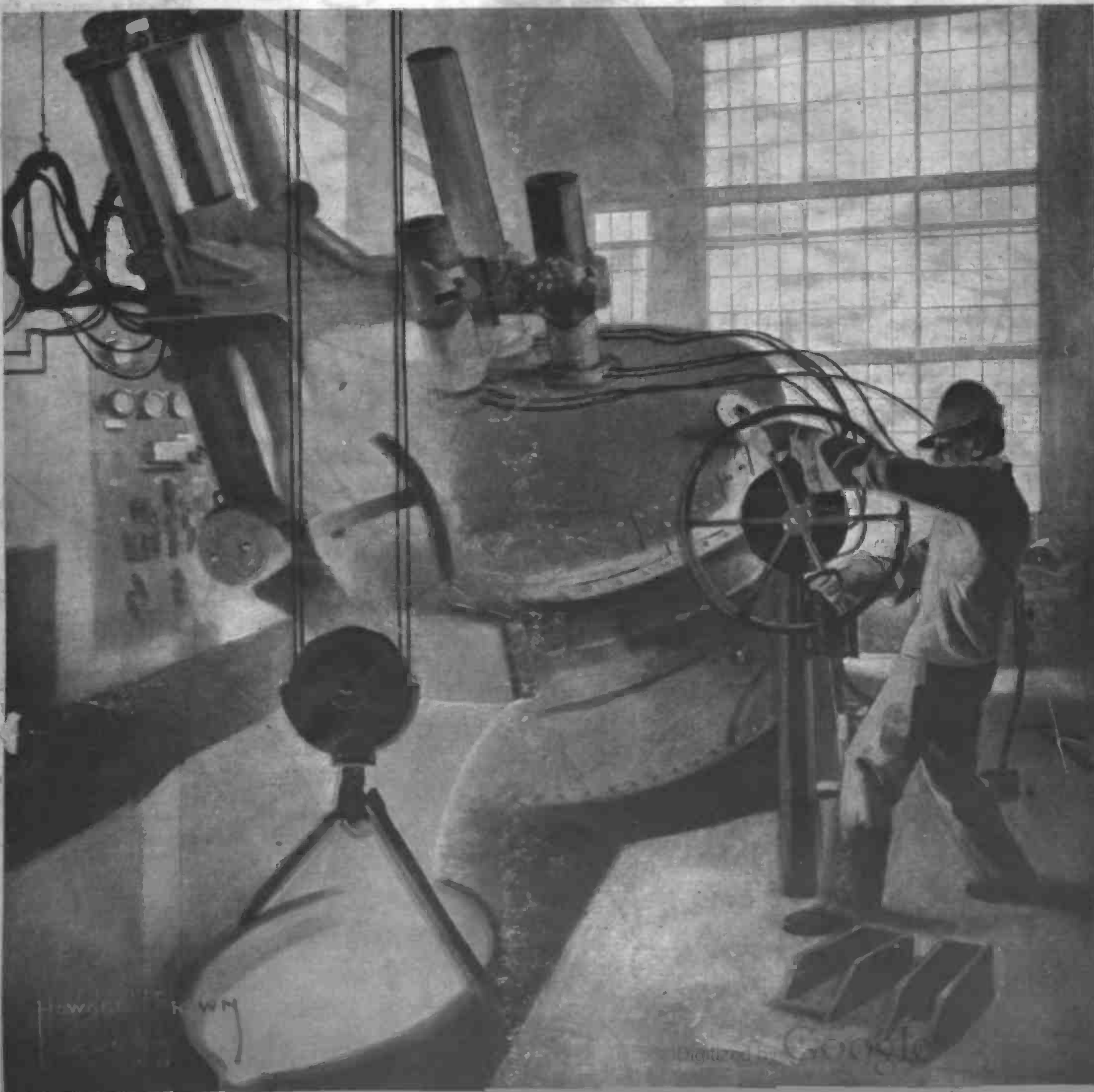
EVERYDAY ENGINEERING MAGAZINE

November—December
1919—Vol. 8—Nos. 2-3

Fifteen Cents
a Copy



CONTENTS

Vol. 8 November—December, 1919 No. 2—3

EVERYDAY ENGINEERING MAGAZINE

2 West 45th Street New York City

Editor RAYMOND F. YATES — *Managing Editor* VICTOR W. PAGÉ — *Radio Editor* M. B. SLEEPER

Contributing Editor
PROF. T. O'CONOR SLOANE

Advertising Manager
STEPHEN ROBERTS

Branch Advertising Offices
E. M. CLEMENT, 320 Wayne Avenue, East Oakland, Calif.
SEARS & IRVING, Peoples Gas Building, Chicago, Ill.

Southern Representative
H. W. ENGLISH, P. O. Box 339, Birmingham, Ala.

Published Monthly by
EVERYDAY MECHANICS COMPANY, INC.
New York, N. Y.

Entered as second-class matter November 20, 1915, at the post office at New York, N. Y., under the Act of March 3, 1879.

Subscription price $1.50 a year in the United States and possessions. Canada, $1.75; Foreign, $2.00 a year.

AN EXPLANATION

AS many of our readers probably know, both the November and December numbers of "Everyday" have been unavoidably delayed by a very disastrous printers' strike—disastrous both to the printers and publishers alike. It is claimed that the strike, which completely crippled the printing industry in New York City, cost the publishers about $50,000,000 and the printers $750,000 in lost salary.

THE printers demanded a 44-hour week with a flat increase of $14.00 per week on all wage scales. It would be impossible to even outline the developments that followed thereafter. Suffice it to say that the demands precipitated a strike which left the publishers of "Everyday" in an absolutely helpless way. Not a wheel of the printing industry was turning in New York City. We could not have paid the increase, even though it was agreeable to us, as the magazine is printed by contract with a large New York printer, who produces many other magazines besides "Everyday". We could have printed out of town at a tremendous expense, and with no end of trouble in moving tons of paper, type matter and cuts, to say nothing of the editorial staff. The strike caused a great increase of work in the lithographing establishments, and thereby cut off this avenue of possible retreat. Even then, it would have been necessary to typewrite the magazine at the cost of its appearance and amount of reading matter.

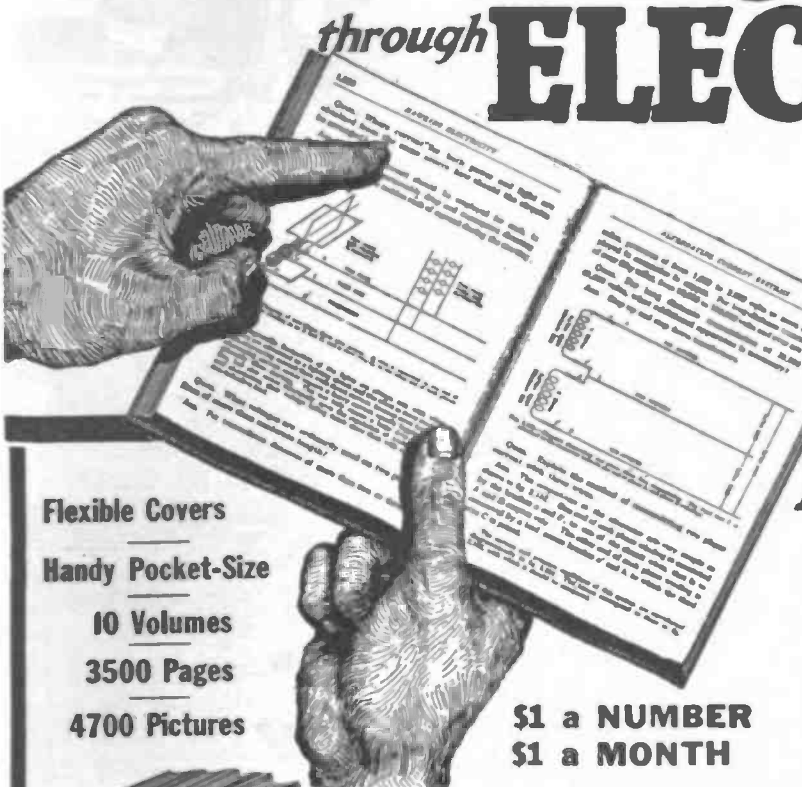
AT the very moment when it looked as if it would be necessary for us to take the magazine from New York, the printers appeared at their posts. It was then decided to put out a double number of the magazine, which would include the very best material that was to appear in the November and December numbers. Hence, the 96-page November-December number of "Everyday" which is now in your hands. This issue, however, will not be counted as two on subscriptions. Every subscription will be advanced one month.

WE take this opportunity to thank our many readers who have kept their faith in us and who have been forced to share our misfortunes.

RAYMOND FRANCIS YATES,
Editor.

Get Bigger Pay

through ELECTRICIT



by using your set of HAWKINS Electrical Guides Every Day. They tell you just what you need to know.

HAWKINS
Electrical Guides

Flexible Covers

Handy Pocket-Size

10 Volumes

3500 Pages

4700 Pictures

$1 a NUMBER
$1 a MONTH

place electricity at your fingers' ends. They cover every subject, principle, theory, problem, trouble, and way of doing things electrically. Every subject is indexed so that you can turn right to it. They are a study course and a reference guide in one, written in plain every day language—no wasted words—only what you need to know—full of up-to-the-minute electrical knowledge. The guides are a complete course in electrical engineering.

They will help you in every detail of the day's work. You can't ask an electrical question that Hawkins Guides can't give you help on.

The WHOLE SET sent for your inspection FREE

The books are small enough to slip into your coat pocket—handsomely bound in flexible black covers.

You can carry each volume with you until you have mastered its contents. 3,500 pages of actual information and 4,700 illustrations. Once you see these books and put them into actual use you will never again want to be without them. Try it at our expense.

TO EARN MORE—LEARN MORE

It will cost you nothing to receive these books—to look them over—ask them all the questions you can think of—use them in your work—study them—pick up some information that will increase your earning ability. We will ship you the entire set of 10 volumes entirely FREE.

This is a sign of our confidence in the guides. Pure gold does not object to being tested. Keep them for seven days and if you do not decide that you can't get along without them, return them to us and owe us nothing.

When you decide to keep them you only have to pay $1.00 down and remit the balance of $9.00 on the easy payment of $1.00 a month till paid for.

Use the coupon to get the books. It will pay you many times over.

READ THIS PARTIAL LIST OF CONTENTS

No. 1 Contains 348 pages, 388 illustrations. Electrical signs and symbols—static and current electricity—primary cells—conductors and insulators—resistance and conductivity—magnetism—induction coils—dynamo principles—classes of dynamos—armatures—windings—commutation—brushes, etc.

No. 2 Contains 348 pages, 394 illustrations. Motor principles—armature reaction—motor starting—calculations—brake horsepower—selection and installation of dynamos and motors—galvanometers—standard cells—current measurement—resistance measurement—voltmeters—wattmeters—watthour meters—operation of dynamos—operation of motors, etc.

No. 3 Contains 300 pages, 423 illustrations. Distribution systems—wires and wire calculations—inside, outside and underground wiring—sign flashers—lighting protection—rectifiers—storage battery systems, etc.

No. 4 Contains 270 pages, 379 illustrations. Alternating current principles—alternating current diagrams—the power factor—alternator principles—alternator construction—windings, etc.

No. 5 Contains 320 pages, 614 illustrations. A. C. Motors—synchronous and induction motor principles—A. C. commutator motors—induction motors—transformers: losses, construction, connections, tests—converters—rectifiers, etc.

No. 6 Contains 293 pages, 472 illustrations. Alternating current systems—switching devices—current breakers—relays—lightning protector apparatus—regulating devices—synchronous condensers—indicating devices—meters—power factor indicators—wave form measurement—switch boards, etc.

No. 7 Contains 31. pages, 379 illustrations. Alternating current, wiring power stations—turbines: management, selection, location erection, testing, running, care and repair—telephones, etc.

No. 8 Contains 332 pages, 436 illustrations. Telegraph—simultaneous telegraphy and telephony—wireless—electrolysis bells—electric lighting—photometry, etc.

No. 9 Contains 322 pages, 627 illustrations. Electric railways—electric locomotives—car lighting—trolley car operation—miscellaneous applications—motion pictures—gas engine ignition—automobile self-starters and lighting systems, electric vehicles, etc.

No. 10 Contains 513 pages, 599 illustrations. Elevators—cranes—pumps—air compressors—electric heating—electric welding—soldering and brazing—industrial electrolysis—electro-plating—electro-therapeutics—X-rays, etc.

Also a complete 126 page ready reference index of the complete library. This index has been planned to render easily accessible all the vast information contained in the 10 electrical guides. There are over 13,500 cross references. You find what you want to know instantly.

What Users Say:

Become a Superintendent

Hawkins Guides are worth double their price. I have been able to secure higher pay and a better position with their aid.

K. W. Monard.
Supt. Erskine Light & Power Plant, Erskine, Minn.

$5,000 Saved

The ten dollars I invested in Hawkins Electrical Guides netted the company by whom I am employed somewhere around $5,000.

The knowledge gained from your books enabled me to save a transformer house, whereas a year ago I should have thought myself in great danger and have run.

Use this letter as you please as I am truly thankful for having the little wonders. A. L. Foster, Opher, Colo.

Handy to Carry

The great beauty of them is that you can carry them in your pocket. That suits me for I never want to be without them. F. S. Collins.
Richardson Engineering Co., Hartford, Conn.

THEO. AUDEL & CO.
72 Fifth Ave., New York, N. Y.

THIS COUPON BRINGS THE GUIDES

SEND NO MONEY

THEO. AUDEL & COMPANY
72 Fifth Avenue, N. Y.

Please submit me for examination Hawkins Electrical Guides (price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory I agree to send you $1 within seven days and to further mail you $1 each month until paid.

Signature ....

Occupation ....

Employed by..........

Residence ....

Reference .... Nov.-Dec.

SEND NO MONEY-USE THE COUPON

Face the Facts-

Training Brings Real Money

There are too many bookkeepers and clerks—not enough Expert Accountants. Training makes the difference. Only by training can you win the bigger job.

You—yourself—must decide whether tomorrow you will be a plodding bookkeeper or clerk or an independent executive. The worker market has plenty of $800 employees—but altogether too few qualified to handle the **$3,000, $5,000** and **$10,000** positions.

Why Accountancy Training Is So Valuable Today

New Income and Excess Profit taxes have brought home to literally thousands of firms the necessity of accurate records. American business is branching out in all directions—foreign and domestic—and with this tremendous expansion has come a keen appreciation of the importance of preventing waste and misdirected energies—of developing better methods of Cost Accounting. Positions are open today in every community for auditors, comptrollers, cost accountants, credit men, and public accountants at salaries ranging from $2,500 to $12,000, and even higher. Face the subject squarely. **Where men are scarcest**—there must trained experience demand highest salaries. Fit yourself for this most profitable of professions and tomorrow's success will take care of itself.

Applying the Success Formula

W. A. Thompson was once a bookkeeper—today he is Comptroller of the Allis Chalmers Mfg. Co. In less than 3 years through I. A. S. training he made the jump.

Arnold O. Link rose from Assistant Bookkeeper to Office Manager through the study of our course in Accountancy—**increasing his salary 500%.**

E. W. Brickell was a clerk when he began his I. A. S. training—today he is General Auditor of the Everwear Hosiery Company.

These stories are not the exceptions—if you will mail the coupon below for our book, "Stories of Success," you will find hundreds of similar examples. They prove, without a shadow of a doubt, that you **can** learn through the home study method—that I. A. S. trained men actually **are** holding big executive, auditing and cost positions.

Executive Positions Always Open to the Trained Accountant

Big business simply cannot get enough of men with trained accountancy experience. The accountant is executive timber. His work gives him a bird's-eye view of the whole business. The accountancy trained man dominates. No matter what your present position or education—if you have the gritty determination to make good—I. A. S. training will bridge the gap for you between your present position and high salaried independence—training that may be secured in spare time without giving up your present work.

Study at Home Under the Guidance of Experts

Every member of our faculty is a Certified Public Accountant actively engaged in the practice of his profession with successful experience in the teaching of Accounting. The sixteen-year successful record backs up the course—among our students and graduates are over 100 Certified Public Accountants. Low tuition and easy terms place the benefits of I. A. S. home study training within the reach of every ambitious man.

Elective Features Multiply the Value of the Lessons

In addition to a remarkably thorough practical training in Accountancy you are enabled through our elective feature to specialize in any branch of Accountancy you may prefer. Scientifically planned lessons fitted to the individual needs of each student enable you to save more than six months in the completion of your course—make it possible for you to cash in on the value of your training just that much sooner.

Two Big Books "Stories of Success" and "How to Learn Accounting"—FREE

Get these books—at once. They describe in a simple, straight-forward way the opportunities in higher accountancy today—show how hundreds of others have won better positions—tell how you, too, can fit yourself for a better position—a bigger salary. The evidence will certainly convince you.

Request

International Accountants Society
Dept 44-E Chicago Illinois

Gentlemen:-

Please send me without obligation whatsoever "Stories of Success" post paid

Very truly

Name ____________

Address ____________

City ____________ State ____________

INTERNATIONAL ACCOUNTANTS SOCIETY
a department of the Tanner-Gilman Schools Incorporated
DEPARTMENT 44-E, 2626 S. Michigan Ave., CHICAGO, ILL.

Short Cuts to Bigger Pay

Your last chance to procure one of these famous McGraw-Hill Home Study Courses at the old prices.

Here are three of the McGraw-Hill Home Study Courses that make promotion sure. Each represents practically a life time of study and practice. They are not correspondence courses. They are self-teachers. All the information you need is laid before you in plain language and plain illustrations.

Croft's Library of Practical Electricity

The only electrical library in existence that actually teaches electrical practice as experts know it. 3,000 pages and 2,100 illustrations taken from electrical work itself. 8 flexibly bound volumes, pocket-size. Easy to read and easy to understand, and the principles easily applied to work as it is done. For both the beginner and trained man, for reference or study. Price before February 28, 1920, $16. Afterwards $20, payable $2 in ten days and $3 per month.

Power Plant Library

The most used engineers' library ever published. Over 30,000 power plant men are using them as a means of passing examinations and becoming chief engineers. 8 volumes, durably bound in dark blue cloth. About 2,700 pages, 1,800 illustrations. If you are interested in any branch of power plant work you must have these books. They will enable you to pass the examination in any state. Price before February 28, 1920, $12. Afterwards $16, payable $2 per month.

Not one cent in advance

Merely check the library in which you are interested, fill out the coupon and return to us. We will ship the set of your choice for ten days' absolutely free examination. Return at our expense if you are not thoroughly pleased. Pay only the small monthly payments called for if you are satisfied the books will increase your earning power. But act now. Tomorrow may be too late to get the books at the old price.

