cooling service, as well as the average temperature of the room in which the refrigerator is to be placed. Other factors bearing on the choice of a refrigerator are: freedom from the harmful effects of certain gases, in case of a leak, which may occur in any machine, and one's attitude toward a conventional unit with its possibility of certain minor repair troubles such as seal leaks and belt adjustments as compared with his attitude toward a sealed-in mechanism which will have to be replaced in its entirety in case of trouble.

Under present merchandising arrangements, it is usually the dealer who must bear the burden of servicing a refrigerator in case of trouble during the period for which it is guaranteed. It is true that the manufacturer in most cases backs up the dealer on the guarantee, but all the manufacturer does is to furnish a replacement part. The dealer pays the transportation on the parts and does all the work. Consequently it is important to purchase a refrigerator from a reliable dealer.

In only a few cities, where energy is cheap, or average temperatures are low, cost of energy for operation is relatively unimportant. Where energy cost is important, as it ordinarily is, data on the relative energy requirements is of considerable economic value. It would seem to be of some significance that those refrigerators which operated most economically required less service, as a group, than the others and also suffered less depreciation in efficiency.

ACKNOWLEDGEMENT: *The writer desires to express his appreciation for the real assistance rendered by those loyal student assistants—Joel Hogan, Standley Naysmith, James A. Zimmerman, Ralph S. Parker, and especially Herbert W. Flath—without whom this test could not have been completed. The consulting services of Mr. V. M. Murray and the technical assistance of Mr. Ralph R. Benedict were of great value also. The costs of the test and refrigerators were financed by Consumers' Research, Inc.*

"Newfangled invention" makes good

"Can you really talk through a wire?" people still asked when this early telephone switchboard went into service in 1881. ℂ Apparatus was crude—service limited—but the *idea* was right. It took hold in spite of ridicule. Today there are more than 13,000,000 telephones in the Bell System—telephone conversations average 60,000,000 daily—the service is faster and clearer than ever. ℂ Telephone growth and improvement will go on. For Bell System men and women work constantly toward one goal: enabling you to talk to anyone, anywhere, anytime.

Why not call Mother and Dad tonight? For lowest rates, call by number after 7 P. M.

BELL TELEPHONE SYSTEM

ON THE CAMPUS

FROSH COME THROUGH

Below is given the freshman honor list for the first semester. The men listed are in the high 15% of their class.

High Honor Rate

	Credits	Grade Pt. Average
Grindrod, John M.	17	3.00
Fuchs, Leo J.	18	2.83
Schuette, Roger E.	18	2.83
Brodzeller, Leo E.	17	2.82
Hoeppner, Conrad	17	2.82
Jankus, Anniset A.	17	2.82
Ring, Robert C.	17	2.82
Voss, Arnold W.	17	2.82
Thompson, Glen A.	18	2.78
Wright, Hugh W.	17	2.76

Honor Rate

Weseloh, John W.	18	2.72
Hamachek, Richard L.	17	2.71
Sanford, Herbert B.	17	2.71
Parent, Robert J.	18	2.67
Bauer, Edward E.	17	2.65
Christianson, Thos. K.	17	2.65
Heuser, John E.	17	2.65
Huppler, John J.	17	2.65
Liedke, Walter A.	14	2.64
Bondehagen, Melvin	16	2.63
Thorkelson, Wm. L.	18	2.61
Wadell, Stanley F.	18	2.61
Webb, Robert G.	18	2.61
Forsgren, Karl E.	17	2.59
Metter, Richard W.	17	2.59
Amery, George R.	14	2.57
Albrecht, Edmund H.	16	2.56
Eron, Allan H.	18	2.56
Hood, William E.	18	2.56
Rezba, John S.	18	2.56
O'Leary, James G.	15	2.53
Bartolowits, Fred F.	17	2.53
Blodgett, Don G.	17	2.53
Kommers, William J.	17	2.53
Kutchera, Harvey W.	17	2.53
Neipert, Marshall P.	17	2.53
Novy, Raymond E.	17	2.53
Olds, Howard R.	16	2.44
Plumb, Mahlon J.	17	2.41
Schubert, Raymond P.	18	2.39
Eickner, Herbert W.	17	2.35
Hartwig, Karl T.	17	2.35
Johannes, Kenenth P.	17	2.35
Slack, Carstens	17	2.35
Brittan, Raymond O.	18	2.33
Browne, Philip L.	15	2.33
Koehler, John W.	18	2.33
Ludvigsen, Carl Wm.	18	2.33
Harry, John E.	17	2.29
Andren, Bertil T.	17	2.29
Bodoh, Albinus G.	17	2.29
Dietrich, Harold A.	17	2.29
Runstrom, George A.	17	2.29
Vander Wall, Clifford	17	2.29
MacArthur, John E.	16	2.25

MRS. JOHNSON DIES

Mrs. Phoebe E. Johnson, widow of the former Dean Johnson—author of "Johnson's Materials of Construction" and Dean of the College of Engineering at the University of Wisconsin—died January 24, 1935. She was a resident of Madison.

S. P. E. E. CONVENTION HERE IN JUNE

The forty-fourth annual meeting of the Society for the Promotion of Engineering Education will be held here on the campus of the University of Wisconsin in June. Between 1,000 and 1,200 people are expected to register. The last time the S. P. E. E. convention was held here was in 1910. In 1933 the Administrative Group of the society met here.

The general chairman is Dean Turneaure who, with Prof. B. G. Elliott, Prof. F. M. Dawson, and Mrs. A. V. Millar make up the general committee in charge of the arrangements. The committee in charge of making arrangements for the women who will be present for the convention is composed of Mrs. A. V. Millar, Mrs. P. H. Hyland, and the past presidents of Pentagon.

At this early date no definite arrangements have been made but everyone concerned is working hard to make the conference a success.

CONGRATULATIONS

Our congratulations and best wishes for Lester G. Ahrens, M.E. Feb. '36 graduate, and his new wife, the former Miss Claire Maxine Volk. Both are from Milwaukee, where they were married Saturday, February 8. Shortly, they will leave for Cincinnati, Ohio, where Mr. Ahrens will be engaged by Procter and Gamble.

ENGINEERING SOCIETY CONVENTION

The annual convention of the Engineering Society of Wisconsin will be held February 20 and 21 in the auditorium of the Engineering building. Thursday afternoon the topic of discussion will be surveying and related problems. In the afternoon officials of T. M. E. R. & L. Co. will conduct a symposium on their new Port Washington Power Plant. At a joint banquet of the society with the Technical Club of Madison in the evening, Colonel H. W. Miller, of the University of Michigan, will speak on "The Paris Gun." Colonel Miller has collected all available information on this interesting weapon. Friday morning will be occupied with a general business meeting and representatives of the U. S. Army Engineers will discuss the Upper Mississippi Improvement Project in the afternoon.

Students are invited to attend the meetings.

WENDT NEW ENGINEER DIRECTOR

Mr. K. F. Wendt has recently been made a member of the Board of Directors for **The Wisconsin Engineer.** Judging from his other accomplishments, we can be sure that the board has gained a valuable man. Congratulations, Mr. Wendt!

RESEARCH CONFERENCE

The first meeting of the research conference in the current school year was held the evening of January 14 in the Mechanical Engineering building. Prof. M. O. Withey spoke on "The Effect of Vibration in the Placement of Concrete." The paper, "Split Phase Starting of Three Phase Motors," was presented by Prof. G. F. Tracy. A. J. Hoiberg and W. K. Neill, graduates in Chemical Engineering, discussed "The Absorption Coefficients of Ammonia in a Bubble Cap Tower."

There will probably be two more research conferences, on which we hope to have more information in the March issue.

AIR RESERVE TRAINING

Three Wisconsin men, Richard Upson, K. G. Davis, and A. C. McDonough, are receiving flight training at the Naval Air Station at Pensacola, Florida. At the completion of their training they will be commissioned in the Naval Reserve Air Corps. New classes will be starting again in June and any seniors desiring detailed information on this subject may receive it by corresponding with

Commanding Officer
Naval Reserve Aviation Base
Great Lakes, Illinois

RESEARCH IN THE STEAM & GAS ENGINE LABORATORY

Due to the limited amount of money available for research, the efforts in the engine laboratory have been concentrated on only two projects.

Mr. E. B. Barney, B.S.'35, is continuing the study of the proper length of exhaust pipe for two-stroke Diesel engines which was begun in 1932. Fundamental theories were established and checked by K. C. Whitefield, M.S.'33, and E. R. Kaiser, M.S.'34. Mr. Barney is extending this study for the longer lengths of pipe.

Mr. R. A. Rose, instructor in Steam & Gas, with the assistance of Mr. R. R. Benedict, instructor in Electrical Engineering, has developed a three-beam cathode ray oscillograph for indicating combustion in a high speed Diesel engine. This oscillograph, working in conjunction with photo-electric cells and amplifiers, makes it possible to obtain a simultaneous record of fuel injection, radiation emission, and pressure rise during combustion. Since the important part of combustion takes place in from one to three one-thousandths of a second, high speed indicating apparatus is a necessity. Due to the most recent developments of this indicating system, the burning characteristics of various fuels can be studied in an actual engine. It is possible to divide combustion into the period of delay after fuel injection before it ignites and the period after ignition before the pressure starts to rise. This indicating system, which permits time measurements to 1/60,000 of a second, opens up unlimited fields in the study of combustion.

REVISED EDITION OF "STRENGTH OF MATERIALS"

The second revised edition of "Strength of Materials" by Professors E. R. Maurer and M. O. Withey was published a short time ago. Changes, as shown to be necessary from several years of teaching from the book have been made, and the book has been revised generally.

In addition to bringing the material up to date, there are several improvements. The chapter on columns has been made to conform to recommendations of the Committee on Steel Column Research of the A. S. C. E.; an article on welded joints has been added; the sections dealing with axial impact with tubes under external pressure have been modified, as have the tables of working stresses, properties of materials and of sections; a table on elements of wide-flange beams has been included; and the collection of problems has been augmented.

Ten Year Old Concrete

M. O. WITHEY

Professor of Mechanics, University of Wisconsin

THE belief that information on strength of concrete after aging for long periods of time would be of much value to users of this material led to the making of 450, 6 x 18-inch, 1:2:4 and 1:3:6 concrete cylinders in 1910. These have been under observation, and many of them have been tested at regular intervals since that time. In 1923 a larger program involving four brands of cement, three coarse aggregates, three proportions, two consistencies, and two curing conditions was begun. The later program involved making 1600, 6 x 12-inch cylinders, 96, 4 x 6 x 24-inch slabs for contraction measurements, and about 2000 mortar specimens for tension and compression tests. The testing for the earlier series of tests is scheduled over a 50-year period; the latter series is scheduled to be tested over a 100-year period. All of this work has been done in the Materials Testing Laboratory as a part of the research program of the Department of Mechanics. Acknowledgement is due Messrs. C. A. Wiepking, R. S. Phillips and K. F. Wendt for assistance in the conduct of this work.

Results of tests of the earlier series have been reported at intervals up to 20 years, and data from the 1923 series was reported after the 5-year tests had been run.* Herein will be given a summary of the more important results obtained from the 1923 series during the first 10-year period, and certain comparisons will be made between the concretes of the two series.

Materials

The cements for the 1923 series were purchased in three 10-bag shipments, each of four brands commonly used in Wisconsin. After sampling and testing, the three shipments of each brand were mixed, and the four lots thus formed represented the brands in all major tests of this series. Table I shows results of Professor O. A. Hougen's chemical analysis, compound compositions calculated by Bogue's method, and the finenesses by sieve and turbidimeter. The physical tests made on the four brands showed that they were of standard quality. The tensile strengths of neat cement and 1:3 standard sand mortar briquets cured under water at room temperature indicate that all brands suffered retrogression in both neat and mortar strengths between ages of 90 days and 5 years, with small increases in some cases between 5 and 10 years. At 10 years, the neat strengths ranged from 507 lb./in.^{2} for 5M to 777 lb./in.^{2} for 3M and the 1:3 mortar strengths varied between 300 lb./in.^{2} for 3M and 338 lb./in.^{2} for 7M.

Janesville sand, consisting mainly of quartz and dolomite, was used as the fine aggregate. All of it passed a ¼-inch sieve; 49 per cent was held on a 28 sieve; 12 per cent passed a 48-mesh; and the fineness modulus was 2.86. The coarse aggregates were Janesville gravel, Lannon dolomite, and red granite. All of these aggregates were well graded, passed a 1½-inch sieve and were retained on a ¼-inch sieve; each aggregate had a fineness modulus of 7.28. The gravel contained about half crushed fragments and consisted approximately of ¾ dolomite, 1/5 quartz and the remainder, igneous material. The red granite was principally quartz and feldspar. The specific weights of the sand, gravel, dolomite and granite were 112.6, 105, 92 and 94 lb. per cu. ft., respectively. The specific gravities of these aggregates were 2.70, 2.67, 2.73 and 2.62, respectively; and the percentages of absorption, by weight, were 0.6, 1.3, 0.7 and 0.19, in the order named. The aggregates represent the better types of their respective classes. The particles of gravel were the most nearly equiaxed, the particles of granite the least.

Making of Specimens

The mortar cylinders and briquets made for outside storage were mixed and moulded in a standard manner. The consistency for the different proportions was based on Feret's formula. These mortar specimens were then cured 1 day in a moist closet and 27 days in water at room temperature, after which they were placed on shelves outdoors.