McGraw-Hill Book Co., Inc.

239 West 39th Street, New York

Machine Shop Library

The practical side of machine shop work, written by such well known authorities as Colvin, Stanley, Lake, Goodrich, Haas, &c., 3,000 pages, 2,000 illustrations. 9 volumes, dark red cloth, morocco grained. Suitable to the needs of every man connected in any way with the machine shop. Records of actual practice that show the way to more pay. Price before February 28, 1920, $16. Afterwards $20, payable $2 in ten days and $3 per month.

Save $4 by ordering NOW

An advance of $4 in the price of each set must be put into effect after February 28, 1920. Orders received by us after that date will be charged at the increased rate. No exceptions can be made. Even at the new prices these books are the best buy in engineering literature of the time.

FREE EXAMINATION COUPON

Add $4 to the price of each set after February 28, 1920

McGraw-Hill Book Co., Inc., 239 W. 39th St., N. Y.
Gentlemen: Send for ten days' free inspection the Library I have checked below:

- ☐ Croft's Electricity, $16—payable $2 per month.
- ☐ Machine Shop Library, $16—payable $2 per month.
- ☐ Power Plant Library, $12—payable $1 per month.

If satisfactory I will send first payment in ten days and the same amount each month until paid. If not wanted I will return the books at your expense.

Signature ....

Residence address ....

City and State ....

Your employer ....

His address ....

Your occupation ED-11

This Boy Knows. Do You?

This boy has had THE BOOK OF KNOWLEDGE in his home for a year and he can explain to you interestingly and correctly all the familiar things which he sees around him. His teacher will tell you that when she wants a quick and intelligent answer from her class, this boy always answers first. He understands many subjects of interest in the papers and magazines and in the conversation of his elders. *He has made a long start in the race for knowledge.*

Answers Every Question a Child Can Ask

Why is ice slippery?
Why is the sea never still?
Can a plant see?
What are eyebrows for?
Why does milk turn sour?
Why is snow white?
Do the stars really twinkle?
What makes the color of the sunset?
What makes knots in wood?
What makes an echo?
What makes shadows?
Why is it warm in summer?
What is camouflage?

The Book of Knowledge

The Children's Encyclopedia

10,000 Educational Pictures **In Five Languages** **350 Colored Plates**

English French Spanish Italian Portuguese

Curiosity—The Great Teacher

Curiosity is the beginning of all knowledge. Do you know any subject about which your child has not asked you a dozen questions? Let him ask as many as he likes, and be sure to answer them correctly. That is the parent's most important and most easily neglected duty. If you discourage your child's curiosity you will injure his mind, and the bright boy or girl becomes stupid or indifferent. Through curiosity Columbus discovered America. THE BOOK OF KNOWLEDGE is the simplest and most natural method of helping the child to educate himself. *It answers every question a child can ask in plain and simple language.* So captivating is this great original work to the mind of a child that he absorbs with little effort the profound truths and great facts of the world of knowledge, while reading its delightful pages and looking at the thousands of striking educational pictures.

Your Child is Unique

Your child is like no other child in the world. He has his own peculiar taste and need for both physical and mental food. If you put a meal before him and let him choose what agrees with him best, he will thrive. THE BOOK OF KNOWLEDGE is the right kind of nourishing food for the child's mind during the growing years. Give your child this remarkable, original work, and watch carefully which of the 16 Great Departments interests him most, Nature, Science, History, Biography, Astronomy, Physiology, Art, Literature, Poetry, or Manual Training. It will prove *THE KEY* to his natural bent, and the kind of work or profession in which he will most easily succeed.

Your Child's Chance

In round numbers, what is your child's chance to become successful? If uneducated, he has one chance out of 150,000; with a common school education, 4 chances; with a high school education, 87 chances; with a college education, 800 chances, *with THE BOOK OF KNOWLEDGE in the home,* every chance. It is not a luxury, it is an absolute necessity. It is an *INVESTMENT* in your child's future which will pay dividends as long as he lives. In over *600,000* homes today the children are being educated with THE BOOK OF KNOWLEDGE. *Give your child his chance to compete with them.*

Satisfy Your Desire To Know By Mailing FREE COUPON Today

If you have a child to educate, *between four and sixteen years old,* send for the FREE sample-page BOOKLET TODAY. It contains 80 fascinating pictures and pages from THE BOOK OF KNOWLEDGE, some in natural colors. It will help you to decide this important matter without delay. Every day without it is a loss to your child.

Send for this BOOKLET TODAY. Mail the FREE COUPON NOW!

THE GROLIER SOCIETY
2 West 45th Street, New York

Please mail descriptive book containing specimen pages and illustrations from THE BOOK OF KNOWLEDGE, and explaining the use and meaning of the work for the mind of a child.

Name ....

Address ....

EDE 203

CLASSIFIED ADVERTISING COLUMNS

Advertisements in these columns 5c per word, average 7 words to the line. To insert advertisement under proper classification copy should reach us not later than the first of the month.

Agents Wanted

AGENTS—Something different! Our Bradium (Luminous) Crucifix actually Shines in the Dark. Startling! Mysterious! Wonderful enthusiasm follows every demonstration. 150% profit on every sale. Sole manufacturers. The Pioneer Corporation, 1265 W. 63rd Street, Chicago.

GET OUR BIG MONEY MAKER monogramming Autos, etc., by transfer method. Catalogue and particulars free. Motorists Accessories Co., Mansfield, Ohio.

AGENTS. Signs for store and offices. Entirely new. $50-week easily made. Chicago Sign System I-326 River St., Chicago.

American Made Toys

AMERICAN MADE TOYS WANTED. An opportunity for homeworkers on small scale and manufacturers on large scale. Unlimited quantities needed of Toy Soldiers, Army, Navy, Marines, Cannons, Machine Guns, Warships and other toys and novelties. Enormous demand and future in American Made Toys all over United States, Canada, Mexico and South America with over 50,000 10-cent stores and toy dealers. This new American industry stands out conspicuously. Factories are established, people trained, machineries made. Christmas Sets needed in millions this year. The great hit for 1919 without any competition. We are buyers of these goods all year, paying fixed prices. Attractive prices offered for painted goods. Experience or tools unnecessary. Hundred and more made complete per hour. Casting form outfits from $3.00 up. If you mean business, send for booklet and information free. TOY SOLDIER MANUFACTURING CO., 32 Union Square, New York.

Auctioneers

AUCTIONEERS. Make big money. Free Catalogue. Carpenter's Auction School, Kansas City.

Automobile Accessories

MORE Power, less fuel, no carbon. No Mystery, plain facts, results guaranteed. Write for booklet. No-Leak-O Piston Ring Company, Baltimore, Maryland.

FORD SPEED and Power Specialties in stock; 4 Speed Forward Auxiliary Transmission, doubles the pulling power or increases speed 40%; 16 Overhead Valve Cylinder Head; speed carburetor; cam shaft; piston rings; light cast iron and aluminum pistons; crankshaft counter balances; high tension magnetos; underslung fixtures; front wheel roller bearings; speed, power bevel gears; foot accelerator; large steering wheels; racing bodies; radiators; complete racing cars $650—$1750 two weeks delivery. Victor H. Ford, Transmission Manufacturers, 250 W. 54th, New York.

BATTERY CHARGING. Profit $100 to $250 Clear Monthly with HB Equipment. Your lighting current or engine operates. No expense to you. Easy payment plan lets outfit earn own way. Satisfaction guaranteed. Write HOBARTS, TROY, OHIO. Box EE.

VULCANIZE RUBBER without heat or tools. Whirlwind seller to every Auto Owner. Further particulars free. Muscatine Agency, E402, Muscatine, Iowa.

Automobile Schools

HAVE YOU A TRADE?—Why not learn the Automobile Business—actual practice under expert instructors qualifies you in a few weeks' time to repair or drive any make of car, truck or tractor. There are always plenty of good positions open for trained men. Write today for particulars to Buffalo Auto School, Dept. 84, Buffalo, N. Y.

Aviation

WANT TO EXCHANGE small airplane for motorcycle. Brubaker, 522 East 78th St., New York.

BUILD A STAR JUNIOR BIPLANE—Plan $2.00. Or send $3.75 for plan and book "Aeroplane Construction and Operation." Chicago Aero Works, Plan Dept., 326 River St., Chicago.

Blueprints

BLUEPRINTS of Model Boat Turbine 50c and U. S. Destroyer $1.00. Adams, 163 De L'Epee Ave., Montreal.

BLUEPRINTS: Small Steam Engines & Boilers, Gaso. Engines, ⅛—¼—½ H. P. 3 Sets, (13 Sheets) Postpaid $1.00. Circular on Castings for Stp. Modern Model Engineering Co., 364 Monadnock Blk., Chicago.

MODEL ELECTRIC MOTOR Blue Prints 25c. Complete working outfit $1.75. A. F. Cassel, 52 West 130th St., New York City.

Books

WHAT DID YOU DREAM? Ten Thousand Answers $1.25. Exclusive Sensational Novel "Genevieve de Brabant" $1.10. Voice Hindoo Mystic "senam" 33c. "Phenomena of Spirit" 33c. Catalogues 2c. Sovereign Company, 160 Sycamore, Buffalo, N. Y.

BOOK READERS—Write for free descriptive catalogue. Central Sales Co., 601 Ninth Ave., New York.

Business Opportunities

$1 DOES IT. Texas oil land making holders big money everyday. Bank references furnished. Investigate us thoroughly, that's all we ask. Results count. Our plan $1 down, balance monthly few months gives you Warranty Deed to land. May pay profits $200 or more monthly. Maps, reports, Established facts FREE. Address Sourlake Texas Oil Co., 835 DeMenil, St. Louis, Mo.

Business Opportunities

MONEY SAVED—All kinds used correspondence courses sold. (Also courses bought.) Write Lee Mountain, Pisgah, Ala.

Chemicals

CHEMICALS—50 different chemicals including Iodine, Mercury, Antimony, etc. Material sufficient for hundreds of experiments. Send $4.

LABORATORY APPARATUS—25 piece set. Includes Alcohol Lamp, Beaker, Erlenmeyer Flask, funnel, 10 test-tubes, Test-tube holder, etc. Send $3.

PIGMENTS—25 different pigments used in manufacturing Paints, Varnishes, Rubber, Paper, etc. Send $4. TECHNICAL EQUIPMENT COMPANY, Dept. 3CC, 22 East 17 Street, New York.

MICROSCOPES, Balances, Experimental Laboratories. Buy through our easy Payment Plan. No red tape. Write for Booklet 24-E. Chemical and apparatus supplied for all Chemistry articles appearing in Everyday Engineering. Perform their experiments with our equipment. Lions Scientific Institute, Bausman Street, Mt. Oliver, Pittsburgh, Penna.

CRUDE RUBBER: Experiment with pure uncompounded India Rubber. Make tire patching cements, water proof cloth, porous tire filler, rubber stamps, etc. First latex Para (highest grade India rubber) 4 oz., 50c; 8 oz., 80c; 1 lb., $1.25; 5 lbs., $5.00. Address, Bunsen Supply House, 14 S. Canal St., Akron, Ohio.

EXPERIMENTERS.—This Ad pays for itself because Everyday Engineering Readers are our regular customers. Our chemicals, apparatus, and supplies outfit their laboratories. Why not yours? Ask for free pricelist and free service card. Lions Scientific Institute, Mt. Oliver, Pittsburgh, Pa.

Drafting

MECHANICAL DRAFTING, all descriptions. Inventions and models developed, lowest rates, personal and prompt attention. F. L. Miller, 36 Jewett Ave., Cortland, N. Y.

Educational

CIVIL ENGINEERING one year. Students received any time. Technical Institute, Greenville, Ohio.

Electrical

"DANDITOY" Transformers, 2½—27½ volts only $2.98. Description sent. Eagleco, Darien, Connecticut.

100 INDUCTION MOTOR winding diagrams 1, 2, 3, phase star delta. 2 to 12 poles inclusive. Postpaid $5.00. E. Glass, 2108 South Broad Street, Philadelphia, Pennsylvania.

CHRISTMAS TREE Lighting Outfits; 8 light $2.75; 16 light, $5.50. Send for list. Eagleco, Darien, Connecticut.

Fish

GOLD FISH. Imported Japanese, Chinese and American fish aquarium plants. We manufacture beautiful home aquariums. Descriptive circular free. Pioneer Goldfish Hatcheries, Racine, Wisconsin.

Formulas

10,000 TESTED FORMULAS; Cost 1c for 25, before ordering send for catalogue "KK"—today. Goodnow, Highland Ave., South Sudbury, Mass.

370 FORMULAS, 10c. Fitzgerald, 15 West 65th St., New York.

GUARANTEED Workable Formulas—$1.00 each: Mechanics' Hand Paste; Bluing Steel Parts (heatless process); Carpet Cleaning Paste; Fire Extinguishing Compound. Detailed method of preparation and sources of supply accompany all formulas. Industrial Methods Bureau, 1 West 34th Street, New York City.

EXPERT CHEMIST will furnish Formulas, Processes and Trade Secrets. All lines. Lists free. W. L. Cummings, Ph.D., 228-230 Gordon Ave., Syracuse, N. Y.

MANUFACTURING PROCESSES, Formulas, Technical Information. Interesting booklet free. Consulting Chemist, Little Falls, N. J.

For Advertisers

"THE TEN GREAT SECRETS of a Successful Letter"—A wonderful little book in 10 short chapters by Ad-Man Davison, highest-paid advertising writer in the world. Cloth-bound, postpaid $1. E. B. Davison, Publisher, Dept. E., 512 Fifth Avenue, New York.

For Sale

100 6¾ ENVELOPES PRINTED to your order (2) colors, 75c prepaid. Write for Samples. Lincoln Novelty Co., Rochester, N. Y.

GENUINE INDIAN BASKETS—90 Styles. Catalogue. GILHAM, Highland Springs, California.

FOR SALE—Knapp Type SS Dynamo 6 volts, 4 amp., slightly used, $7.00. Red Devil Water Motor, $3.90. Slightly used tools and electrical supplies. Send stamps for list and prices. J. Norlie, 2158 Knapp Street, St. Paul, Minn.

FOR SALE. Scott Boiler and Turbine in working order. Adams, 163 De L'Epee Ave., Montreal.

NO. 29 GOODELL LATHE Outfits $25.00 Speedy and Oscillating, castings and Small tools for sale. Enclose postal. Steam and Water Gauge Parts also valves all for $1.50. Aitken, 1714 Brown St., Philadelphia, Pa.

FOR SALE. Every issue Everyday Engineering ever published. In good condition. Also complete line of wireless instruments. Bard L. Frankhauser, 179 Marcy Avenue, Brooklyn, N. Y.

For Sale

CALIFORNIA FARMS FOR SALE. Write for list. E. R. Waite, Shawnee, Oklahoma.

Gummed Labels

FREE CATALOGUE containing ideas in package labels suitable for your business. Stock labels a specialty. Royal Label Co., 29 S. Seventh, Philadelphia.

Help Wanted

WRITE for newspapers and magazines. Big Pay. Experience unnecessary, details free. Press Reporting Syndicate, 534 St. Louis.

CENSUS CLERKS; Railway Mail Clerks; Mail Carriers wanted by Government. Thousands men—women needed. $1100 year. Common education sufficient. List positions free. Urgent. Write today. Franklin Institute, Dept. L-99, Rochester, N. Y.

WE WILL START YOU in the cleaning and dyeing business, little capital needed, big profits. Write for booklet. The Ben-Vonde System, Dept. B, Charlotte, N. C.

THOUSANDS U. S. GOVERNMENT Census and Railway Mail Positions now open. Men, Women, 18 up. $1100—$1700 year. Common education sufficient. Write immediately for list positions. Franklin Institute, Dept. M 99, Rochester, N. Y.

GOVERNMENT positions highly desirable; thousands appointed annually through frequent examinations everywhere; prepare immediately for Post Office Clerk, City or Rural Letter Carrier, Railway Mail Clerk, Washington Departmental Clerk, Stenographer-Typist, unexcelled correspondence instruction at $5. Request particulars concerning positions desired. Federal Civil Service School, 604 Kellogg, Washington, D. C.

2000 GOVERNMENT Railway Mail Clerks wanted. Men, women, 18 up. $1300 year to beginners. Write immediately for list of positions open. Franklin Institute, Dept. N 99, Rochester, N. Y.

Inventors

INVENTORS. In all matters concerning Patents, The National Institute of Inventors, 118 Fulton St., New York City, a co-operative society of 2500 will help you protect, develop and market your inventions. Annual dues $10.00. Booklet on request.

INVENTORS—We do experimental, Model, Tool, Die and Jig work. Light manufacturing. Miller & O'Brien Mfg. Co., Saint Paul, Minn.

INVENTIONS WANTED.. CASH OR ROYALTY for ideas. Adam Fisher Mfg. Co., 223, St. Louis, Mo.

Machinery

VIOLET RAY MACHINES. Complete. Working Drawings $1.00. All parts ready to assemble $10.00. Satisfaction Guaranteed. J. Barwick, 89 Britannia Ave., Hamilton, Ont., Canada.

CONCRETE BUILDING Block Machines and Moulds. Free Catalogue. 200 South Second Street, St. Louis, Mo.

Male Help Wanted

RAILWAY TRAFFIC INSPECTORS; $110.00 a month to start and expenses; travel if desired; unlimited advancement. No age limit. Three months home study. Situation arranged. Prepare for permanent position. Write for booklet CM-36. STANDARD BUSINESS TRAINING INSTITUTE, Buffalo, N. Y.

Miscellaneous

WE MAKE GOVERNORS to control Auto and Cycle engines when used as stationary. Write today for circulars. C. D. H., Box 582, Dept. E., Taft, Calif.

CREATING A SENSATION. The Mack Sennett Bathing Beauties now appearing on the stage in the principal cities of the United States. Three splendid photographs 25c. Descriptive literature free. Mutual Supply Co. Publishers, Bradford, Pa.

TOBACCO OR SNUFF HABIT cured or no pay. $1.00 if cured. Remedy sent on trial. Superba Co., S. M., Baltimore, Md.

BREED Canaries—Profitable pastime. Particulars free. Bird Farm, Lynnhaven, Virginia.

SPORTSMEN.—Trained beagles, rabbit, fox, coon, skunk, squirrel, and opossum dogs, bird dogs, pet and farm dogs, swine, rabbits, pigeons, pheasants, goats.—100 Varieties blooded stock. Circulars 10c. VIOLET HILL KENNELS, YORK, PA.

$1.00 PAID for Volume 1 Numbers 4 and 5, Everyday Engineering Magazine. George Walter, 2312 Hughes Street, Brooklyn, N. Y.

Model Supplies

MODEL VENTILATORS. Height from 1½ to 2¾ ins. Diameter at mouth 1 in., ⅝in. and ⅞ in. Price $2.00. Polished copper lacquered. Menne, 74 West 89th Street, New York.

BOYS build your own Electric Motor. Complete outfit $1.75. Blue Prints 25c. A. F. Cassel, 52 West 130th St., New York City.

Motion Picture Plays & Supplies

$25-300 paid anyone for ideas, suggestions suitable for photoplays. Experience unnecessary; complete outline Free. Producers League, 530 St. Louis, Mo.

BARGAIN lists free. Motion Picture machines, film and supplies. National Equipment Company, Duluth, Minn.

CLASSIFIED ADVERTISING COLUMNS—*Continued*

Patents

PATENTS. Over 70 years' practice; all communications strictly confidential; handbook on patents free on request; special facilities for office consultations. Munn & Co., patent attorneys, 641 Woolworth Building, New York. 625 F Street, Washington. Tower Building, Chicago.

INVENTORS—Send sketch of your invention for advice regarding patent protection. Twenty Years' Experience. Hand-book on Patents sent Free. TALBERT & TALBERT, Patent Lawyers, 4821 Talbert Bldg., Washington, D. C.

PATENT WHAT YOU INVENT. It may be valuable. Write me. No attorney's fee until patent is allowed. Estab. 1882. "Inventor's Guide" FREE. Franklin H. Hough, 510 Loan & Trust Building, Washington, D. C.

PATENTS. Prompt, personal efficient service by an Attorney-at-law skilled in all branches of Patent practice. Over 12 years actual experience, full information upon request. B. P. Fishburne, 323 McGill Building, Washington, D. C.

PATENTS—Fees in installments. Frank T. Fuller, formerly Lieutenant, Engineers. Washington, D. C.

INVENTIONS PATENTED; Trade-Marks Registered; Labels, Prints, Publications Copyrighted; prompt service; reasonable fees; plain advice; request detailed information before placing your business. Jaynes & Jaynes, 884 Kellogg, Washington, D. C.

INVENTORS—Write for our free illustrated guide book, "How to Obtain a Patent." Send model or sketch and description of invention for our opinion of its patentable nature free. Highest References. Prompt Service. Reasonable Terms. VICTOR J. EVANS & CO., 748 Ninth, Washington, D. C.

PATENTS. Booklet free. Highest references. Best results. Promptness assured. WATSON E. COLEMAN, Patent Lawyer, 624 F St., Washington, D. C.

PATENTS—Herbert Jenner, patent attorney and mechanical expert. 622 F St., Washington, D. C. I report if a patent can be had and its exact cost. Send for circular.

M. H. LOUGHBRIDGE, Patent Attorney Consulting Engineer. The same high class service that is obtained by the large manufacturers. Charges moderate. Designs and Manufacturing specifications prepared. 1457 Broadway, New York.

PATENT RIGHTS on Automobile Snow Plow: new, superior, all metal. For clearing highways. Attractive commercial proposition. Harry Clark, Woodbury, Conn.

Photography

DO YOU TAKE PICTURES? Write for free sample of our big magazine showing how to make better pictures and earn money. American Photography, 466 Pope Building, Boston, Mass.

LIKE PHOTOGRAPHS? Real pictures? State wants, send dime for sample. Our lists free, over 800 negatives from all parts of the world. Gulf Curio Co., Houston, Texas.

DEVELOPING AND PRINTING of the highest class. Send your next Film roll to us. Developing 15c per roll. Prints 3 to 5c. R. R. McIntyre, General Post Office, New York City.

YOUR PHOTO and 30c gets 25 gummed stamp size Photos. Your photo returned. Work guaranteed. Muscatine Agency, E-402, Muscatine, Iowa.

Printing

100 LETTERHEADS or Envelopes, 85c; 100 Business Cards, 35c, prepaid; samples free. Wellmann Printing Co., Huntington, West Virginia.

Radio

YOU ARE NOT MODERN unless you read "The Radioist." "The Radioist" is a monthly amateur radio magazine, as original as its name; containing many novel departments and sure to please either novice or expert as it contains live, peppy articles interesting to both. You can greatly improve your set by reading the latest advanced ideas in "The Radioist." Yearly subscription $2.00. Special three months' trial subscription, 50 cents. (Stamps not accepted.) Be progressive. Send your subscription, regular or trial, immediately and receive the "New Year Issue" which will be a rip-roaring success. Delay means you're missing such as act now and subscribe today. INTERNATIONAL SOCIETY OF RADIOISTS, OMAHA.

Rubber Stamps

RUBBER STAMPS. If not delivered in 5 days return to your name and address, 50c. Stamp pads 25c. Order direct or send stamp for circular. Albert Porch, 7939 Bennett Ave., Chicago.

Stamps

APPROVALS 60% discount. Reference, please. Stamps bought. Lang, 1433-J 50th, Cicero, Illinois.

STAMPS SENT on approval at 70% discount. Reference required. J. Emory Renoll, Dept. W., Hanover, Pa.

100 STAMPS 5c, 300—10c, Buckey, 412-B Bowen, Dayton, Ohio.

JAPAN'S Stamp Dealer. Stamps of all countries. Purchase and sale or exchange on approval sheets. $1.00—$20.00 every mail. 40—400 Stamps in exchange, registered desired. Nakade Stamp Company, 26 Sakaecho, Hamamatsu, Japan.

VICTORY stamp packet 35c. Catalog value $1.50 to $2.00. All Different. A. J. Hotz, 1334½ Maple Ave., Los Angeles, Calif. NO STAMPS ACCEPTED.

50,000 COINS, Medals, Paper Money, Antique Fire Arms, Swords, Indian Relics, Curios, Stamp Collections. List free. Antique Shop, 33 South 18th St., Philadelphia.

Short Stories Wanted

SHORT STORIES, Poems, Plays, Etc., are wanted for publication. Literary Bureau, 166 Hannibal, Mo.

Telegraph

TELEGRAPHY (both Morse and Wireless) **AND RAILWAY ACCOUNTING** taught thoroughly and quickly. Big salaries now paid. Great opportunities. Oldest and Largest School. Est. 45 years. Catalog free. Dodges Institute, 24th Street, Valparaiso, Ind.

Tricks

1,000 STAGE TRICKS with 500 illustrations. Catalogue 15c. Small Catalogue Free. Hornmann Magic Co., Station 8, 304 West 34th St., New York.

Typewriter Supplies

RIBNSAVER makes dried, pale ribbons like new for one cent. 50c postpaid. Order yours today. Ribnsaver Co., 186 N. La Salle St., Dept. 18, Chicago, Ill.

Wireless

THE AUDION. Its early history and development. Electron Theory and Trigger Action. Compiled by a Chief Electrician Radio man who was situated at the Naval Radio School as Instructor for two years, written by an old amateur for the Amateurs in words that they can un-lerstand. Also Blue Print Diagrams for hook ups for Receiving Damped signals using both air exhausted and gas Bulbs. Receiving undamped signals and regenerative circuits. Two step Amplifier using same (A) and (B) Batteries for both steps. Wireless Telephony with a Power Bulb. Working Blue Prints on how to build a "One to One" transformer for use with Audion Amplifier. All for TWO DOLLARS. Address T. O. McKENZIE, 104 Warburton Ave., Yonkers, N. Y.

WIRELESS PARTS, PROMPT DELIVERY. Standard 1¼" switch knob-lever complete 35c. Switch points with screws 25c dozen. State panel thickness. Novotoy Electric, Charlotte, N. C.

WIRELESS. 22.5 Volts—15 cells B. Batteries—Standard Signal Corps, U. S. Army for Vacuum Tubes Type BA-2. Fully GUARANTEED, worth $1.50—our price 90c postpaid. State your wants in Receiving and Sending Wireless apparatus. We will quote very reasonable prices. The H. S. Wireless Co., 164 Ross St., Brooklyn, N. Y.

HIGH PRICES

OF APPARATUS ARE A HANDICAP TO MANY — EXPERIMENTERS —

Why not sell some of the things you need no longer, and put the money into new equipment?

Or have you instruments to exchange?

Thousands of experimenters read Everyday Engineering, so many that a single classified advertisement will bring you results, and at such a small cost.

THINK—WHAT CAN YOU BUY, SELL, OR EXCHANGE? TELL THE OTHER EXPERIMENTERS IN A CLASSIFIED ADVERTISEMENT.

PRACTICAL MECHANICS FOR EVERYDAY MEN

EVERYDAY ENGINEERING MAGAZINE

IT TELLS YOU HOW TO MAKE AND DO THINGS

VOLUME 8 NOVEMBER and DECEMBER 1919 NUMBERS 2 and 3

Electric Furnaces and Their Products

By Raymond Francis Yates

TWO centuries have passed since Sir Humphrey Davy "struck" the first electric arc. Barely a quarter of a century has passed since the first electric furnace capable of performing a serviceable day's work was put into operation. To-day the electric furnace has been applied to a multitude of industries. In some instances, as in the steel industry, it has taken the place of fuel-heated furnaces. In other cases it has made possible the creation of a new product which could not have been produced with the heat made available by any known process of combustion.

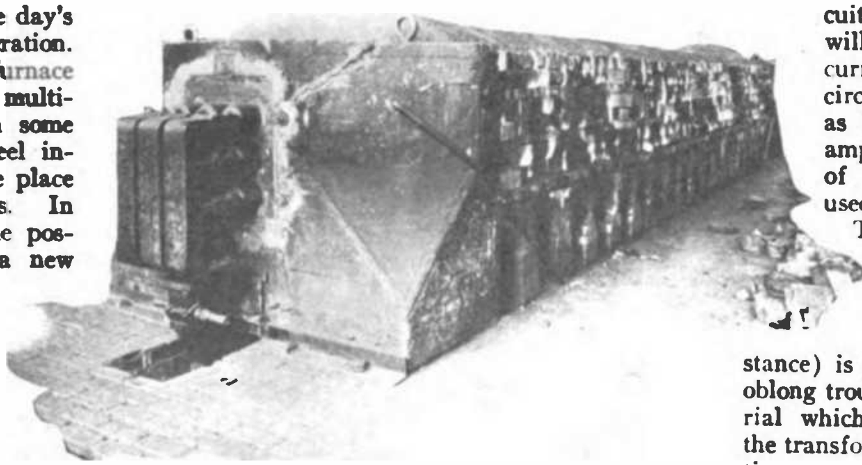


Photo Courtesy Acheson Graphite Co.

A resistance furnace used in the production of Acheson graphite. The highest temperature developed commercially is produced within the walls of this furnace

Wondrous changes are wrought within the glowing radiance of the electric furnace. Solid matter is made liquid, and liquid gaseous. Under the influence of a terrific heat chemical changes of combination and decomposition are brought about that would otherwise be impossible. For many years chemists dreamed of melting carbon. Moissian not only melted it; he boiled it! Nothing can withstand the continued application of the tremendous heat produced by the electric arc. In a sense, the electric furnace is probably one of the most destructive of earthly agencies. At least this is the belief of scientific men. No solid matter, regardless of its refractive properties, has been able to hold its identity within the electric furnace. There is no heat so terrible, so cruel and disruptive as that generated by the electric arc.

Electric furnaces are divided into three classes, *i.e.*, arc., resistance and induction. An electric arc is established when two electrodes of different potential are brought in contact and withdrawn. Thus, when two carbon electrodes are brought together to complete an electric circuit considerable heat is developed for the instant at the point of contact. This vaporizes a small amount of carbon which fills the space between the electrodes when they are separated. Current will continue to flow across this space, generating a terrific heat. The hot carbon vapor reduces the electrical resistance of the space between the arc from many thousand ohms to a few ohms. The quantity of heat generated will depnd entirely upon the current strength.

> *The electric furnace has fast grown to be a great and useful device in the industry of the world. Many wonders are wrought within its walls. In the blinding whiteness of its cruel, destructive heat chemical processes are brought about that could not be accomplished by any other known process. Through the medium of the electric furnace, Nature has been forced to yield some of her most guarded elements and compounds. This article, with the limited space it occupies, can be nothing more than a brief resumé of the great work that has been done in the field of electro-thermics.*

Resistance furnaces bear no resemblance to those of the arc type. Heat is produced by interposing some resisting material in an electric circuit. The heat generated will be governed by the current strength of the circuit. A current strength as high as ten thousand amperes with a pressure of fifty volts has been used.

The main part of an induction furnace is a transformer. The charge (which must be a conducting substance) is placed in a circular or oblong trough of refractory material which encircles one leg of the transformer and thereby functions as a short-circuited secondary. The induction furnace is not used to any great extent in America.

Arc furnaces are divided into two classes. Where the arc is drawn between one or more electrodes and the metal charge, the furnace is said to be of the direct heating type. Furnaces where the charge is heated by radiation from an arc established between two electrodes within the furnace are said to be of the indirect heating type.

Carborundum was one of the first products of the high temperature electric furnace. Dr. Edward Goodrich Acheson was the man whose genius gave this wonderful commodity to an awaiting world. Chemically, Carborundum is known as silicon carbide, which is expressed by the formula SiC. Its production is brought about by the reaction between the element silicon (in the form of silica or sand) and carbon in the form of coke. This reaction takes place within the confines of what has become known as "Carborundum furnace," which is a resistance furnace of the most simple and rugged type. A large graphite electrode is placed at each end of a long trough-shaped structure made of fire bricks or other highly refractory material. The resistance, which consists of ground coke, is interposed between the electrodes in the form of a round core. The charge is packed about this core and a refractory substance is placed between the charge and the furnace walls to prevent serious heat radiation and destruction of the walls by the exceedingly high temperature produced when the furnace is in operation.

A current strength of several thousand amperes is sent through the charge in the furnace under a pressure of from 80 to 110 volts. Under the influence of this great rush of current the core in the furnace soon reaches a tremendous temperature in the neighborhood of 2000 deg. C. The production of this temperature is accompanied by violent chemical decomposition and complete rearrangement of the elements within the charge. The more volatile substances succumb to the heat and the inflammable, gaseous products burn quietly at the furnace sides. In the interior of the furnace there is a fiery mass of blinding whiteness; in fact, the charge is brought to the point of incandescence. If it were not for the fact that it was smothered in a bed of refractory materials the charge would soon be consumed by the process of oxidation.

After thirty-six hours of operation the current is turned off and the furnace is allowed to cool. The sides are then taken away and a large core of still red-hot Carborundum crystals is bared to the atmosphere. As the cooling continues great masses of sharply pointed, iridescent crystals are in evidence. These are the crystals of Carborundum, second in hardness only to the diamond. Carborundum is the greatest artificial abrasive known and little can the layman appreciate the great value of this substance to industry. Carborundum is used in grinding steel rails and pearl buttons; it is used in grinding leather as well as glass. In fact, even the little wheels that buzz against our teeth in the dentist's chair are made of Carborundum.

It was while experimenting with the production of Carborundum that Acheson accidentally carried the temperature of his furnace too high. The result of this accident was the production of artificial graphite, a substance which has since done the world a wealth of good. If the temperature of Carborundum is carried too high the silicon is unable to withstand the increase and escapes in a volatile condition. This leaves the carbonaceous portion of the charge in the form of soft, unctuous graphite which is capable of withstanding the high temperature.

The graphite furnace is essentially the same type as the Carborundum furnace. In operation, however, the temperature of the graphite furnace is brought to a point considerably above that produced in the Carborundum furnace. As will be seen from the photograph, great copper bars carry the heavy current to the electrodes which are embedded in the concrete end blocks of the furnace. A number of large graphite rods form the electrodes.

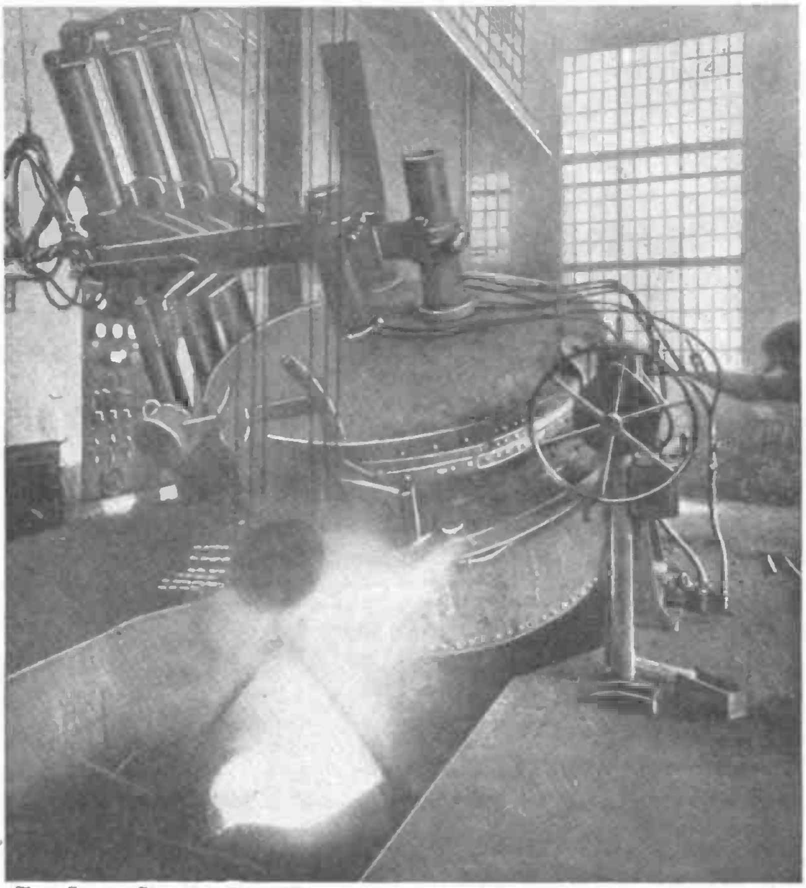


Photo Courtesy Pittsburgh Electric Furnace Co.

A small steel furnace pouring its charge

Silicon is another product that had its birthplace in the unconquerable heat of the electric furnace. The process of producing silicon electro-thermally is due to Mr. Frank Tone, a metallurgist of international fame. Unlike Carborundum or graphite, silicon is produced in a furnace of the arc type. The process is that of reduction. Carbon in the form of coke is placed in the furnace, together with silica. The reaction is one of substitution. The silica, unable to withstand the reducing action of the carbon, decomposes and thus liberates its silicon. The oxygen in turn combines with the carbon, producing carbon dioxide and mono-oxide. The silicon continuously runs forth from the spout of the furnace in a little fiery-red stream.