Concrete cylinders 6 inches in diameter and 12 inches high were made in a mixer under a standardized procedure in batches of 20, and the consistency determined on a 30-inch flow table using 15½-inch drops in 15 seconds. Molds were filled and rodded and the specimens capped

TABLE I. OXIDES AND COMPOUNDS IN CEMENTS
Based on Analyses of Cements

Cement No.	3M	4M	5M	7M	A(1910)
Brand	Medusa	Lehigh	Universal	Marquette	Atlas
Specific Gravity	3.12	3.14	3.13	3.16	
Residue on 200-Sieve	23.5	21.7	20.7	18.3	
Surface Area, cm²/gm.	1100	1285	1235	1295	
CaO	61.40	61.16	62.55	60.49	61.28
SiO_2	22.53	22.21	21.41	23.48	21.59
Al_2O_3	5.43	7.32	7.18	5.92	6.96
Fe_2O_3	2.56	2.69	2.57	3.10	2.74
MgO	4.39	2.57	2.30	3.57	2.52
SO_3	1.73	1.90	1.53	2.04	2.09
Ignition Loss	2.32	1.64	2.40	1.65	
Insoluble Residue	0.22	0.44	0.16	0.43	
$3CaO \cdot SiO_2$	33.5	21.3	35.1	17.6	28.8
$2CaO \cdot SiO_2$	39.4	47.7	35.0	54.2	40.2
$3CaO \cdot Al_2O_3$	10.1	14.9	14.7	10.4	13.8
$4CaO \cdot Al_2O_3 \cdot Fe_2O_3$	7.7	8.2	7.8	9.4	8.3
$CaSO_4$	2.9	3.2	2.6	3.5	3.6

*See *Wis. Engr.* Feb. 1915, Feb. 1918, Nov. 1920; also *Jour. Am. Conc. Inst.* Feb. 1931.

with neat cement in the standard manner. After curing 1 day in molds and 27 days in a moist closet, the specimens were placed with ends resting on the ground outdoors or in a room. The room temperature varies between 65° and 85°F. and the humidity usually runs from 20 to 50 per cent with occasional periods in summer of higher moisture content. The annual outdoor temperature range is approximately –20° to 95°F., the humidity approximates 75 per cent with departures on either side which occasionally reach 10 per cent. The average rainfall is 32 inches, which includes an average annual snowfall of 38 inches. Readings of temperature within a similar concrete cylinder during the past two years indicate that 20 to 30 cycles of freezing and thawing occur annually.

Procedure in Testing

Absorption tests were made on 6 by 12 inch cylinders with roughened surfaces after curing for 27 days in the moist closet. They were dried to constant weight at temperatures just above the boiling point of water and then immersed in water at room temperature for 48 hours. After weighing, the cylinders were boiled for 5 hours and again weighed. The absorptions under each treatment were based on the percentage of water in terms of the oven dry weight of the specimen.

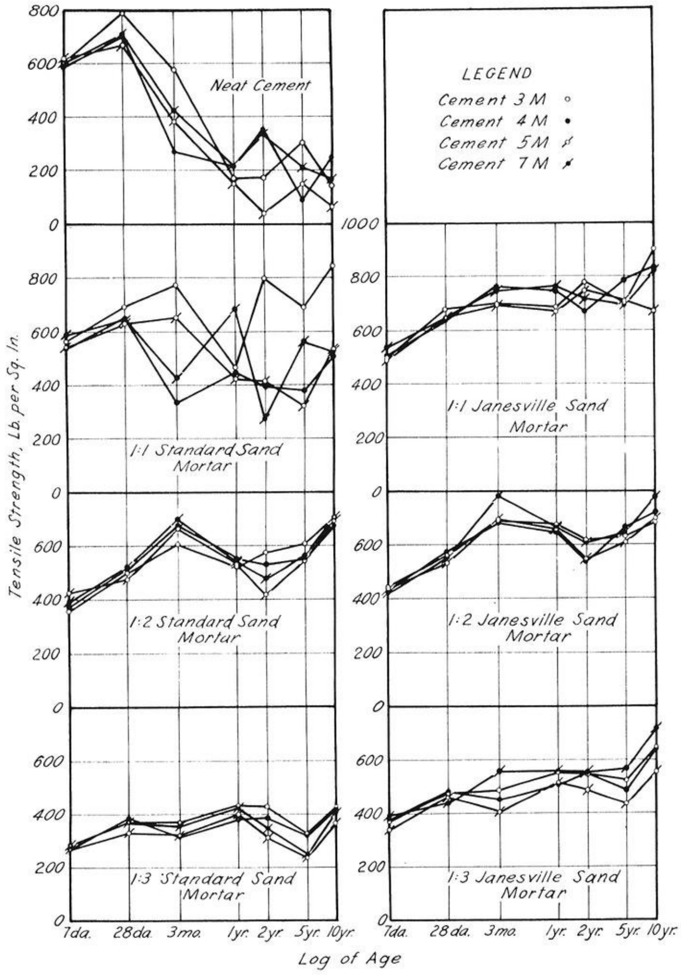


FIG. 1 – RESULTS OF TENSION TESTS ON MORTAR AND NEAT CEMENT BRIQUETS CURED OUTSIDE AFTER 28 DAYS.

The freezing and thawing tests were made on 5, 6 x 12-inch cylinders for each mix, cement, and aggregate tested. After 28 days in the moist closet, the specimens were soaked in hot water at 190°F. for several hours prior to placing in the freezer at an average temperature of 21°F. Following 20 cycles of freezing and thawing in hot water at 190°F., the specimens were tested in compression.

Contraction measurements were made with a 20-inch Berry strain gage reading to 0.0001 inch on the 4 x 6 x 24-inch slabs. Contractions were based on readings taken after the specimens were 1 day old.

Specimens cured outdoors were stored inside two days prior to testing. Concrete cylinders were crushed under speeds of 0.06 inch per minute.

Results of Tests

The results of the tension tests on mortars cured outside are shown in Fig. 1. The poor weathering qualities of the neat cement briquets are indicated by the low and variable strength values after 3 months. Many of the specimens were cracked. Similar variability in strength was not evidenced in the compression tests of neat cement although cracks reduced the 10-year strength of the cylinders made of 5M cement. Why the 1:1 mortars of standard sand exhibited such variability in strength is not apparent. Exposure of these specimens did not differ from those of Janesville sand. The mortars made of the well-graded Janesville sand were superior to mortars of like proportions made of standard sand. Although most of the mortars exhibited retrogression in strength during part of the 10-year period, the increase in strength between 5 and 10 years shown by the 1:2 and 1:3 mortars, especially in the 1:3 Janesville sand mortars, is marked. Janesville sand mortars exhibited increases in tensile strength of 20 to 40 per cent between ages of 28 days and 10 years. The tensile strength of the 1:2 standard sand mortars also increased in strength about one-third over the same period of time.

In compression the mortar strengths were more consistent, and the discrepancies between the standard sand and Janesville sand mortars were less than in tension. At 10 years, the average compressive strengths of the neat cement cylinders cured outside ranged from 10,210 for 5M to 16,455 lb./in.^{2} for 4M, and the compressive strengths of the 1:3 Janesville sand mortars ranged from 6,420 for 3M to 7,305 lb./in.^{2} for 7M. The 1:3 cylinders of standard Ottawa sand cured in water at room temperature for 10 years exhibited only 45 per cent of these strengths.