Aluminum was at one time a metallic rarity. Men gazed at small samples of it enviously through the glass cases in the museum. The furnace in which aluminum is produced does not in any way resemble the more conventional types. In fact, it is really an electrolytic cell maintained at a high temperature. The electrolyte is composed of a molten mass of cryolite and alumina. This molten mass is held in a large rectangular steel case heavily lined with carbon. Two large electrodes are introduced through the top of the device and these make contact with the charge. During the operation the alumina is decomposed into aluminum and oxygen. The aluminum collects at the bottom of the furnace in a fused condition. The aluminum furnace, or what is better known as the Hall furnace (named after its inventor) does not employ an arc in any way, the required heat being produced by the resistivity of the charge. The normal operating temperature of this furnace is in the neighborhood of 1,600 degrees Centigrade.

Calcium carbide was first produced by Wilson. Like many other discoveries of note, its first production was purely accidental. The Wilson carbide furnace is a very interesting but simple type. A large iron crucible mounted upon a truck and heavily lined with carbon forms the body of the furnace. Suspended above this are two graphite electrodes so arranged that they can be adjusted vertically. The charge in the furnace consists of powdered lime and coke. The arc is drawn between the molten mass of carbide and the two electrodes. The potential difference between the electrodes is 175 volts. The current strength is 3,500 amperes.

The chemical reaction which is brought about within the furnace between the powdered lime and coke follows: $CaO + C = Ca + CO_2$ and $Ca + 2C = CaC_2$. The molten carbide forms a pool at the bottom of the furnaces.

A great number of these electric furnaces are operated at Niagara

Falls, N. Y., which is the greatest electric furnace center in the world. This is because cheap electrical energy is available in great, but on the other hand, limited quantities.

It was in the year 1898 that Capt. Stassano produced the first real workable electric furnace for the production of steel. Today, there are hundreds of such furnaces in operation wherever cheap power is available for their operation. In fact, they have been developed to such a point of efficiency that they are being operated in many localities where power is not cheap. The production of steel from metallic ingredients is brought about in furnaces which greatly resemble the open hearth furnace in their action. A number of these are used for the fusion of pure materials in the proper proportion for making steel. These materials are pure pig iron, wrought iron or molten steel. Other furnaces are employed in melting together pig iron, steel scrap and ore. Furnaces of this type are always made with a basic lining to allow the removal of phosphorous and sulphur from the steel by limey slag.

Steel furnaces of the arc, induction and resistance types have been developed. In America the Héroult furnace has gained considerable popularity. This furnace is of the series arc type. Two large electrodes pass through the roof and arcs are drawn between these and the metallic charge. In this way the current passes in the furnace through one electrode and out through the other. The Héroult furnace is encased in a steel shell lined with dolomite bricks and crushed dolomite. The roof is made up of silica bricks. The hearth of the Héroult furnace which is exposed to the molten charge, is made of burnt magnesite. To prevent excessive oxidation of the electrodes a water jacket is placed around them at the point where they enter the furnace. By the circulation of water through these jackets the temperature of the electrodes is kept fairly low. When the charge is ready to pour the furnace is tipped by mechanical means.

The electrode regulation of the Héroult furnace is entirely automatic. If the arc becomes too long, the electrode is lowered, or, if the arc becomes too short, the electrode is raised. This happens without the attention of the furnace attendant.

There are a number of different types of electric furnaces in America. They all have their advantages and disadvantages like many other things. It would require more space than is allowable to completely describe the outstanding features of the various steel furnaces in use. They range all the way from one ton capacity to the great giants that are able to accommodate twenty tons as one charge.

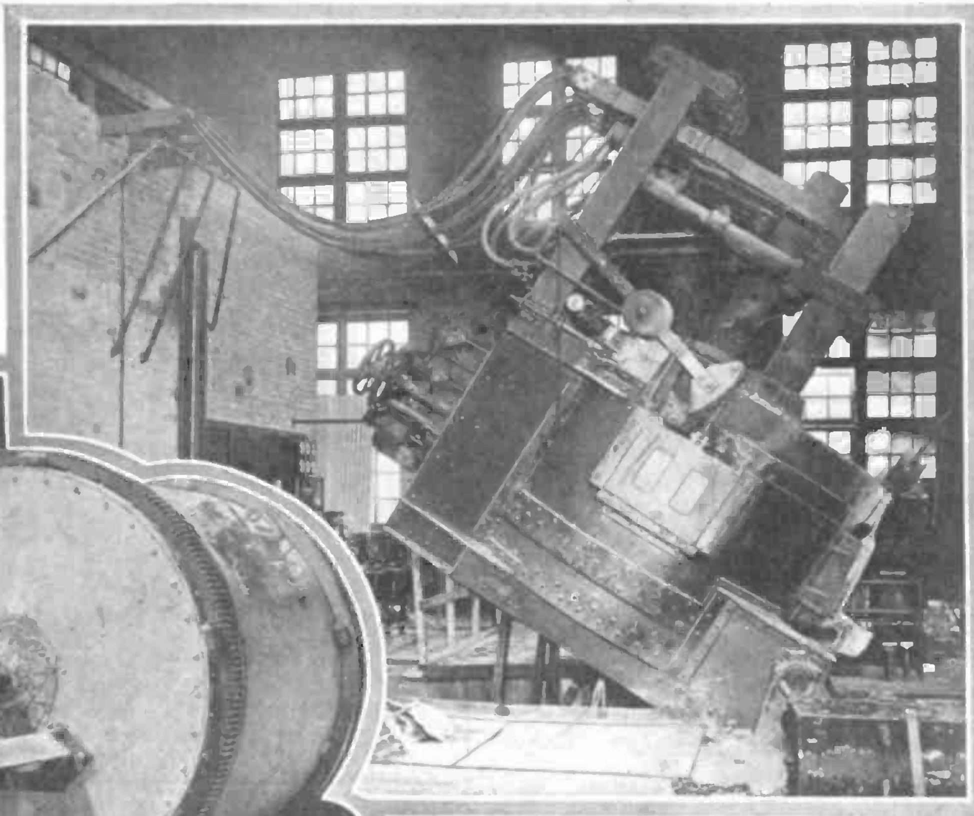


Photo Courtesy Westinghouse Elec. Mfg. Co.

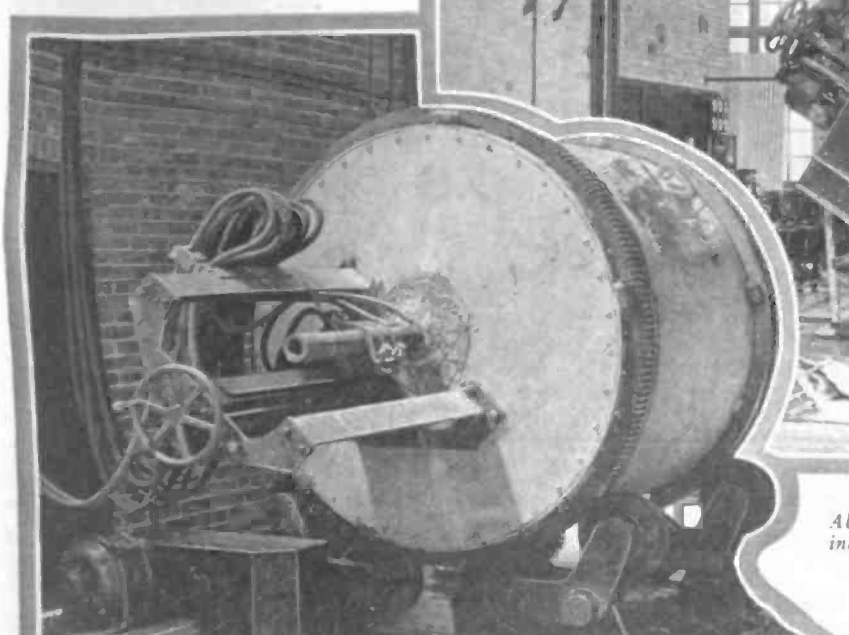


Photo Courtesy Detroit Electric Furnace Co.

Above: A Westinghouse electric furnace for the steel industry. Below, left: A newly developed furnace used in melting brass

A few years ago carbon disulphide was produced by passing sulphur vapor over red hot charcoal. Thanks to the ingenuity and resourcefulness of one R. E. Taylor this product is now being produced abundantly and cheaply with the aid of the electric furnace. It is one of the many products that has been cheapened through the medium of the electric furnace.

A great quantity of ferro-alloys are used annually in the steel industry for deoxidizing steel to produce sound ingots. These alloys include ferro-silicon, ferro-chrome and ferro-manganese. Such alloys are now produced in great quantities by means of electric furnaces of the arc type. The process of electric production is a great improvement over the older processes formerly used in the ferro-alloy industry. Like many other electric furnace productions, the ferro-alloys are produced in enormous quantities at Niagara Falls.

Phosphorous is produced within the electric furnace by heating phosphoric acid with some form of carbon. The resulting vapor is distilled and condensed outside of the furnace. Owing to the fact that the process of producing phosphorous must be carried on without the presence of air this operation is nicely adapted to the electric furnace.

Within the last few years a furnace has been developed in which brass can be successfully melted. This has been the aim of metallurgists for some time. Mr. H. W. Gillett of the United States Bureau of Mines must receive the credit for having designed one of the most successful electric furnaces for the melting of brass.

A furnace used for melting brass must of necessity have many unique features owing to the peculiarity of the service which it is required to render. The speed of production depends largely upon the rate at which heat can be produced within the furnace without serious injury to the refractories from the metal under treatment.

One of the most important items of cost in melting copper alloys which contain large percentages of zinc and lead is the loss of metal through vaporization and oxidation. It is quite impossible to entirely eliminate this loss, but on the other hand, it is possible to reduce it to a minimum by melting the alloy in a tightly closed furnace chamber in the presence of a neutral or reducing atmosphere. In the ordinary fuel heated furnace there must be a constant draft.

The rocking electric furnace for the melting of brass which is shown in one of the photographs accompanying this article is really one of the greatest triumphs of electro-metallurgy. The furnace shown consists essentially of a cylindrical steel shell lined with refractory substances and mounted on rollers and ring gears in such a way that it is free to move within an arc of 200 degrees. The rocking motion during operation is produced by a small motor through the proper reducing gears. The sourc of heat in this particular furnace is an electric arc drawn between two graphite electrodes placed axially within the furnace. These electrodes are regulated by wheels. The arc is produced in the exact center of the furnace.

When the furnace is charged the electrodes are withdrawn and only their tips are flush with the inner walls of the furnace. This is to prevent them from being broken by the heavy pieces of metal that are dumped into the furnace. During the first few minutes of operation the furnace remains still since rocking it at this state would probably break the electrodes. After the heat has been applied for some time and the metal becomes soft the rocking motion is started, first through a small arc and gradually increased until the metal becomes completely molten. During this rocking motion the molten metal washes the inner lining of the furnace to within a few inches of the charging door. Two complete oscillations are made per minute. As the molten metal washes over the refractory lining any excess heat which the lining may have is directly absorbed by the metal and put to a useful purpose.

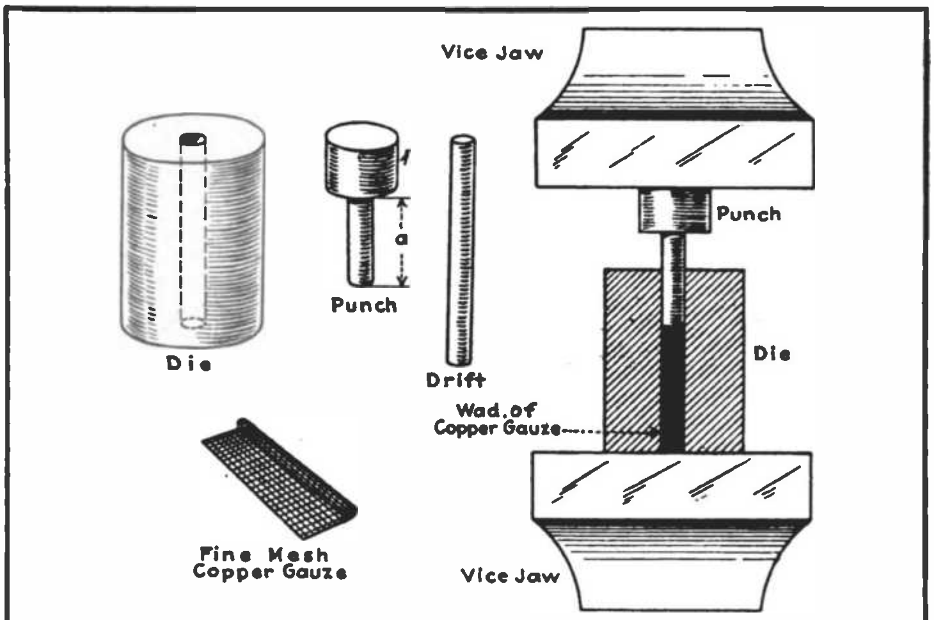
Making Copper Gauze Motor Brushes

By J. A. Weaver

COPPER guaze brushes are widely used on the smaller sizes of motors and dynamos, especially low voltage machines where the high resistance of a carbon brush is not suitable. No doubt most experimenters think it is beyond their means to make their own brushes and it should be interesting to learn how easy it can be accomplished with the aid of a simple home-made device.

First, it is necessary to make a die in which the brushes are formed. There are several types that can be employed, but, as it would require considerable trouble to make a split die without proper shop facilities, the simple one piece die illustrated in the drawings was selected, as it can be easily made with the aid of a small lathe, and serves the purpose admirably. Cold rolled steel shafting will do for the material. A piece of shafting of suitable diameter should be cut about twice as long as the length of the brush desired, and its ends faced off square. Next, a hole the same size and shape as the cross section of the brush to be made is formed in the center of the shafting. This should extend through its entire length. In the case of a round brush, this is a simple matter. Then a punch or follower should be made with an easy sliding fit for the die. The length of the portion A from the shoulder to the end of the punch should equal the length of the die minus the length of the finished brush. The ends of this punch should be faced off square. A drift the same size as the punch, but a little longer than the die, should be provided for ejecting the finished brush. These parts and the method of using the same are clearly shown in the drawings.

The copper gauze used, especially for the smaller sizes of brushes, should be of as fine a mesh as can be obtained and the experimenter should experience little trouble in obtaining a suitable grade from any hardware or supply house. A strip of gauze is cut with a width about twice as great as the length of the finished brush, although the exact width necessary to use in order to make a finished brush of a certain length depends upon the pressure applied in forming and can only be determined by experiment. The strip should be of sufficient length so that when it is wadded up it can be readily forced into the die. After the wad is pushed in the die the punch should be started in behind it. Then the outfit should be placed between the jaws of a vise and pressure steadily applied until the shoulder of the punch rests against the face of the die. The wad will then be fully compressed. Then the punch should be removed and the brush ejected by means of the drift. When the diameter of the punch is very small and there is danger of it buckling under the pressure necessary to compress the gauze then it can be driven in by light blows from a hammer. It is well to keep the punch and die well lubricated.



The copper gause brush is better, for small machines, than carbon on a flat metal brush

In compressing the copper gauze, it will be found that a tremendous pressure can be exerted by means of the vice. It must be remembered that a vice is really a combination of the screw and lever.

The Everyday Engineering Cup Races

Speed Boat Contest at Central Park Causes Lively Competition

On the 21st of September, the Everyday Engineering Magazine cup races were run off at Central Park. A large, enthusiastic crowd of spectators were present and everyone thoroughly enjoyed the event which was not without its exciting, as well as amusing, moments.

Mr. Raymond Francis Yates, Editor of Everyday Engineering, framed the racing rules to which the model boat owners adhered to closely. The rules were as simple as possible. The boats were raced separately around a circular course 300 feet in circumference. Each boat had to make three laps. The owners were each given a half an hour to make their boats cover the required distance. The boat that made the three laps with the lowest total of seconds was the winner. Thus, a boat making three laps with 15 seconds for the first, 12 seconds for the second and 11 seconds for the third, which would produce a total of 38 seconds, would win over a boat that made the three laps at 15 seconds a lap, giving a total of 45 seconds.

The rules stated that it was not necessary to make three continuous laps. Time could elapse between the laps, providing they were all run off within the half hour allowed. None of the boats that entered the race ran for three continuous laps without an interval of time in between.

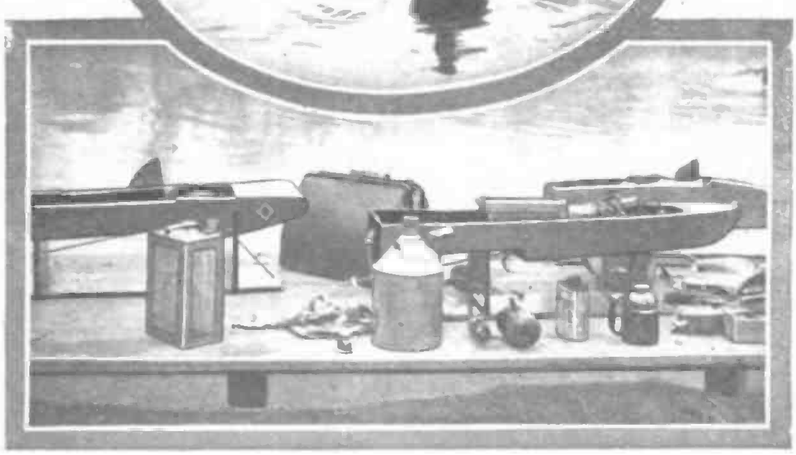
Mr. J. Fawcett Rapp's speed hydroplane "Elmara V" won the race. Her time was 15 seconds, 17 seconds and 24 seconds, for the first, second and third laps, respectively. This gave "Elmara V" a total of 56 seconds. The boat was not making her usual speed and the time by no means represents the best she can do. It seems that just at the time the owners of the model power boats want them to perform their very best, they slack off and make a very poor showing.

Mr. Harry Johnson's boat "Ex Calibur" came very near winning the cup. She had covered two continuous laps at a speed of 15 seconds per lap, and at the beginning of the third lap she burst into a marvelous speed. Mr. Yates, who was the official timekeeper, had timed her for six seconds for three-quarters of the third lap. At the very moment when it looked as if the third lap was to be made in record time, a small piece of wood fouled her propeller and stalled the engine. Further efforts were made to coax "Ex Calibur" into making the third lap, but she suffered such severe strain owing to her accident, that this could not be done within the time allowed.