TABLE 2. PROPERTIES OF CONCRETE MIXES

Mix By Vol.	Mix By Weight	Coarse Aggregate	Cement Content, Sacks Per Cu. Yd.	Water Cement Ratio, w/c	Flow in Per Cent	Specific Weight, Lb. Per Cu. Ft.	Density, ρ
1:2:4	1:2.4:4.47	Gravel	5.15	0.76	165	151.5	0.828
1:2:4	1:2.4:4.47	Gravel	5.04	1.01	250	150.7	0.808
1:2:4	1:2.4:3.92	Lannon Dol.	5.52	0.81	165	151.6	0.814
1:2:4	1:2.4:4.00	Red Gr.	5.41	0.77	165	149.1	0.824
1:3:6	1:3.6:6.70	Gravel	3.58	1.04	165	150.5	0.830
1:1½:3	1:1.8:3.35	Gravel	6.62	0.61	165	152.2	0.828

The cement contents, water-cement ratios, and densities for the mixes tested are recorded in Table II. Table III furnishes a summary of the results of the absorption; freezing and thawing, and contraction tests. The data in

TABLE 3. SUMMARY OF RESULTS OF ABSORPTION FREEZING AND THAWING AND CONTRACTION TESTS ON CONCRETE

Cement	Aggregate	Mix By Volume	Per Cent Absorption After		Per Cent Loss in Comp Strength after 20 Cycles of Freezing and Thawing	Contraction after 10 Yr. Inside Curing Multiplied by 100,000 **	Per Cent Loss in Weight after 10 Years	
			48 Hr	5-Hr Boil			Inside **	Outside
3M	All averaged	1:2:4*	5.04	5.98	19	36	2.01	0.59
4M	All averaged	1:2:4	5.01	5.65	27	39	1.83	0.78
5M	All averaged	1:2:4	5.12	5.86	32	42	1.96	0.71
7M	All averaged	1:2:4	5.01	5.78	26	50	2.10	0.63
All averaged	Dolomite	1:2:4	5.47	6.11	25	—	—	0.81
All averaged	Granite	1:2:4	4.49	5.37	27	—	—	0.21
All averaged	Gravel	1:2:4	5.17	5.96	27	42	1.98	1.02

* Flow 165 per cent ** Average for gravel concrete only.

Table III shows that the absorptions of the 1:2:4 mixes was low, independent of the brand of cement, and lowest in the concrete made with granite. The loss in strength in

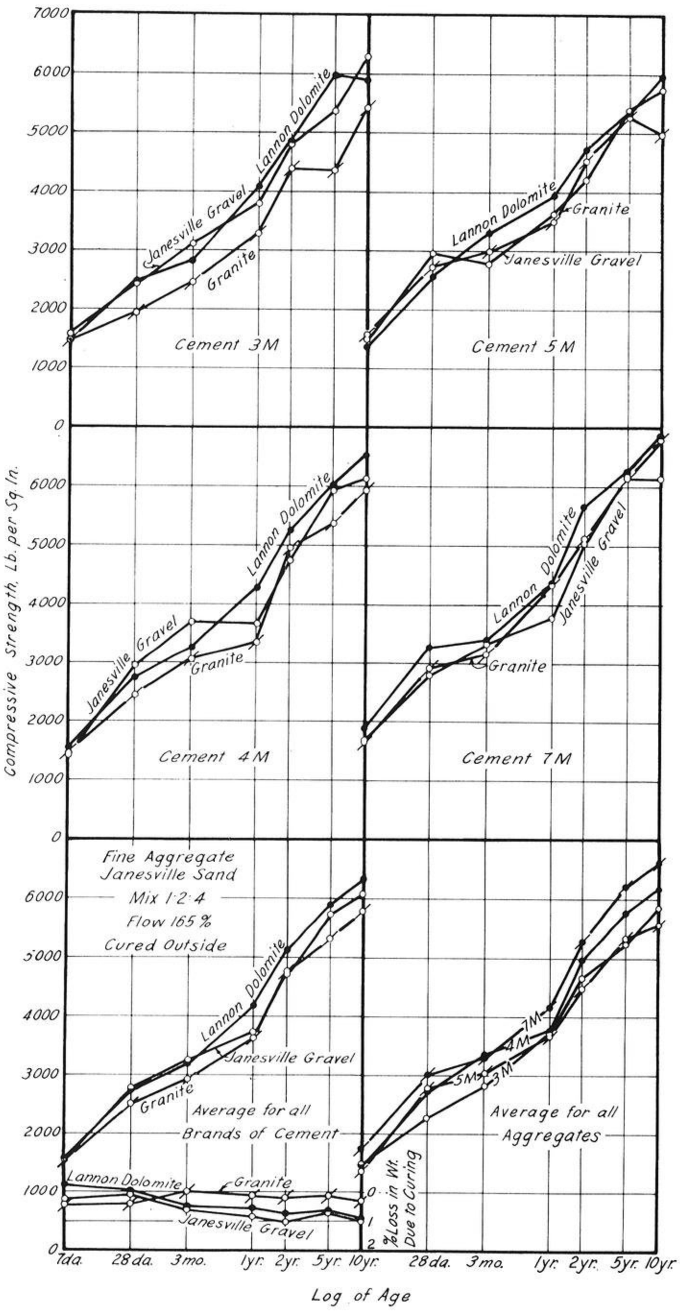


FIG. 2 – STRENGTH-AGE RELATIONSHIP FOR CONCRETE MADE OF DIFFERENT BRANDS OF CEMENT AND DIFFERENT AGGREGATES.

the freezing and thawing test used in 1923, judging by recent experience with the test, was largely due to the action of the hot water. In this test, cement 3M exhibited less loss in strength than the other brands. Judging from the strength-age relationships in Fig. 2 this superiority in that freezing and thawing test furnished little evidence of resistance to the weathering afforded by the outside exposure used.

The contraction of 1:2:4 mixes under indoor curing increased rapidly to 3 months, at which time it approximated 0.025 per cent, and less rapidly to 5 years. The values in the table for the 10-year measurements averaging 0.04 per cent are slightly less than those obtained at 5 years. Owing to the loosening of plugs in the contraction prisms cured outside no measurements were available for the outside specimens at 10 years. Since previous results indicate that the loss in weight is an index of the contraction, the average contraction of the outside specimens at 10 years approximated 0.010 to 0.015 per cent. The granite concrete specimens which showed very low loss in weight probably contracted a much less amount.

The strength-age relationships in Fig. 2 and 3 show that the strength of concrete made with the cements of 1910 and those of 1923 and cured outside in this climate increased approximately as the logarithm of the age. For the mixes used there was little difference in the strengths of concretes made with the different aggregates, concrete of Lannon dolomite being slightly stronger than that made with the other aggregates. Concrete of cement 7M was somewhat stronger than that of the other brands, with 4M concrete next at ages above 2 years. These cements were highest in dicalcium silicate and the most finely ground judging by surface area measurements.

Fig. 3 shows that the effects of outdoor curing on the compressive strengths of concrete having 3.5 to 6.6 sacks of cement per cu. yd. have been on the whole beneficial throughout the 10-year period. The dip in the 1:2:4 concrete of the 1910 series was not significant, as the 20-year tests for that concrete exhibited a good gain in strength. The record also shows that the use of wet mixes, like the 1:2:4 concrete of 250 flow is accompanied by a greater sacrifice of strength at 5 and 10 years than at the early ages. Making allowance for the discrepancies in water-cement ratio and length of cylinders used in the 1910 tests, it appears that the concrete of the later series was slightly stronger at 10 years than that of the 1910 series. The concretes of both series exhibited good gains in strength during 10 years of outdoor exposure during which time they were probably frozen and thawed 200 times. Judging from the 20-year tests of the 1910 series and the trend of the data at 10 years, the concrete of the 1923 series should exhibit further increases in strength with age.