"Whiz Bang," a boat owned by Mr. Clarence Johnson, refused to function properly after many attempts to make her do so. "Bo-Bo," a neat little craft owned and operated by Matthew Bolles, had a cranky power plant and although her owner made a desperate effort to put her into running order, she only made one lap successfully. (*Contd. to page 132*)

Part of the crowd. From left to right seated: Mr. J. Berg, Commodore C. P. M. Y. C.; H. Griffiths, Secretary; R. F. Yates and M. B. Sleeper

Some of the entries. Mr. Fischer, who is in the center, under a sudden impulse of enthusiasm and excitement, jumped into the water without waiting to put on his waders



Some of the boats and running equipment. The center oval shows an exciting moment during the races. Mr. Rapp's boat stalled on the third lap with 24 seconds to finish

Adjusting and Flying Model Airplanes

By H. C. Ellis

A great deal of success in flying models depends, as in full-sized machines, in thoroughly understanding the principles under which they operate. It takes practice to acquire the feel and balance of the machines; so is the case in flying model aeroplanes; their principles of operation should be well understood to secure good results. It is practice that helps in everything; building and flying model airplanes is no exception to the rule. Once you understand the principles of model flying you will never lose interest, it is so fascinating and its possibilities so varied and interesting. Almost every time you fly a model you learn something new, and every success or failure teaches its lesson to the observant experimenter.

Take care to see that everything is constructed exactly as indicated, if building from plans. See that all planes are true and parallel to one another, all rudders and stabilizing surfaces straight. Holding the model balanced in the right hand throw it steadily horizontally against the wind. Adjust as explained below until it will glide on a level keel to the ground.

To test the model, first wind its motor up about half the number of revolutions ordinarily used and then launch from the hand against the wind, being careful to observe its action, so as to adjust it accordingly.

If, after leaving the hand, the model exhibits a tendency to dive, it shows that it is head heavy; that is to say, there is not enough lift in front. This is easily corrected by sliding the main plane forward to increase the lift in front.

If, on the other hand, the model climbs too much, it shows that it is tail heavy, in which case just the reverse procedure is used—i. e., shifting the main plane back to increase the lift in the back. Putting a small weight either in the front or back, as the case requires, will help, but is not advisable if shifting the plane will give the required balance.

If the model tips over sideways, either to the right or left, it is probably due to the torque or twisting tendency of the propeller or faulty alignment of the main planes, tailplane or rudder, or, in the case of a double propeller machine, one propeller being wound up more than the other. This last cannot be the fault if a double winder is used, as both propellers are turned the same number of revolutions.

To correct this tipping and swerving sideways it is only necessary to increase the angle of the main plane on the side that the model tips over or swerves. This is done by bending the rear corner of the low wing down and bending the rear corner of the opposite wing upward a bit. This corresponds to warping the planes in a large machine. Adjust rudder to turn machine to the other side. If these few simple rules and instructions are studied and followed out you will soon grasp the principles of model flight and there should be no limit but the reader's mechanical skill to the varied and interesting models one can construct and fly with perfect success.

TWENTY-FOUR-CYLINDER LIBERTY ENGINE

As a result of experimental work at McCook field, a 24-cylinder engine, built largely of Liberty 12 engine parts, has been successfully completed. But few changes were necessary, these being in the crank case and connecting rod construction. The figures given were furnished by the Army Air Service:

Horse Power (Normal)

Liberty 24... 673 Liberty 12... 400

Pounds Per H. P. (Dry)

Liberty 24...1.97 Liberty 12...2.11

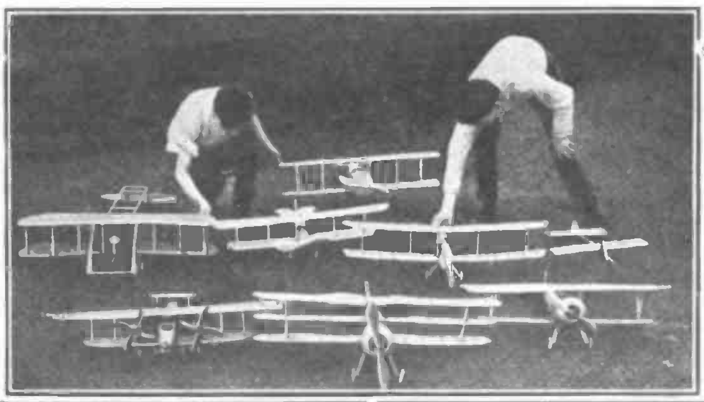
Gas Consumption (Pounds) Per H. P. an Hour

Liberty 24...0.55 Liberty 12...0.51

An engine of this power, if run at the normal speed, would permit the use of a comparatively large slow-speed propeller without gear reduction, thus increasing propeller efficiency.

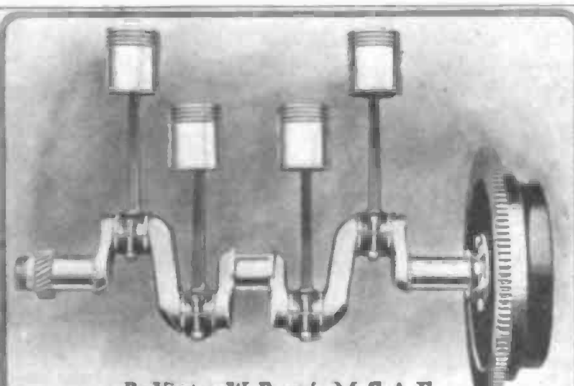
The first air delivery of late mail for outgoing ocean liners was ingeniously accomplished recently when the pilot of a flying boat dropped a pouch on the White Star liner *Adriatic*. The feat was successful despite adverse weather conditions and a heavy sea and the ship was reached an hour and a half after it had left port.

The manufacture of scale models for instruction purposes is an industry of some importance. Below, workmen are shown putting finishing touches on miniature D. H. 4 and Nieuport airplanes



Practically all leading airplanes have been reproduced in model form. In the group at the left, there is an early Wright, a Handley-Page, Sopwith triplane, D. H. 4., Nieuport biplane and others

Fitting and Adjusting Connecting Rod Bearings



By Victor W. Page M.S.A.E

THE experienced motorist will always seek the cause for any strange noise in the car motor. A most common noise is "knocking," a sharp metallic clank easily noticed by even the untrained ear. The causes are: Running with spark lever too far advanced with engine at full load, too rich mixture, carbon deposits, loose valve tappets or loose bearings at crankshaft, either at the main bearings where the shaft revolves in the crankcase or at the connecting rod journals. Sometimes loose wrist-pin bearings cause noise. If a motor has a tendency to heat up abnormally and knocks only after it has been run a while, this is usually caused by excessive deposits of carbon. Loose valve operating mechanism causes a clicking noise and is not so sharp as the knocking caused by loose bearings.

A loose connecting rod bearing makes a clattering noise that increases with the speed and is especially noticeable if the cylinders are short circuited in turn. The knock occurs twice each revolution of the crank shaft. With the bottom of the crank case removed as shown at Fig. 1, it is very easy to determine which bearings are loose.

There is nothing so important as the proper taking up of motor bearings when necessary. It has been noted that many automobile motors have been seriously damaged through carelessness of operators in doing this work. Bearings should not be allowed to run loose for any length of time. When the pounding is first noticed time should be taken to properly take up the bearing. If the bearing is allowed to pound it will not only flatten the crank pin (under which condition it is impossible to fit a new bearing to operate satisfactorily without trueing the shaft), but it is destructive to the entire engine.

Connecting Rod Big Ends

Fitting and adjusting rod bearings, especially those at the crank pin end, is one of the operations that must be performed several times a year if a car is used to any extent. The common form of connecting rods in general use is known as the marine type and is clearly shown at Fig. 2. In this one or two bolts are employed at each side and the cap must be removed entirely before the bearing can be taken off of the crank pin. The tightness of the brasses around the crank pin can never be determined solely by the adjustment of the bolts, as while it is important that these should be drawn up as tightly as possible the bearing should fit the shaft without undue binding, even if the brasses must be scraped to insure a proper fit. The marine form of connecting rod usually has a number of liners or shims interposed between the top and lower portions of the rod end and these may be reduced in number when necessary to bring the brasses closer together.

On the new eight and twelve cylinder V type engines which are fitted on several models of modern cars, the connecting rod design is different from that ordinarily used, as it is always necessary to have two rods working from the same crank pin. The construction follows very closely that used in motorcycle engines of the two-cylinder V form. Two methods of connecting rod arrangement are shown at Fig. 2. In the example at the top of the illustration, one connecting rod has a forked end which encircles the main crank pin bushing. These ends are of the usual marine type, straddling the big end of the other rod which is free to oscillate on the crank pin bushing. Care must be taken to fit rod A in such a manner that it will be clamped tightly around the end of the main crank pin bushing so that member will move in unison with rod A. The method outlined in the other view uses a master or main rod of the conventional pattern, excepting that a slotted boss is forged on one side of the connecting rod to take the lower end of the short rod which hinges on a suitable bearing pin. The crank pin bearing works in connection with main rod just as in a four-cylinder engine, and the point to be watched for wear is at the hinge where the short rod fastens to the main member. The same method of fitting brasses to be described in connection with the conventional forms of bearings apply just as well to the special type, though somewhat greater care will

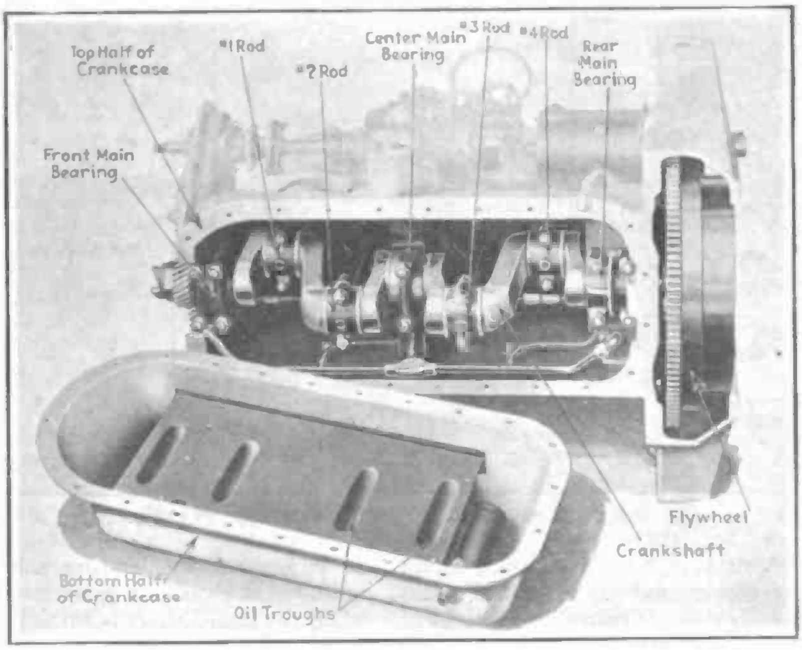


Fig. 1. Bottom half removed from four-cylinder automobile engine to expose connecting rods

be necessary in fitting the yoke or forked end rod construction than is required with the simpler bearing subject to wear only at its inner periphery. If the depreciation is at all pronounced, bearings in rods of the "scissors" or forked type should be replaced with new ones.

To Tighten Big End Bearings

When the bearings have become loose from wear but are not damaged from lack of oil or from actual cutting and the bearing surface is smooth it is only necessary to tighten it. After removing the nuts (a special socket wrench may be obtained to fit these nuts) and taking the bearing cap off, the condition of the bearing may be determined. If against the metal. This will have a tendency to press out slight inequalities and will loosen the bearing slightly. The motor should then be turned over by the crank or fly wheel if that member is exposed. By rocking it back and forth over center you can determine if bearing is too tight by the resistance it offers, or if too loose it can be detected by working the connecting rod back and forth. When trying a bearing the bolts should always be drawn up tightly. If bearing is found too tight replace enough shims to make it right.

Never loosen up a bearing by loosening the nuts—if bearing is too tight insert another layer of shims until the proper fit is obtained. When the proper bushing at the upper end in some types. In others, the wrist pin is clamped to the rod. The bushings are usually of the solid form and no compensation is possible for depreciation except renewal. A few engines have a split bushing that can be clamped around the wrist pin by a suitable bolt in the upper rod end. Even though the bearing is much less in area than at the big end, it has a rocking or oscillating motion and does not wear out as soon as the lower ones. While wrist pins are usually made of very tough steel, case-hardened with the object of wearing out an easily renewable bronze bushing in the upper end of the connecting rod rather than the wrist pin, it sometimes happens that these members

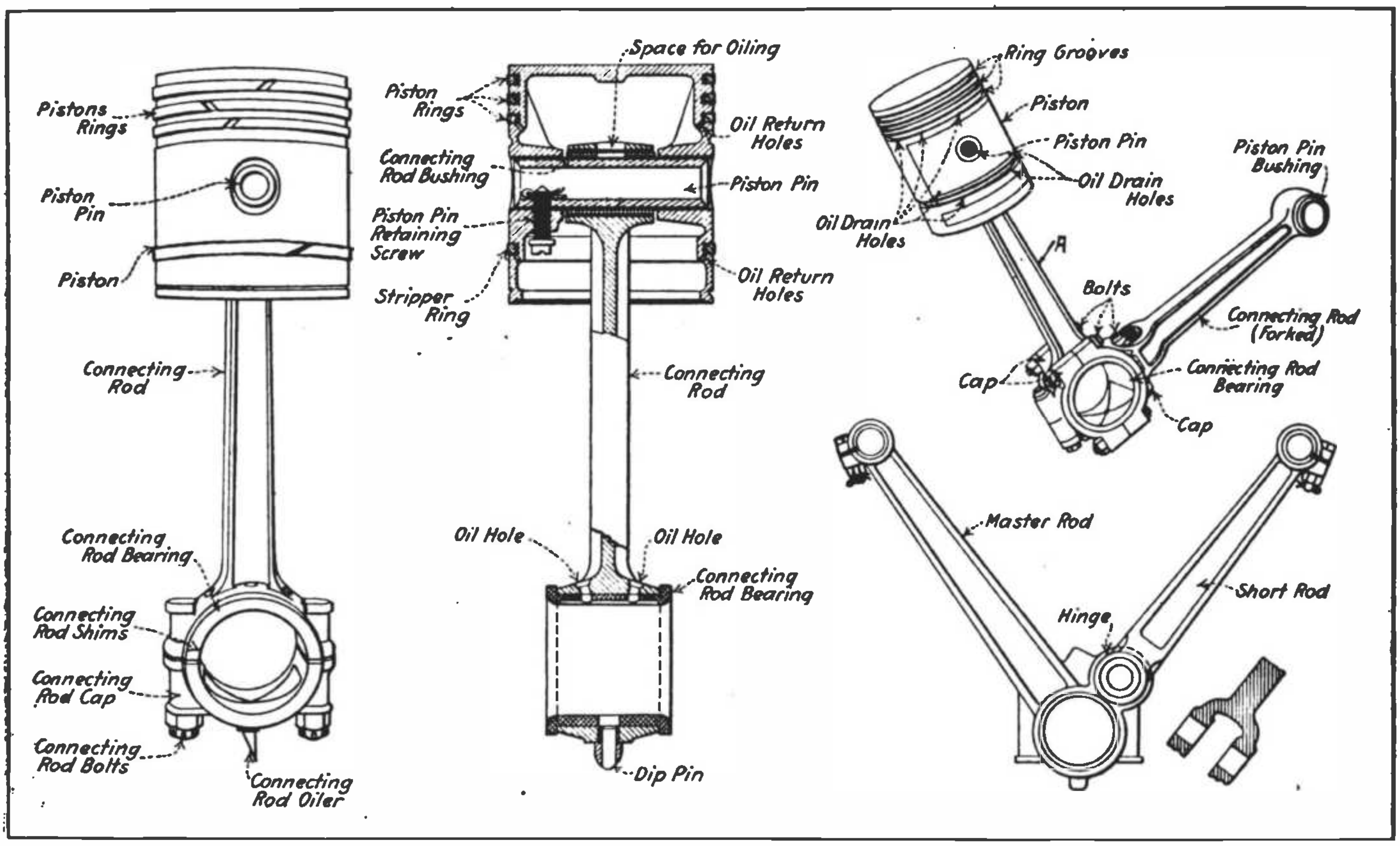


Fig. 2. Connecting rods for the usual type of engine shown at left and for V type outlined at right

smooth, it may be placed back again after removing some of the metal shims from each side. These shims consist of a number of thin pieces of metal which may be separated until the desired thickness is secured. Good judgment should be used as to the thickness taken off and also that the same amount is removed from each side. Be sure to place the caps back the same way they came off. Serious consequences might result if bearing caps were changed or turned around.

After bearing has been set up and nuts drawn up tight, take a hammer and a block of wood and pound the lower part against the shaft. Be careful not to hammer directly against any of the parts or bolts, or injure the small pipe in lower cap, but use the wood fit is secured the bearing should not bind, but it should offer some resistance when the crank shaft is turned. When the bearing is properly fitted put in new cotter pins that fit the holes snugly. Do not back up the nut to line up the cotter pin hole. If it is not in line when nut has been tightened securely remove the nut and file the face slightly. Before engine is run, thoroughly oil all bearings. Put a fresh supply of oil in the crank case and run motor slowly and watch it carefully for a few hours, or until satisfied that the bearings have been properly fitted and do not overheat.

Wrist Pin End of Rod

A connecting rod is a double end proposition as there is a small bearing will be worn so that even the replacement of a new bushing in the connecting rod will not reduce the lost motion and attendant noise due to a loose wrist pin. The only remedy is to fit new wrist pins to the piston. Where the connecting rod is clamped to the wrist pin and that member oscillates in the piston bosses the wear will usually be on bronze bushings which are pressed into the piston bosses. These are easily renewed and after running a reamer through them of the proper size no difficulty should be experienced in replacing either the old or a new wrist pin depending upon the condition of that member. Where the wrist pin oscillates directly in the bosses of an iron or aluminum piston and these wear, the only remedy is reaming out the worn bosses and fitting over-size wrist pins.

Fitting New Brasses

In fitting new brasses there are two conditions to be avoided, these being outlined at Fig. 2, C and D. In the case shown at C the light edges of the bushings are in contact, but the connecting rod and its cap do not meet. When the retaining nuts are tightened the entire strain is taken on the comparatively small area of the edges of the bushings which are not strong enough to withstand the strains existing and which flatten out quickly, permitting the bearing to run loose. In the example outlined at D the edges of the brasses do not touch when the connecting rod cap is drawn in place. This is not good practice, because the brasses soon become loose in their retaining member. In the case outlined it is necessary to file off the faces of the rod and cap until these meet, and to insure contact of the edges of the brasses as well. In event of the brasses coming together before the cap and rod make contact, as shown at C, the bearing halves should be reduced at the edges until both the caps and brasses meet against the surfaces of the liners as shown at A, Fig. 3.

Before assembling on the shaft it is sometimes necessary to fit the bearings by scraping. It is apparent that if the crank pins are not round no amount of scraping will insure a true bearing. A point to observe is to make sure that the heads of the bolts are imbedded solidly in their proper position and that they are not raised by any burrs or particles of dirt under the head which will flatten out after the engine has been run for a time and allow the bolts to slack off. Similarly, care should be taken that there is no foreign matter under the brasses and the box in which they seat or that no burrs exist on the edges. To guard against this the bolts should be struck with a hammer several times after they are tightened up, and the connecting rod can be hit sharply several times under the cap with a wooden mallet or lead hammer. It is important to rivet the brasses in place to prevent movement as lubrication may be interfered with if the bushing turns round and breaks the correct register between the oil hole in the cap and brasses.

Care should be taken in screwing on the retaining nuts to insure that they will remain in place and not slack off. Spring washers should not be used on either connecting rod ends or main bearing bolts, because these sometimes snap in two pieces and leave the nut slack. The best method of locking is to use well-fitting split pins and castellated nuts.

(*To be continued*)

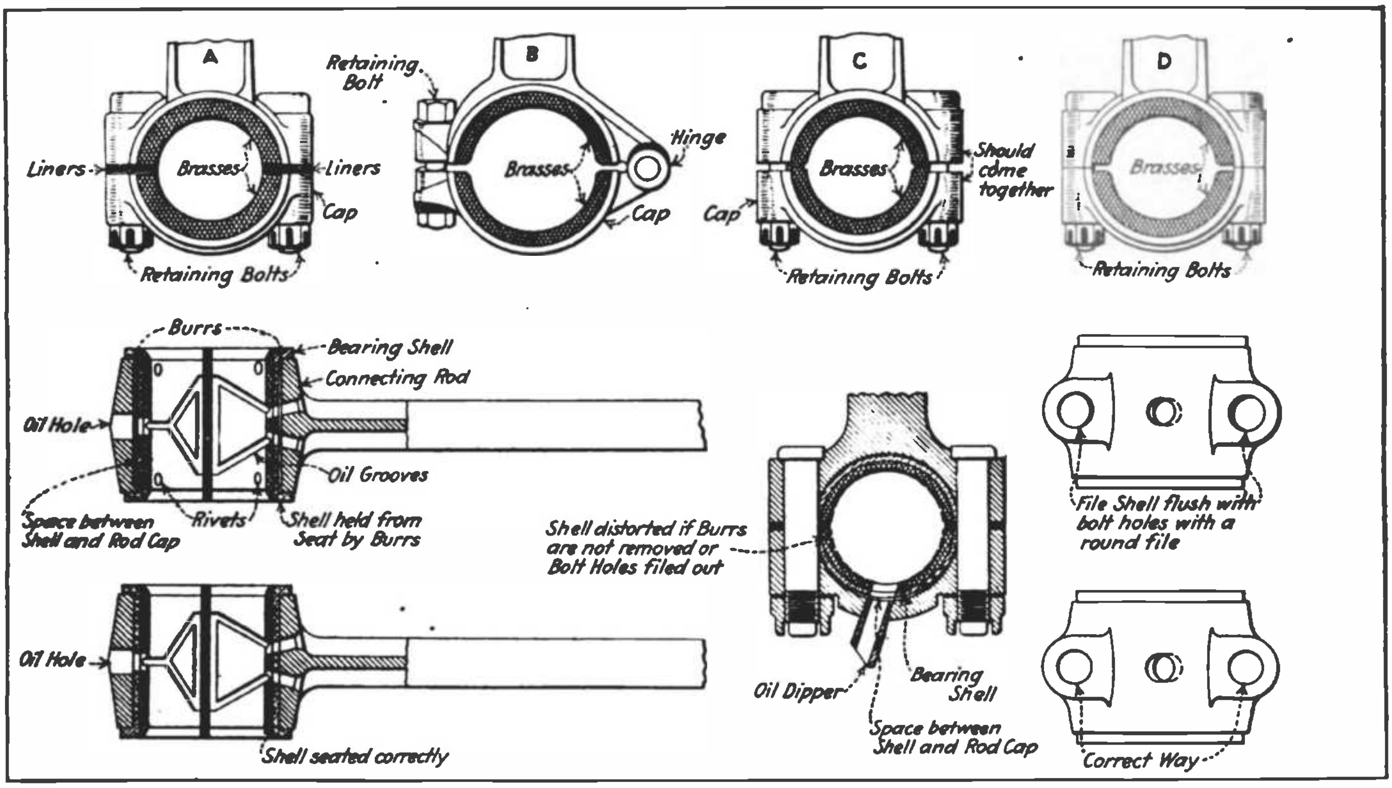


Fig. 3. Diagrams outlining precautions to be taken in fitting brasses to connecting rod big ends

Among the Alloys for bearings is the following:—Cadmium, 45 per cent.; zinc, 45 per cent.; antimony, 10 per cent. This has a very low coefficient of friction and casts well.

BELT GLUE

A GLUE for belts can be prepared as follows: Soak 50 parts by weight of gelatine in water, pour off the excess of water and heat on the water bath. With good stirring, add, first, 5 parts by weight of glycerine, then 10 parts by weight of turpentine and 5 parts by weight of linseed oil varnish and thin with water as required. The ends of the belts to be glued are cut off obliquely and warmed; then the hot glue is applied, and the united parts are subjected to strong pressure, allowing them to dry thus for twenty-four hours before the belts are used.

An easy test for carburetor adjustment may be made by pressing down on the air valve while the engine is running throttled down. A slight pressure should not change the engine speed, but a greater pressure will stall it if the mixture is correct. If the engine stalls with a slight pressure, the mixture is too lean.

In the absence of any reliable horsepower rating for motorcycle engines, and having instanced the unsuitability of existing formulas in determining the horsepower of such high-speed engines, the *Motorcycle* (English) recommends that 100 cubic centimeters be regarded as one horsepower. Thus the popular 350 cubic centimeter and 500 cubic centimeter cycle power plants would be rated at 3½ and 5 horsepower respectively. This simple rating can also be successfully applied to small cars.

Construction of a Mechanical Vacuum Cleaner

By E. H. Williamson, Jr.

PART I.

THE vacuum cleaner has become a household necessity in the comparatively few years which have elapsed since it was first introduced. Starting with the type which consisted of a heavy vertical case containing one or more suction pumps, operated by an electric motor, where the cleaning was done by attaching lengths of air hose to the stationary pump, there has been a constant improvement in the way of increased portability and reduced weight, and the present style of domestic cleaner leaves little to be desired. The modern cleaner consists of a small exhaust fan connected directly on the shaft of an electric motor. This is enclosed in an aluminum case provided with a broad nozzle, in which is a revolving bristle brush, and a slot of narrow width, which travels close to the carpet or other surface to be cleaned. The dust, etc., is stirred up by the brush, and sucked into the slot, and so through the fan into a long bag of silk or other close woven fabric. For those whose residences are provided with electric current, a cleaner of this sort leaves little to be desired, but some still lack this convenience, and it is for their benefit that the following description of a mechanically operated cleaner is given. To bring the construction of the machine within the scope of the average home workshop or den, the machine is built largely of white pine which is light, and easily worked, and can be obtained from the scrap heap of any pattern shop. The majority of the metal work can be done with an ordinary bench vise and bench drill or even a breast drill, while if the reader possesses a wood lathe or engine lathe, the whole machine can be easily constructed at home.

The photographs shown are pictures of the cleaner made by the writer, and are used as illustrations for construction in preference to line drawings except in four or five cases. As the fan, which by its rotation produces the vacuum, is the most important part of the machine, and probably the most difficult part to construct, we will consider it first. Figure No. 1 shows the fan (A) removed from the case together with one side of the fan box. It consists of a round disc of 1/32-in. sheet brass, 5 inches in diameter. This is cut from stock, either on a metal working lathe, or by marking a centre and scribing a circle of the required size. The disc is then cut out along the line with heavy tinners' shears, the rough edges being smoothed off with a file so that a true circle is formed. The disc must be perfectly flat, and if bent in cutting, must be hammered out level. A 3/8-in. hole is now drilled in the exact centre of the disc, a smaller hole,

The finished vacuum cleaner in use

say 1/8-in., being drilled first as a guide.

The hub on which the disc revolves is shown in Fig. 2, and is 1 in. long and 1/2 in. outside diameter with an 1 1/4-in. flange at one end. The writer was fortunate enough to find a portion of an old "floor push," such as is used

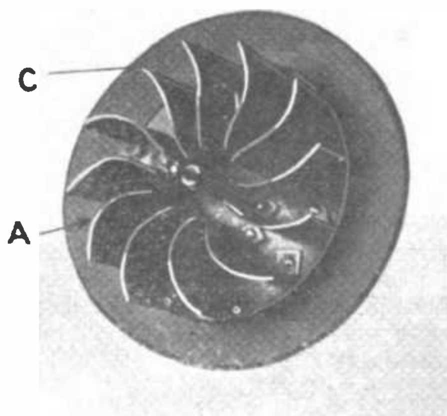


Fig. 1.

to operate an electric bell or buzzer from the dining room to the kitchen, which was just the right size for this, when the hole through the centre was bored out to 3/8 of an inch. To assemble, a piece of round iron rod, a trifle less than 3/8 in., was set vertically in a vise and the disc set upon it, together with the hub so that the flange of the latter rested on the disc. The hub and disc were sweated together with solder to anchor them, and then removed from the bar and permanently connected with three 8-32 round head iron machine screws driven through flange and disc, the screw heads being on the flange side. An 8-32 brass nut is then run on each of the protruding ends of the screws and screwed up tight, and then sweated with solder. The balance of the screw is cut off flush with the nut. The fan has twelve vanes or blades, which are cut from a sheet of No. 22 brass, 1 3/4 in. wide.

Each blade is 2 1/4 in. long and is shaped as shown in Fig. 3. Having cut the twelve pieces, they are stacked up with the edges even and clamped together in a vise. All the edges are now trued up with a file and the rounded corner filed to shape. The pack is now reversed in the vise, and the two lugs are formed by making cross cuts with a hack saw to the required depth, and cutting away the surplus metal either by chipping with a sharp cold chisel and filing, or by filing alone.

The stack is now removed from the vise, separated and each blade is then clamped and the lugs bent over at right angles, even with the bottom of the blade. Care should be taken, however, not to bend them so sharply as to crack the brass. A circle 4 in. diameter is now marked on paper for a pattern, and each blade is bent in a curve, corresponding to an arc of the circle, the lugs being on the inside of the curve. The iron bar is again set upright in the vise, and after the circumference of the disc has been spaced off into twelve equal parts with a pair of dividers, and radial lines drawn from each point to the centre, the disc with its hub is set on the bar, and the blades set in place, one by one, using the lines as guides and taking care to have all blades equally distant from the centre. The easiest method is to first solder each blade in place, holding it with pliers, and then fasten it permanently with a 4-36 machine screw through each lug and the disc.

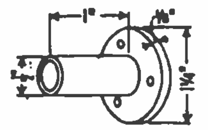
It is very important that the fan should be equally balanced on its centre, as under the high speed of rotation, any eccentricity would soon cause it to shake itself to pieces. Slight inequalities in weight may be compensated for by a drop or two of solder on the light side of the fan. The spindle of the fan is a piece of round steel rod 4¾ in. long, and in order to reduce friction, each end of the shaft is cut down to 5/32 in. for a space of ½ in., the diameter of the part between being 11/32 in. It is best to have the spindle made up at a machine shop, unless one is an expert with a machine lathe.

The fan is now set on the spindle so that the end of the hub is ¼ in. from one end of the shaft proper, and is secured in place with an 8-32 iron machine screw, driven through both hub and shaft, and locked with a nut on the farther side. Fig. 4 shows the construction of the fan box from which the fan has been removed. The circular shell (D) is made from a block of pine, 2 in. thick and 12 in. square, both sides of which have been planed. An 8-in. circle is marked on one side and a circular block of that size is cut out with a band saw. The block is then screwed to the face plate of a wood lathe, and the outer circumference turned down to 7½ in., while the centre of the block is cut out to 6 in. inside diameter, making the sides of the shell ¾ in. thick by 2 in. deep.

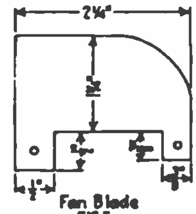
The circular cover (C) shown in Fig. 1 should also be turned, from ⅜-in. stuff, the diameter being 7½ in. with a 7/16 in. hole in the centre for the fan shaft. The cover for the other side of the box is not circular but comes to a square edge on one side, tapering from the full diameter of 7½ in. to a width of 5 in. on the square portion.

This cover must be centered on the lathe, however, and a 3½ in. hole turned out, to give access to the air duct which is attached to this side. The cross bar which supports the inside fan bearing may be seen crossing this hole, and consists of a piece of ⅛-in. strap iron, ½ in. wide and 7½ in. long, which is screwed to the edges of the shell being set in shallow notches to allow the cover to be screwed flat on the edge of the shell. The bearing proper (E) is a piece of brass ¼ in. thick, ½ in. wide and 1 in. long, which is bored to receive the gudgeon of the spindle, and screwed to the cross bar, which is correspondingly bored. The block (F), which forms the outlet from the fan box, is part of the piece left over when the 8-in. block was sawed out, and is used because the curve corresponds closely to that of the shell.

It is 4 in. long by 3 in. deep and 2 in. thick and is both nailed and glued to the side of the shell, in the position shown. When in place a 1½ in. circular opening is driven through both



Hub of Fan FIG.2



Fan Blade FIG.3

block and shell, and to avoid splitting either it is best to drill a smaller hole first and then enlarge it to the required size with a sharp gouge.

The hole should be a true circle for at least one inch in depth, so as to make an air-tight fit with the metal neck of the dust bag.

The photograph, Fig. 5, shows the arrangement of gears by which the fan is driven. A cast-iron pinion (⅞ in. diameter, ⅜ in. face, 20 pitch, bore ⅜ in.) is reamed out a trifle and driven on the end of the fan spindle to a point ¼ in. from the end. It should fit tightly on the spindle. The gear (G) which drives this pinion is 3½ in. diameter and the same face and pitch as the latter. It revolves on a spindle 1½ in. long with a ⅛-in. gudgeon at each end, ⅜ in. long. The diameter of the spindle will be ½ in., as stock gears of this size are usually so bored, and the gear will have a ½-in. hub on one side, making the bore ⅞ in. through.

The gear (G) is driven on the spindle to a point ½ in. below the end and a 1in. pinion of the same face and pitch as the others is set on this projecting end, against the side of the gear (G), to which it is fastened with a couple of 8-32 round head machine screws. The bearings for the gears are made as follows: Two pieces of 3-in. pine (GG) are gotten out, 3½ in. long and 2¼ in. high. These are screwed to the wooden cover (C) in an upright position, parallel with each other, the inner sides being 4½ in. apart. Two 6-in. lengths of ½ in. by ⅛ in. strap iron are now prepared and drilled for No. 8 wood screws at points ⅜ in. from each end. Two pieces of 3/16-in. brass, 1½ in. long by ½ in. wide, are prepared and drilled ¼ in. from each end, to allow a 4-36 machine screw to pass through. One of these pieces is now screwed at the centre of each 6-in. strap. One has a 5/32-in. hole bored in the center of the brass and through the iron. This is the bearing for the fan spindle and is set in place on the two blocks, in notches cut in the wood so that the iron is flush with the top, and screwed firmly in place with 1-in. No. 8 wood screws. The bearing must be adjusted in position so that the fan revolves freely, the shaft being in the centre of the hole in the wooden cover, and the hole in the bearing being reamed out a little if necessary, so the gudgeon does not bind. The bearing for the gear (G) is prepared the same way as the other, except that the hole in the brass is for a ⅛-in. gudgeon.

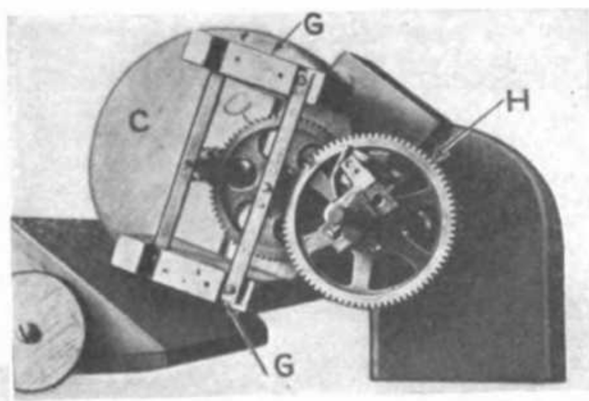


Fig. 5

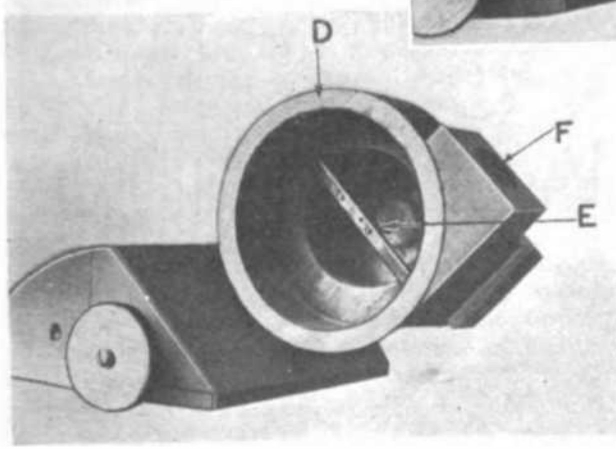
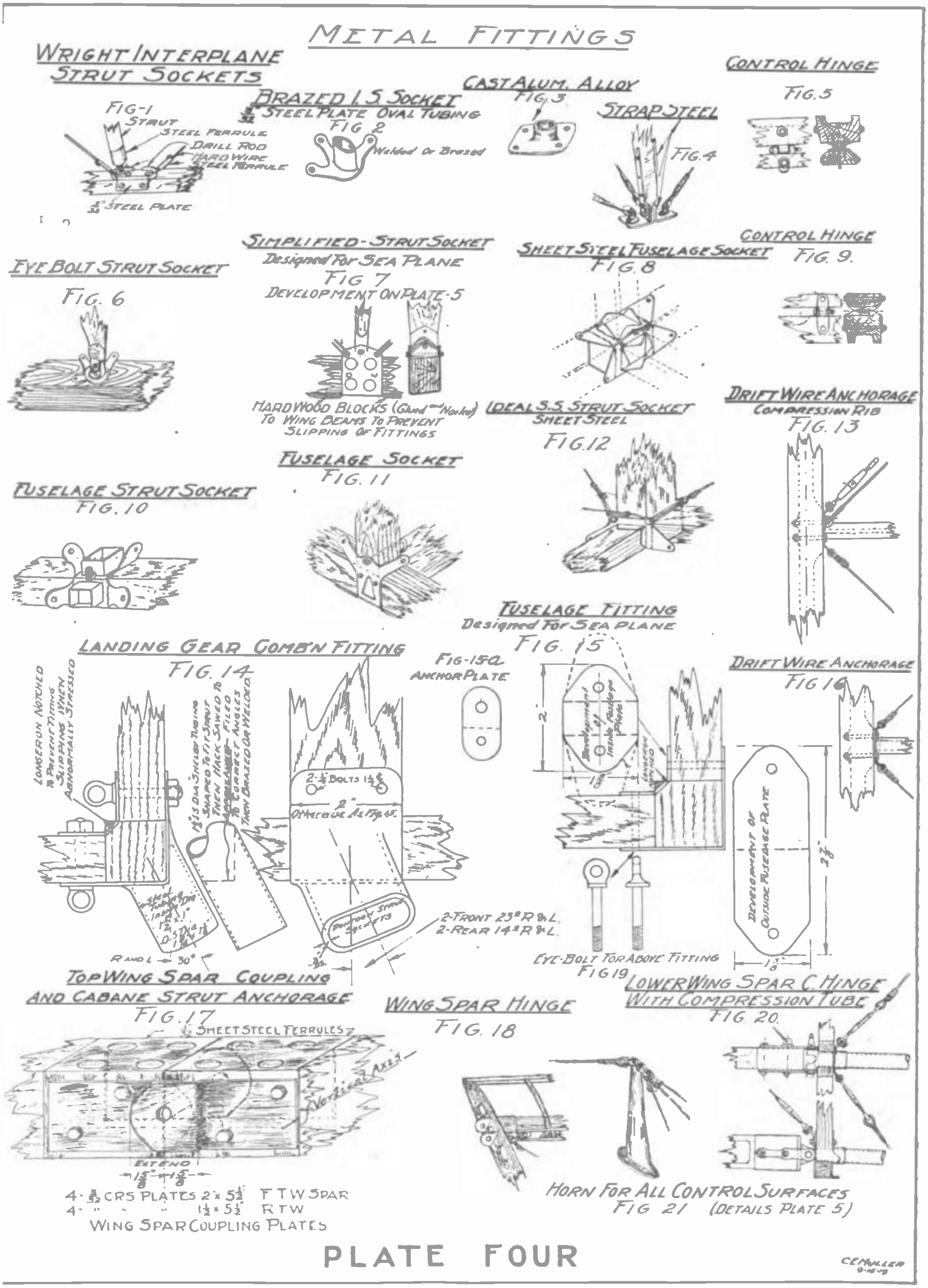


Fig. 4

The bearing for the bottom end of the spindle of (G) is a brass plate, ⅛ in. thick and 2 ins. long by 1 in. wide, which is screwed to the face of the wooden cover, the wood being bored out to accommodate the end of the lower gudgeon.