The detrimental effect of the relatively dry atmosphere indoors on the compressive strength of 1:2:4 concrete of the 1923 series is well illustrated in Fig. 4. These data show that the concrete cured inside after 28 days in the moist closet was superior in strength at 3 months to concrete cured outside, but thereafter the indoor-cured concrete exhibited very little increase in strength and reached

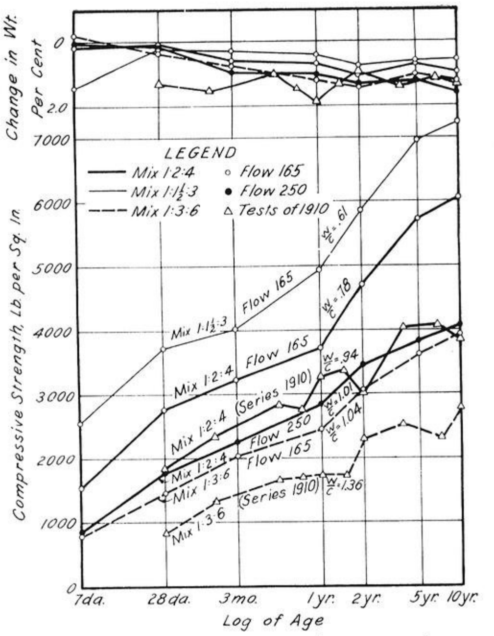


Fig. 3 - Effect of Mix on the Compressive Strength of Concrete and on Loss in Weight Due to Curing

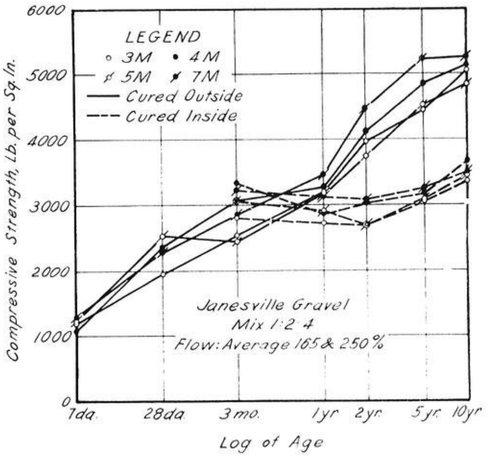


Fig. 4 - Effect of Curing Conditions on Strength of 1:2:4 Concrete with Different Cements.

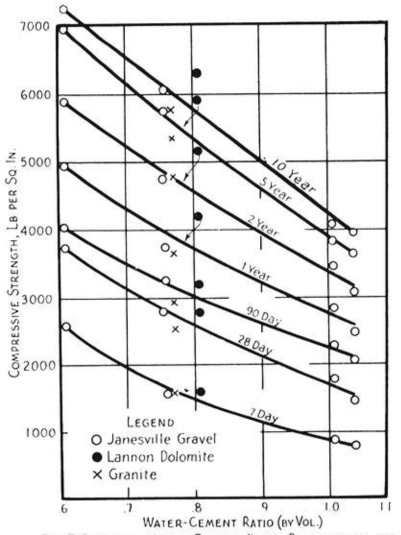


Fig. 5 - Strength Water Cement Ratio Relationship for Concrete of Different Ages

an average strength of only 3,000 lb./in.^{2} at 10 years, where similar concrete cured outside acquired an average strength in excess of 5,000 lb./in.^{2}

The strength water-cement ratio relationship for the concretes of the 1923 series is shown in Fig. 5. Data for the 28-day strength of concrete made of present-day normal Portland cement would accord approximately with the curve representing the 1-year test results in Fig. 5. Manufacturers have achieved such strengths at early ages by raising the content of lime and tricalcium silicate and by grinding the clinker more finely. By such procedure the time rate of increase in strength after the 1-month period is much lower than for the cements of the two series described and does not follow the logarithmic law.

Conclusions

1. The tensile strength of mortar or concrete suffers more from outside exposure than does the compressive strength. Neat cement and 1:1 standard sand mortars exhibited marked variability in strength during these 10-year tests.

2. The compressive strengths of concrete made with cements of the type used in 1910 and 1923 showed a good increase in strength, in accordance with the logarithm of the age when cured unprotected on relatively dry ground in the climate of Madison. Curing indoors at lower humidities markedly reduced the rate of increase in strength after 3 months.

3. Both the mortar and concrete tests show that the cements highest in dicalcium silicate had slightly higher strengths at the 5- and 10-year periods than did those highest in tricalcium silicate.

4. The use of hot water to thaw frozen specimens was probably the cause for the comparatively large reductions in compressive strength obtained in the freezing and thawing test of 20 cycles. These strength losses do not appear to be related to the strength of the concrete or mortar cured outside for 10 years.

5. The retention of excessive amounts of mixing water during the hardening of concrete resulted in a pronounced lowering of the rate of strength increase in the concrete of 250 flow. The actual difference between the strength of concrete of 165 and that of 250 flow was greater as time increased.

6. The data failed to show material differences in concrete strength due to type of aggregate used.

7. Contraction of indoor-cured 1:2:4 gravel concrete of 165 flow averaged 0.04 per cent at 10 years. Estimations, based on measurements and also on losses in weight, of the contraction at 10 years of outdoor-cured gravel, dolomite and granite concrete of similar type are 0.015, 0.01, and 0.005 per cent, respectively. The small losses in weight of the concrete made with the relatively non-absorptive granite are remarkable.

8. Although the outdoor exposure is not the most severe, the data from the tests thus far completed show that concretes and mortars of usual proportions made of the types of cement used and good aggregates had very good weathering qualities.

ALUMNI NOTES

Miners and Metallurgists

SCHWARTZ, ERNEST H., '18, who is superintendent of the open hearth department of the Wisconsin Steel Company, South Chicago, Illinois, has a paper in the January, 1936, issue of the "Iron and Steel Engineer." His paper is titled "The Open Hearth Furnace Operation, Four Million B.T.U. Per Ton."

PETERSON, A. F., '18, is associated with the Bethlehem Steel Company, being their general manager of the Cornwall division of the Bethlehem Mines Corporation, Cornwall, Pennsylvania.

ROSCOE, DAVID C., '06, occupies the position of manager of sales of all material relating to pipes and tubes for the Bethlehem Steel Company, Inc., Bethlehem, Pennsylvania.

JONES, T. D., '22, formerly superintendent of the Perth-Amboy plant of the American Mining and Smelting Company, has been promoted to assistant general manager. He now has charge of all the lead smelters of this company located in the United States and in foreign countries.

HAVARD, JACK, '35, who is with the United States Gypsum Company, was recently promoted to superintendent of mines and quarries.

TONER, HAROLD J., M.S.'34, a metallurgist with the Brooklyn Navy Yard, has made an application for a patent on the centrifugal casting of metal.