To avoid the expense of unnecessary machine work, the spindle of the gear (G) may be made as follows: A piece of ½ in. round iron rod, 1½ ins. long, with a smooth surface is prepared and the ends filed square. Take a center punch and make a dent in the exact center of each end, and start the hole with a No. 40 drill. Next take a ⅛ in. drill and bore a hole to a depth of ¾ in., keeping the drill square with end.



Sheet of details for metal fittings of two-passenger seaplane

Building A Two-Passenger Seaplane

By Charles E. Muller

Consulting Aeronautical Engineer

PART 4—METAL FITTING DETAILS AND DEVELOPMENT

THE essential considerations on the designing or in the adoption of interplane, landing gear or fuselage fittings, are efficiency, facilities of manufacturing and the attachment to vital components without weakening those members. Figs. 1, 2, 3, 6 and 7 graphically depict the evolution of strut fittings from the crude aluminum alloy (Fig. 3) castings to the present day tendency of one piece die stamping, similar to Fig. 7. This latter method will ultimately become the standard practice. Considering the engineering value in design that may be suggested by the history of the various methods of fitting construction, it is considered pertinent to describe the origin and special considerations attached to their use.

Early Wright Fitting Simple.

Fig. 1 is undoubtedly the first practical strut fitting. They were used on the early Wright machines due to the necessity of a flexible attachment to permit the warping of the wings for lateral stability of the Wright machine up to 1912. These fittings were crude possibly, but very serviceable. They not only permitted a ball and socket strut movement but were also used as flying, landing and drift wire anchorages. These will be described more fully in proper sequence. Fig. 2 represents the Curtiss early type and a natural introduction by a bicycle and motor cycle expert. The cast aluminum alloy fitting was employed by many amateurs and some factories during 1911. Strap steel fittings, such as shown at Fig. 5, were much in evidence at Nassau Boulevard and at Mineola, L. I., up to 1912.

The 14 cylinder Gnome Tractor biplane designed and built by the author in 1911 in New York City was, it is believed, the first machine to use all steel fittings. These were made of mild sheet steel plates with "Shelby Steel Tubing" brazed to the plates, the brazing material forming a fillet inside and outside of the joint. The fuselage fitting, Fig. 15, was given a severe try out on this machine, proving very satisfactory. The notching of the longerons to prevent the fitting from sliding originated with this design and has proven entirely practical. Owing to a bad landing in a side wind the landing gear was badly damaged but not one of the fittings failed. Although some of the landing gear strut sockets were damaged they were straightened out and used again.

Pierced Spars Not Desirable.

Fig. 8 shows a one-piece sheet steel fitting riveted parallel to the longeron between the horizontal and the vertical fuselage struts. Fig. 10 is a bent steel plate with rectangular tubing welded on for sockets and held in position by an eye bolt which surely disqualifies it. Any fitting that pierces the wing beams or longerons, thus impairing the strength, should be eliminated if possible. Hard wood blocks glued on these components and wrapped tightly with linen tape, cemented with thick orange shellac or hot glue has never failed to strengthen a pierced member when this construction was unavoidable within the knowledge of the writer.

A method extensively employed is to imbed the fitting bolts half their diameter into the spars. Extra thickness is given the spar at the weakened point or hard wood blocks are attached by marine glue, brads and doped linen, compensating for material displaced. The Curtiss method at the present time is to use a die stamped one piece plate fitting with integral lugs for truss wires and to hold the interplane strut end fitting that has an eye shank welded to a stamped socket. This plate is bolted on the wing spars with four bolts imbedded as described above.

The illustration at Fig. 11 is that of a very simple one piece stamping with a 90° knee bolt (3/16 in. drill rod) that holds the vertical and horizontal longeron struts in place, and also may be used to tighten the cross sectional wires. The fore and aft diagonal wires are also anchored on this knee bolt but require turnbuckles. The objections to this method are that in a short time the wires stretch, some more than others, also that it is necessary to pierce the longerons with wood screws or bolts to hold this style fitting from slipping. In the event of a bad landing it is almost impossible to true up the fuselage without replacing the wires. For this reason it is inadvisable to adopt this method for commercial machines. It was used on the Hanriot monoplane and also on some of the war machines. Its advantages are rapid production, quick repairs and economy, and as the life of an airplane at the front was variously estimated at from 6 to 40 hours, a little distortion of the body was compensated for by the controls when possible rather than rebuilding the entire machine.

The diagram at Fig. 12 appears to be an excellent fuselage fitting meeting the general demands consistently. The horizontal strut is held by a socket formed by punching and turning the tabs outward, the vertical strut is held in position by the bolts that hold the wire clips for the wire anchorages. These bolts also serve to clamp the fitting to the longeron preventing slippage and are obviously adjustable.

Best for Amateur Production.

The fitting at Fig. 15 is undoubtedly the most suitable for the amateur with limited facilities, as the plates can be roughly shaped by a cold chisel and finished off with a file. By drilling a number clamped together or punching them through the holes in one that serves as a template the work will not only be expedited but be of a more uniform character. Satisfactory eye bolts may be purchased or high grade steel bolts with an anchor plate as shown in Fig. 15-A for the brace wires or the inside plate of this fitting may be extended as shown by dotted lines for this purpose.

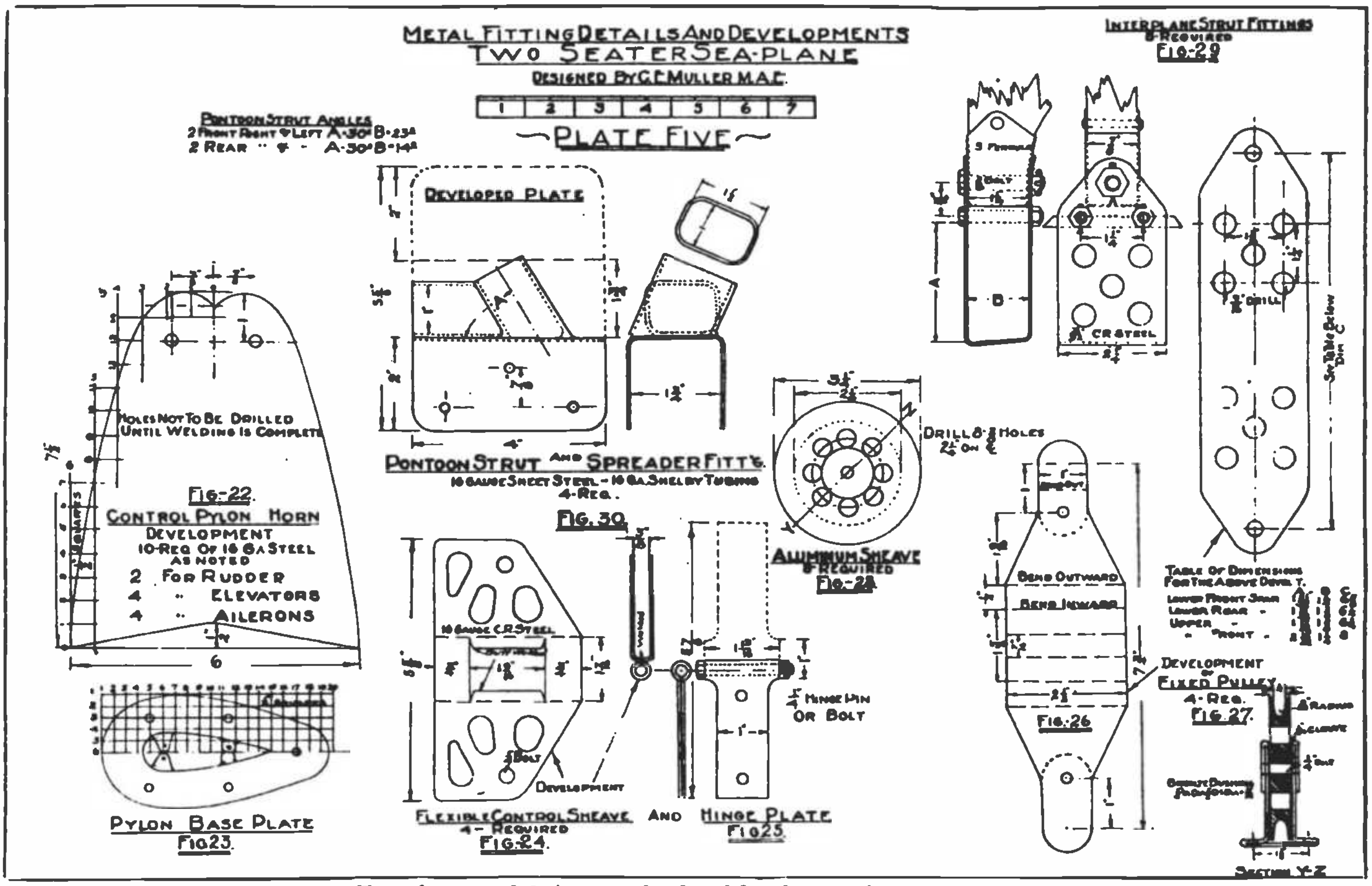
That at Fig. 14 is a combination of Fig. 15 with a piece of Shelby seamless steel tubing formed over a hard wood block to dimension taken from Plate Two, landing gear strut end section, Fig. Y-2. This tubing may be purchased through any dealer of automobile or bicycle tubing. These bolts also serve the purpose of securing the fuselage struts in position.

Control Hinges Simple.

Figs. 5 and 6 are representative of the control hinges and are so simple that they require no further explanation. A very simple hinge may be made by using a 20 gauge plate fashioned like a strap hinge (Fig. 25), but instead of doubling the ends carry one thickness above and one below the attachment using 2⅛ inch bolts for clamping. These simple control hinge fittings were used very extensively and satisfactorily in the early days, even on the large Farman machines.

The fittings at Figs. 13 and 16 are simply anchor plates for the brace wires for staying the wing panels, which are technically called internal drift wires. Fig. 17 represents the simplest form of wing spar coupling in which 20 gauge steel ferrules are formed and butt joint welded, lightened as much as possible by drilling or punching and driven on the inside ends of the wing spars. Fish plates are made and bolted through the wing spars. By offsetting one plate on each spar they will assemble easier. These fish plates are best placed above and below the spar, permitting an eye bolt to answer for locking this joint and also serving the additional purpose of handling the airplane or seaplane by a hoisting cable suspended at the center of gravity. Fig. 18 represents a practical coupling made of an eye plate extending on both vertical sides of the wing spar with a lug plate brazed to the eye plates. They not only space these plates but also give additional strength.

A 3/8 in. pin, Fig. 20, is usually secured by a No. 10 wire or cotton pin. of stress applied, the problem is easily solved by good common sense. On a machine of this type it is well to carry the safety factor high, at least 12, and safer to err on a little over weight. Even steel has its cross grain and defects, also it is affected by temperature and by the strain produced by bending and other operations. In very high grade steel these internal strains are neutralized by a heat treatment. Avoid very sharp bends, scratches or cuts. Sheet steel should never be bent over a sharp corner. A radius equal to at least twice the thickness of the material should be used at all bends. Heating to a cherry red with a blow torch will may be butt welded by the oxy-acetylene process. Fig. 24 depicts the flexible pulley necessary for the aileron control wires which will be explained in another instalment. If a paper pattern be cut out to full size of the development then bent as shown, it will instruct more graphically than a thousand words. This method will also suggest at once that used with other fittings. The aluminum sheave may be made from a casting or from rolled bar stock. I believe that fiber board would make an excellent substitute barring its weight, and even hard wood has been used by experimenters for pulleys.



How sheet metal fittings are developed by the use of paper patterns

Fig. 20 is the Curtiss method used on the JN4 A, B, D, and H. It is a very practical and efficient fitting, but requires much skill in its fabrication. The prominent feature is the steel tubing compression strut extending from wing spar to wing spar, taking the direct compression stress of the lower wings.

Laying Out Fitting Blanks.

A careful analysis of Plate 5 will show the method of laying out sheet steel fittings, which is a very simple matter. There are many calculations necessary for stress allowance, but I feel that with a little elementary knowledge of the tensile strength of the steel used and the appreciation of the kind absolutely prevent accidental fracture, faciliate the work and insure keeping the full strength of the material.

The development at Fig. 23 shows the Control Pylons before forming. These are usually of various lenghts in commercial airplanes due to the movement of control surfaces required which varies, but this one is made universal; the difference in movement will be compensated by changing the leverage at the controls to give the necessary movement. A little study of the squares in the diagram will suggest to the amateur mechanic the method used to lay out these curves which need not be rigidly followed.

The base plate tabs are bent while cherry red to shape; riveted to Pylon to hold it in shape, then brazed or it

TENSILE STRENGTH OF STEEL

Grades of Steel	Tension Ultimate Strength lbs. per sq. in.	Compression
Extra Soft.....	45,000	16,000
Soft	50,000	18,000-20,000
Medium	60,000	22,000-40,000
Hard	70,000	
STEEL CASTINGS:		
Soft	60,000	16,000
Medium	72,000	18,000-20,000
Hard	70,000 up	
Steel Forging...	75 to 90,000	18,000
Spring Steel.....	101,000 to 135,000	
Tempered	130,000 to 200,000	
Vanadium alloy, annealed	54,000 to 96,000	
Oil tempered....	125,000 to 250,000	

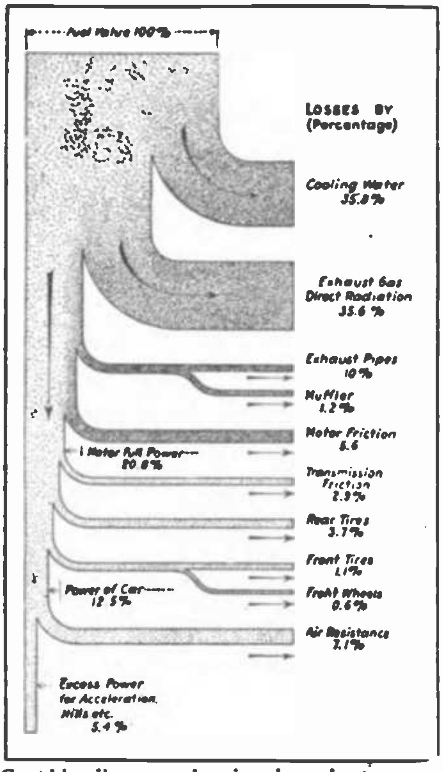
Editor's Note.—The next instalment of this series will describe fully the construction of the fuselage and will show two forms, one suited for the 3-cylinder radial motor and one adapted to a modified, popular 4-cylinder car motor.

Where the Power Goes

THE cost of motoring would be decreased by a substantial amount if it were possible to utilize the full heat value of the gasoline put in the fuel tank and lose none of the potential power contained therein. A motorist receives a return of but 20 per cent as engine power of the total 100 per cent heat value of the fuel at the tank. If it were burned under a steam boiler and steam used to drive the automobile he would obtain even less because the heat efficiency of a steam boiler and engine is less than that of an internal combustion power plant. The chart and plan view of the typical automobile chassis herewith give a good idea of how the heat obtained from the exploded gas is dissipated and how there are further losses even after a relatively small proportion is converted into useful power.

The greater part of the loss takes place in the conversion of heat to power in the engine cylinders. There is an absorption of 35.8 per cent in the water cooling system and 37.8 per cent is lost through the heat of the exhaust gases and direct radiation from exhaust manifold, pipe leading to silencer and the muffler itself. Of the power delivered by the engine a certain amount is needed to overcome frictional resistance at various points as indicated, the tires and wheel bearings taking some power and the power transmission system also taking toll of the energy passing through it. These losses are unavoidable and skillful designing is necessary to secure even the efficiency of heat utilization outlined which is much greater in the modern automobile than it was in the early forms.

The figures given will vary with the type and mechanical condition of the automobile mechanism. Some cars, in which lubrication is neglected or showing considerable wear at essential points, will take a higher friction toll than the approximation given. A poor carburetor adjustment will lessen the efficiency of the engine and result in loss of potential heat units. Even such a common thing as insufficiently inflated tires will increase the power loss at that point.