JAHN, A. J., serves as a mining engineer with the Shenandoah Dives Mining Company at Silverton, Colorado.

SCHMEDEMAN, O. A., is in the Harvard Graduate School, where he is furthering his schooling by taking graduate work.

PFEFFER, OSCAR, '22, acts as a sales engineer for the Allis-Chalmers Manufacturing Company, working out of Detroit, Michigan.

Mechanicals

GEERLINGS, HENRY J., '05, holds the position of consulting engineer with the company of Geerlings and Henschel of Milwaukee.

BRECKINRIDGE, WILLIAM L., '15, who is with the Johns Manville Sales Corporation, acts as a sales engineer for them. At present he is stationed at Davenport, Iowa.

SULLIVAN, JOHN F., '23, has the position of assistant consulting engineer in the mechanical division of the Commonwealth Edison Company of Chicago.

KRATSCH, ARTHUR E., '29, is the designer of machinery and chief engineer for the Curt G. Jos., Inc., Manitowoc.

TAFT, BERNARD E., '31, works as a refrigerating engineer for the Vilter Manufacturing Company of Milwaukee.

Chemicals

HIEMKE, HUGO W., '26, who was formerly with the A. O. Smith Corporation of Milwaukee, now acts as a welding engineer and senior metallurgist in the United States Navy Department at Washington, D. C.

SMITH, DAVID B., '32, acts as a chemist for the Shell Petroleum Corporation of Wood River, Illinois.

BEYERSTEDT, RALPH L., '33, has a position as engineer with the Arps. Corporation of New Holstein, Wis.

SCHAPER, RALPH, '35, has left his position with the Sivyer Steel Company of Milwaukee and is now with the Pelton Steel Company.

PETERS, ADOLPH, '33, M.S.'35, who was formerly with the Sivyer Steel Company, is now employed by the George H. Smith Steel Casting Company.

Electricals

ANDREW, EDWIN L., '16, has the position of vice-president with Fuller and Smith and Ross in Cleveland.

NIELSEN, ARTHUR C., '18, who is the president of A. C. Nielsen Company, has recently announced the removal of their general offices to the new Nielsen Building at 2101 Howard Street, Chicago. The new building is the first ever dedicated to the science of marketing research. In this building are housed some 185 marketing specialists, investigators and statisticians, who carry on the work of providing facts and figures on the flow of goods through retail outlets and into the hands of consumers.

SHARP, HOWARD M., '22, acts in the capacity of lighting sales manager for the Buffalo, Niagara and Eastern Power Corporation of Buffalo.

MANSFIELD, H. STANLEY, '22, is a patent lawyer in the firm of Pennie, Davis, Marvin and Edmonds, 165 Broadway, New York City.

NELSON, ERIK N., '24, had the honor of representing the University at the inauguration of Charles L. Anspach as president of Ashland College, Ashland, Ohio.

ROYCE, WILFRED A., '16, has the position of rate department manager with Cia Impulsora de Empresas Electricas of Mexico City.

ELLIOT, HOWARD S., '03, serves in the capacity of secretary for the Huntly Project Irrigation district at Ballantine, Montana.

KELLY, THOMAS F., is associated with the Anaconda Wire and Cable Company as a sales engineer. He works out of New York City.

Civils

REID, JOHN W., '06, is associated with the Robins Conveying Belt Company of Newark, New Jersey. He acts in the capacity of vice-president for the above company which specializes in engineering, contracting and manufacture of conveying and hoisting machinery.

MOORE, LeROY, '33, who is with the U. S. Biological Survey, working out of Shullsburg, Wisconsin, serves as under engineering aide. He has been doing land surveying on migratory waterfowl refuges. By the way, his friends know him as "Dinty."

MIDERER, EDWARD, '34, has a position with the Philadelphia Electric Company. His work consists mostly of drafting, with a little surveying and estimating.

DODGE, E. R., '32, teaches surveying at Case School of Applied Science, Cleveland, Ohio.

RICHARDS, JERRE T., '95, a construction engineer with the U. S. Public Works Department, recently completed a project at Ames, Iowa.

KLINGER, WILLIAM A., '10, was elected president of the Associated General Contractors of America at their recent annual convention in Miami, Florida. Mr. Klinger is president of W. A. Klinger, Inc., which specializes in building and bridge construction.

SINZ, EDWARD F., '05, of Elkhart Lake, Wis., is spending the winter at Crystal River, Florida.

FLUECK, WALTER J., '25, who is with the Armstrong Cork Products Company of Milwaukee, acts as a sales engineer and branch manager for the company.

TENNANT, A. V., formerly city engineer of Portage, now occupies the position of hydraulic engineer for WPA and is in charge of drainage control work with main office at Madison.

"STATIC"

***by* ENGIN EARS**

● That little goon with the slide rule was in again yesterday with some more sound advice for our frosh, to wit:

THE VOICE OF EXPERIENCE

As you Frosh grow up to be big strong men (like the senior Civils), you must all eventually come to know the Facts of Life. In order to begin this delicate subject, let us state that in the life of every man comes a time when he finds it necessary to do what is so quaintly termed "polish the apple." This has to do neither with fruit nor with manual labor, but rather the establishment of better psychological harmony between instructor and pupil. Then, no matter how he has scorned the practice before, said pupil begins to "polish" to beat all— well, it's pathetic to watch. The fundamental principles of this art are worked out in high school, but it is, rightly enough, in our own fair university that it attains its peaks of development. Speaking from years of research and not a little personal experimentation, we roughly classify the more popular local types into two general groups: the academic and the extra-curricular.

The first group contains three distinct branches which are more or less related. The first and most common is what might be termed "the 3-point fixation." The disciple of this school is the brilliant little boy who knows all the answers and isn't the least bashful about airing them. He hands in all experiments and reports on time. He discusses his sources of error with the teacher. On exams involving a choice of questions, he unnecessarily does every one on the sheet—and gets 'em all right. In general, he tries to make the rest of the class look like the dopes that they are, which attitude is resented by the latter, as they would prefer that the prof. be kept in ignorance of this fact.

The second of these types is less obvious but still wearing on the nerves. In this are the boys who argue each point with the instructor, bring up stray issues, want to know why, and so keep the people around them awake and uncomfortable. Their assumption is, of course, that such debate stamps the polisher as an interested and wide-awake fellow, and that each debate won by the polishee is a boost to his ego. By the end of the semester, this type is heartily loathed by both class and mentor, and plans are under way to dunk him in the soothing waters of Mendota.

Still a third class includes those (their name is legion) who scorn to fawn before instructors, who delay all reports at least two weeks as a matter of principle, who sleep when the lecture bores them, and at the end of the year inform teachers that they are here to learn things, not to glom onto a lot of meaningless grade-points. Theoretically, the instructor is so impressed by their manliness and candor that he gives each at least a B+. This, if it works, is known as the "finesse approach." This type, though, often do come out with a D or a "Con." Instructors do get the darndest ideas!

Nor is the classroom the only field of action for the enterprising; extra-curricular activities play their little part. For purposes of the old shinola, there are two main angles of attack outside of school hours. The first, crudest but most enjoyable one, consists of inviting the teacher out for a couple of beers. It being an established fact that one engineer can drink any faculty member under the well known table, this is combining business with pleasure. If, however, the polishee is a teetotaler, the polisher is behind the equally well known eight-ball.

For fraternity men a much subtler attack is reserved; one might say, the master touch. The instructor in question is invited to one of the house parties. If he be married, presto, he becomes what is humorously known as a chaperon; if he be foot-loose and fancy free, he is provided with a girl. In any case, he is provided with all the materials necessary to produce the pleasant glow. It has been found in many cases that before the evening ebbs away, he will, without any further stimulation, have provided grounds for an exceedingly remote and almost unconscious form of blackmail. This never fails; though it is sometimes hard for all the good brothers to agree on a single victim at each party.

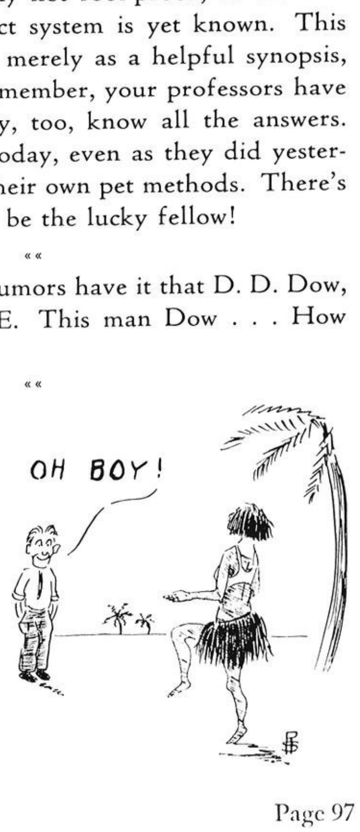
Such systems are obviously not fool-proof; to the best of our knowledge no perfect system is yet known. This short dissertation is offered merely as a helpful synopsis, a basic text, so to speak. Remember, your professors have been through the mill; they, too, know all the answers. Still, students are working today, even as they did yesterday and will tomorrow, on their own pet methods. There's still hope; perhaps you may be the lucky fellow!

»» ««

● The latest Winchellian rumors have it that D. D. Dow, M.E.4, got a bid from G. E. This man Dow . . . How the dickens does he do it?

»» ««

● Did you n o t i c e that Herb Stuewe, M.E.4, and John Wright, Ch.E.4, were hovering around Sterling Hall when the Standard Oil interviewer was here to hire men for foreign service? What's wrong with the French Legion in Afghanistan, boys?



The Comparison Camera

CARL WALTER e'38

HATS off once more to Professor J. H. Mathews, nationally known criminologist, who manages to be a very able chairman of the Department of Chemistry in his spare moments. During the past year he has perfected his own comparison camera, a device first used by T. N. Lewis, to a point where it now surpasses in efficiency the comparison microscope commonly used in ballistic work.

The complete unit, as may be seen from the first illus-

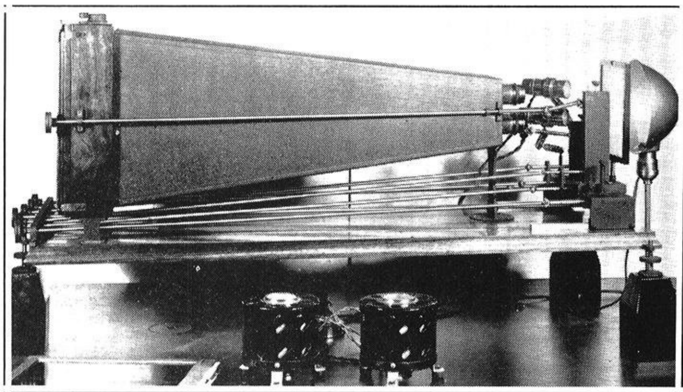


FIG. 1. *The Comparison Camera*

tration, consists of a camera with lenses, bellows, and viewing plate, independent and adjustable mounts for the bullets under observation, and special lighting circuits. A heavy brass block, mounted on slides in front of the lenses, carries the bullet mounts and the necessary lights. The bullets are mounted on interchangeable studs which, in turn, fit on pins centered on the horizontal gears. Small focusing lights, one for each bullet, are also bracketed to this block. A third light behind a frosted glass plate furnishes the necessary silhouette of the bullets. Incidentally, the gears regulating the movements of this unit were so constructed as to eliminate the back-lash commonly found in worm drive systems.

The camera bellows is a rigid box 36″ in length which tapers from a 12″ square back end to a 5″ square front end. It is divided into two lightproof compartments by a thin metal plate inside. This plate is hinged at the forward end so as to bisect this end of the box horizontally and extends to within a quarter-inch of the ground glass

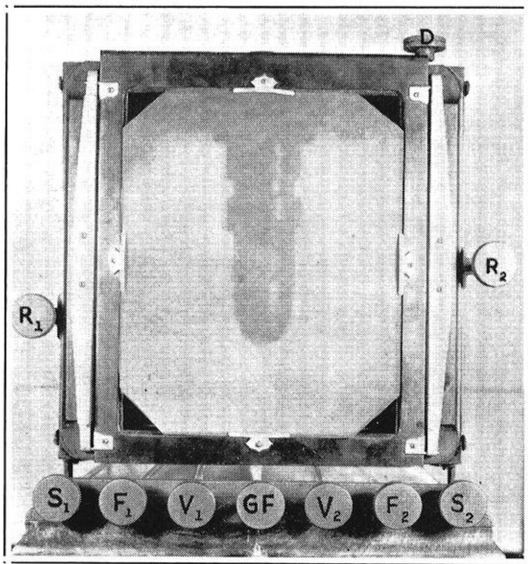


FIG. 2. *Viewplate of Camera*

plate at the rear end, the free end being adjustable up or down by means of knob-rotated, threaded, vertical rods passing through the brass blocks which support this end, the rotation of these rods being synchronized by a sprocket-and-chain arrangement.

By rotation of the knob D at the top rear corner of the box this horizontal partition may be set so that the bullets are compared at any desired point. This division of the bellows shows as a hair line in picture 3, it being the only indication as to where one bullet becomes visible and the other invisible. Focusing is done on the 8″ x 10″ ground glass as shown in the second cut. Paired lenses of the desired focal length are mounted at the front of this bellows, one to focus each of the bullets on the viewing plate, that is, that part of the image not blocked out by the partition in each case.

Once mounted each bullet may be moved independently of the other, moved forward or back by knobs F_1 or F_2, vertically by knobs V_1 or V_2, or from side to side by knobs S_1 or S_2. The entire block may be moved forward or back by knob GF, this in case lenses of different focal length are installed. The diaphragms are stopped down to f 32 and lateral alignment inspected by means of the silhouetting light; illumination on the two bullets is equalized by rheostat control. When the images of the bullets have been clearly and accurately aligned, either may be rotated about its longitudinal axis by knobs R_1 or R_2 until the striations on the visible half of one seem to continue without a break (supposing the bullets to be from the same gun) into the supplementary half of the other, so giving the appearance of one complete bullet. A plate holder then replaces the ground glass and photographs are made using stops f 16 or f 32. Contact prints and enlargements are made from these negatives.

Since long focal lengths are used (either 4.5″, 48 mm., or 60 mm.) keener definition and better detail, so necessary for good enlargements, are more possible with this instrument than with the comparison microscope. The composite image of the bullets, sharp and complete, is at the eye-level of the operator; all rheostats and controls

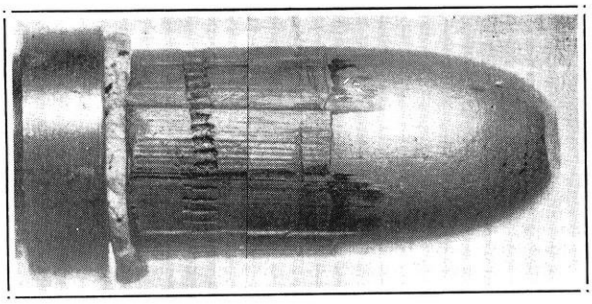


Fig. 3. *Photograph of Bullets*

are also at his finger-tips—thus is eye-strain eliminated and time saved. The enlargements, showing what is apparently a single complete bullet, made up of the fore part of one bullet and the rear half of the other, is a much more convincing court exhibit than pictures of small, allegedly corresponding parts of the fatal and test bullets, more convincing to the eyes of the jury and more satisfying to the scientific preciseness of Dr. Mathews as well.

THOUGHTS OF AN ENGINEER'S SWEETHEART

PATIENCE, my dear . . . . yes, I know, but he has to finish that E.E. report, and his Steam and Gas report has long been overdue. But then he isn't so bad off; the fellow across the hall is eight reports behind . . . .

Oh, he really loves you, but the report **is** due — 'twas truly said, "Man's love is of man's life apart; it is woman's whole existence."

I should think that you would know the engineers by this time — study, study, study is all they do. Why don't you try a few "outside activities" to keep you busy? It's a shame most women are so faithful (I can't say so much for the men). If you had to fall in love, why didn't you pick someone who had a little "social sense"?

Well, at least he can dance. That's more than most engineers can do — perhaps you aren't so bad off anyway . . . .

Oh, don't be a fool and wait for him to call. Go on to bed. He only said he **might** call. And then, besides, there is that report, E.E. again . . . .

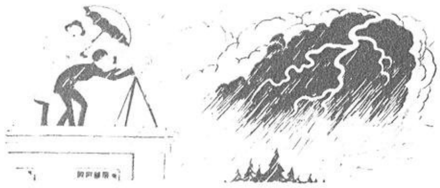
A Word With You

YOU have had Polygon Plans and Activity Fee Cards flung at you from all directions for the past several weeks. However, it would do well to take a square look at the facts.

If there were no Polygon Plan in operation now, these would be your expenses for one year as an engineer. For admission to two dances, $2.00; one year's subscription to **The Wisconsin Engineer** would be $1.50; there would be a small charge to cover expenses of two smokers; money would be required for materials necessary to construct the floats for St. Pat's Parade; and student societies would charge you chapter dues as well as National Professional Society dues. These were the expenditures of engineers before the Polygon Plan came into being. The most elementary piece of arithmetical comparison will show you that paying Polygon its Activity Fee of $1.00 per semester is an enormous saving. That fee pays for those dances, smokers, materials for St. Pat's Parade, **The Wisconsin Engineer** subscription, the chapter dues of your student society, and 60c toward your national dues. That, in short, is the dollars and cents value of the Polygon Plan.

However, there is more than a pecuniary return on such an investment. For one thing, it enables Polygon to establish a definite running budget for the semester, so that the most profitable expending system can be carried out. Not only does that mean greater returns for you, but it guarantees piece of mind and financial stability for your Polygon representatives. Moreover, it removes an enormous burden from the business staff of the magazine, in that there need be no complicated and inconvenient system of soliciting subscriptions. The societies benefit by it, since they are assured a definite source of income. If everyone obviously benefits by such a plan, why not support it? You can pay your Activity Fee at the Engineering Library any time. Do it now!

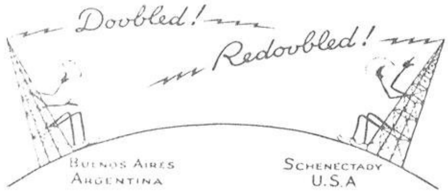
G-E *Campus News*



CRASH!

IT'S a thunderstorm sweeping over Pittsfield, Massachusetts. But G-E engineers, instead of hiding under the bed, go up on the roof to be nearer the lightning. On one of the buildings of the Pittsfield Works they have built and equipped a lightning observatory. By means of an ingenious periscope and a high-speed, motor-driven camera, any lightning flash occurring within many miles—north, south, east, or west—can be automatically photographed. Its characteristics, as recorded on the film, can then be compared with those of the artificial flashes produced by the 10,000,000-volt lightning generator in the laboratory.

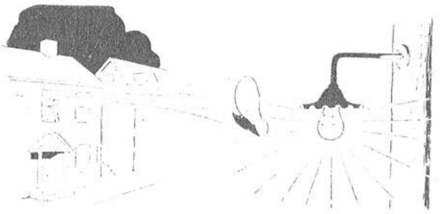
An observatory has to have a hole in the roof. This causes astronomers no embarrassment, because they can work only in clear weather. But with lightning observers it is different—when there is lightning there is also rain. So, to keep the rain from falling on the 12 lenses of the new camera—and from running down the engineers' necks—compressed air is blown upward through the aperture. When next the thunder rolls over the Berkshires, and timid citizens are cowering under the bedclothes, these General Electric engineers will be up on the roof taking elaborate notes on Jove's own brand of lightning.



GAME BID

DOUBLED! Redoubled! North led, but the dummy was 6000 miles away. Psychic bids flew thick and fast when a North American contract-bridge team, including Mr. and Mrs. Ely Culbertson, played a "bridgecast" tournament with a high-ranking team from Argentina. The North Americans were seated on the stage of Rice Hall in the General Electric Company, at Schenectady, N. Y., while the Argentine team played at the Casabal Club in Buenos Aires. The plays were carried by the short-wave stations W2XAF and LSX, of North and South America, respectively.

W2XAF, in Schenectady, used a feed-back circuit so that short-wave listeners all over the world, tuned to the one station, could follow the playing with as great ease as the 500 kibitzers who jammed Rice Hall. This was the first international bridge broadcast in which the principals were all recognized experts. The North American team, captained by Culbertson, won by a margin of 1030 points.



BEDROOM PRIVACY

MANY a man has shinned up a lamppost to daub paint on a street lamp that shone in his bedroom window. Many another light sleeper, of lesser climbing prowess, has tried throwing shoes and hair brushes at the offending light. Now there is hope that this war will soon be over.

Adequate street lighting is, of course, a necessity. G-E illumination engineers have perfected a new fixture that directs the light where it is needed—on the street—and keeps it from trespassing on the pillow. A concealed light source and a reflector designed along new optical lines have removed street lamps from the list of public enemies of sleep. Motorists, too, will welcome these new luminaires. Because the reflector extends below the incandescent source, the driver's eyes are protected from direct glare—he can see the road better.

96-227DH

GENERAL ELECTRIC