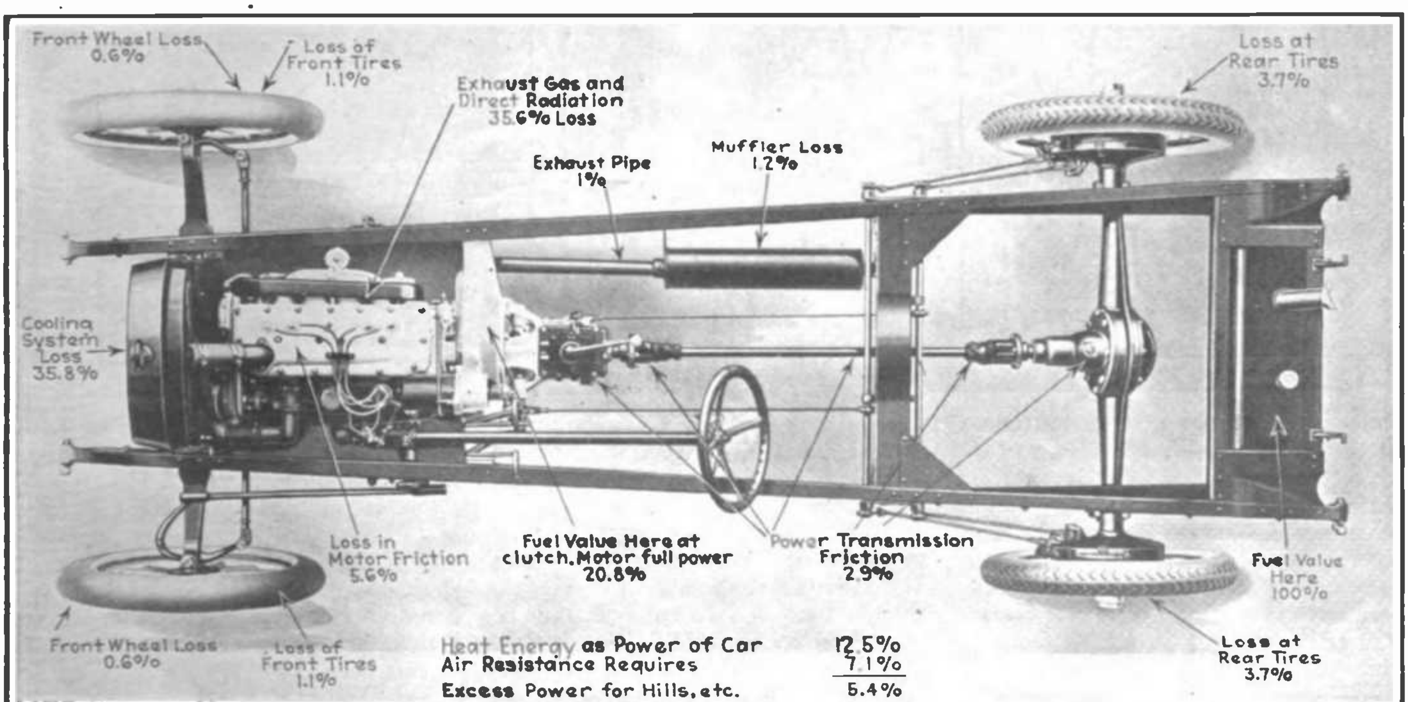
Graphic diagram showing how heat energy in fuel is used in automobile

EXTINGUISHING SMALL GASOLINE FIRES

While pure sawdust gives excellent results in putting out a small gasoline fire, a mixture of 10 pounds of bicarbonate of soda with 12 pounds of clean sawdust is the best medium to have on hand. Have the sawdust dry and free from chips. The action is that the sawdust forms an air-tight blanket as it floats on the burning liquid, and at the same time the heat of the flame generates carbonic acid gas. This gas, together with the sawdust, keeps the oxygen in the air away from the flame and quickly smothers it.

It is essential to have the engine warmed thoroughly before starting to adjust the carburetor, the motor should be run so it is hot when the finishing touches are given. An engine adjusted while cold will not develop full power, and an entirely different fuel needle valve setting will be necessary after it heats as usually the gasoline supply can be reduced, this resulting in increase of power and gasoline economy.

When you have the time study your starting and lighting system carefully, using your instruction book as a guide. Gradually the uses of the parts and the paths of the currents will become clear to you. Give it the care it needs and you will get better service and have less trouble in the end.



Plan view of five passenger four-cylinder automobile showing how heat units obtained by combustion of fuel in engine cylinders are utilized and what proportion is actually employed in driving the car when it is run at a rate of 40 miles per hour on the high gear

THE JUNIOR EXPERIMENTER

A Beginner's Set for Navy Code Practice

This Receiver, With a Small Antenna, Will Tune Above 1,500 Meters, the Wavelength Used for Navy Practice

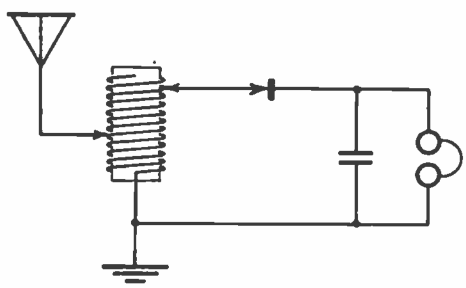
ON October 5th the Naval radio station at 44 Whitehall Street, New York City, started a nightly transmitting program, following the 9 P. M. press news, to give radio experimenters a chance to practice receiving at slow speed. The set described in this article, used with a standard short or long range antenna, will copy the signals at a distance of several hundred miles. It is also a good set for general receiving work, and is simple enough for any beginner to operate.

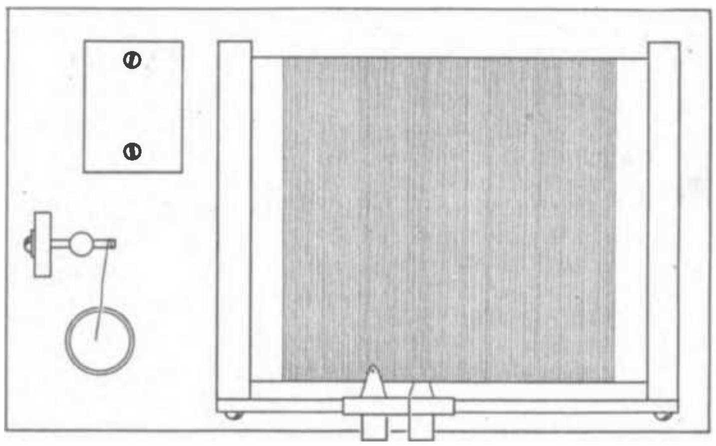
The tuning coil, mounted at the right of the base, is made up of a tube 6 ins. long and 5 ins. in diameter, wound for 5 ins. with No. 24 S. S. C. wire. Two methods can be used for mounting the tube—either holes can be drilled with an extension bit in the 6 x 6 in. end pieces, or wooden discs, fitted into the ends of the tube, may be fastened with brass screws to the end pieces.

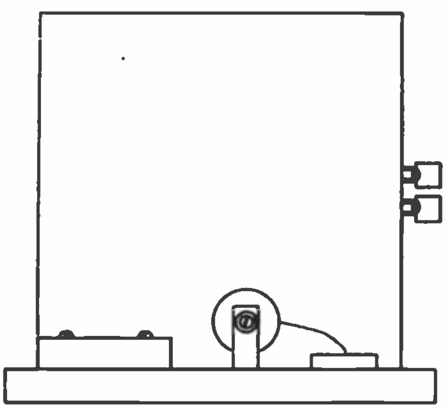
Slider rods of 3/16 x 3/16 in. brass are secured to the end pieces by means of small brass wood screws. The sliders are square brass tubes, 1 in. long. A piece of spring brass, for a contact, is soldered to each one. On the top is soldered a flat head machine screw, to take the adjusting knob.

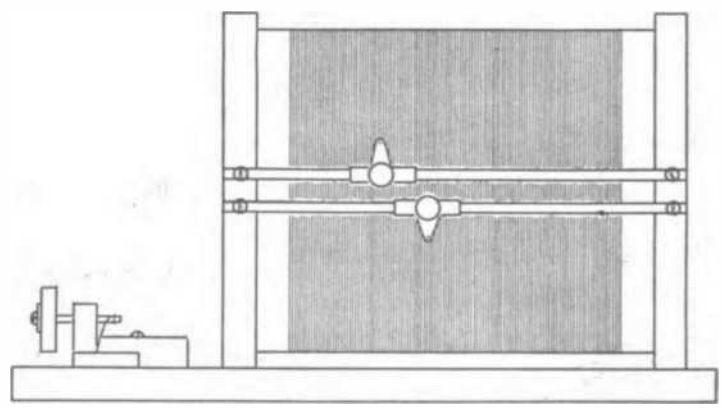
The wiring diagram shows that one end of the winding is brought out for connection to the ground, one slider rod to the antenna, and the other to the detector. Connections should be soldered if possible.

Under the small wooden block, beside the tuner, a fixed condenser is mounted. This consists of 15 sheets of tin foil, 2 x 1 in., separated by paraffined paper sheets. Alternate tin foil sheets are connected together, and leads brought out to shunt the phones. If care is used not to overheat the tin foil, it can be soldered. The completed condenser is set into a place cut out in the under side of the block and sealed with paraffin or sealing wax.









Any type of detector may be used, though the one illustrated here is about the easiest to construct. A 1½ in. 8-32 screw is put through a tight fit in a brass post. For convenience, a simple disc of bakelite is used as a handle. A short piece of No. 30 copper wire, soldered to the screw, acts as a contact. Galena or ferron will give good results in this detector.

Telephones of 1,000 or 2,000 ohms complete the set.

(*Continued on page* 116)

A Simple Apparatus for Signalling Under Water

By Laverne Yates

THE oscillator and microphone described in this article can be used for transmitting signals under water up to a distance of forty feet. Both the transmitting and receiving stations can be put together with a few odds and ends that are generally found around the amateur's laboratory or workshop.

We will first confine our attention to the oscillator. An examination of the drawing shows that it consists primarily of two 20-ohm magnets mounted in a tin receptacle. In the writer's case, the receptacle was a tin can in which mechanic's soap is sold. The can should be cleaned out nicely and wiped dry to prevent it from rusting. A pair of 20-ohm magnets are then mounted on the cover as illustrated. Owing to the depth of the can, it will be necessary to place a wooden block between the magnets and the cover. The holding screws pass through the wooden block and screw into the ends of the pole pieces. The magnets should be so mounted that the opposite end of the pole pieces come within 1/8 in. of the bottom of the can. If more powerful magnets can be obtained, so much the better. However, magnets with too high resistance should not be used.

The magnets are connected in series in the usual manner and one of the free terminals is soldered to the inside of the can. The other terminal passes through the can to the outside. The hole through which the wire passes must be made perfectly water tight. To do this, a brass bushing is first soldered in place. In this a circular piece of fibre is forced with a hole in it just large enough to permit the passage of the wire. After the wire is drawn through, both sides of the fibre bushing should be smeared with white lead.

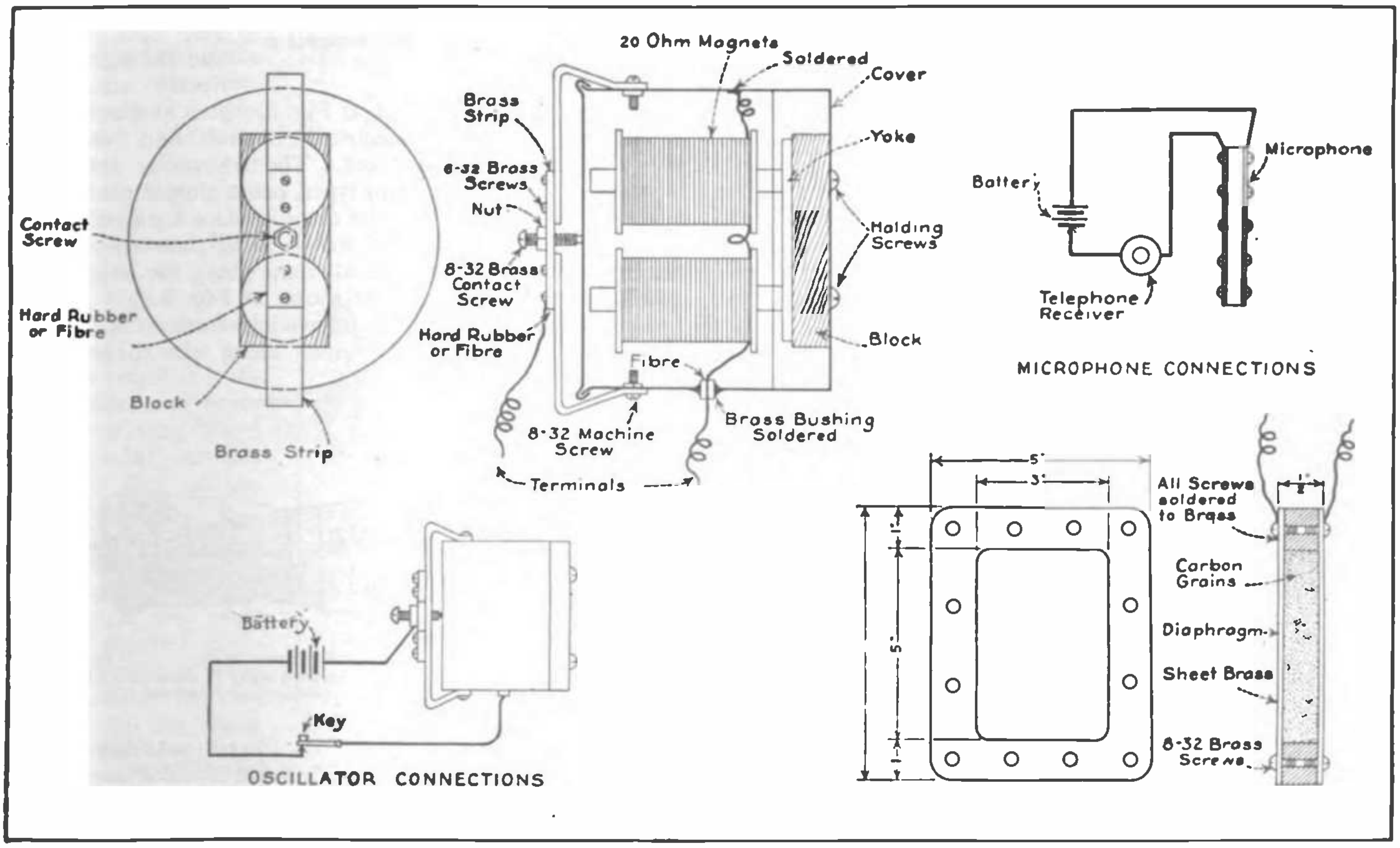
A strip of heavy sheet brass about 1/2 in. wide is then bent and attached to the bottom of the can as shown in the sketch. The screws which hold the strip in place should be covered with a drop of solder to prevent water leakage. The remainder of the work on this particular part is clearly shown in the drawings and the author does not feel it necessary to give it further description.

Before the cover is finally put in place, it should be smeared on the inside where it comes in contact with the can with white lead. After it is in place, the outside should also be painted with white lead and allowed to dry. This will make the can water tight.

The oscillator for the transmitter must be used in connection with a telegraph key and three dry cells. The connections of the device are shown at the bottom of the drawing.

The microphone or receptor is a very simple piece of work. The main frame is cut from a piece of fibre 5 in. x 7 in. The center of this piece is then cut out so that it will form a frame, with inside dimensions of 5 x 3, outside dimensions 5 x 7. Holes are then drilled around the edge of this frame with a 28 drill and tapped out to receive an 8-32 brass screw. A piece of 20 gauge sheet brass is used to cover one side of the frame and holes must be drilled in this piece to correspond with those in the fibre frame. A thin film of white lead is smeared around the frame before the brass sheet is put in place. After the screws are tightened properly a drop of solder can be placed on each one to make the device as nearly water tight as possible. The diaphram should be cut from thin sheet brass. Holes are drilled in it to correspond with those drilled in the frame. To save a lot of work in doing this, the writer placed the two pieces of sheet brass together and clamped them with the frame in the vise. All the holes were then drilled together. Before the diaphragm is put in place, the microphone is laid flat on the bench and filled with carbon grains. These can be made by crushing an old battery carbon. The pieces should be a little smaller than a pea. The microphone should be filled flush with the carbon

(*Continued on page* 132)



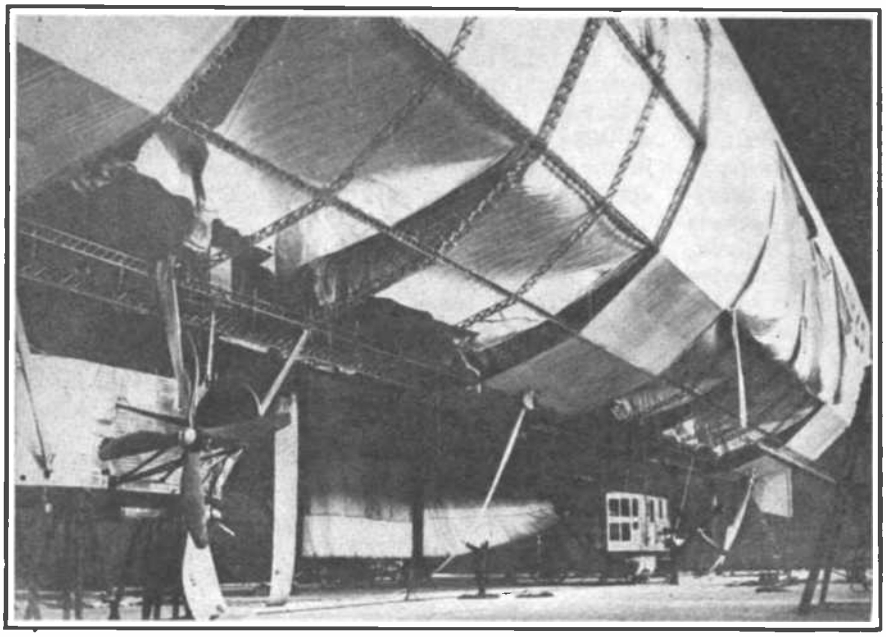
Dirigible Airship Frame Construction

Details of the Hull Structure Showing How a Combination of Engineering Ability and Metallurgical Knowledge Made the Rigid Airship Possible.

By Victor W. Pagé, M. S. A. E.

TO design and construct a frame structure nearly 700 feet long and 80 feet in diameter that will be sufficiently light to form the basis of the modern dirigible airship and at the same time secure the requisite strength to carry a heavy load of passengers and freight and withstand the vibration of powerful engines and buffeting of the elements is a task of no mean proportions. Its successful achievement is a triumph of modern science, not only in the engineering involved in the design and construction of light parts, but also in the metallurgical knowledge called for to select and produce metal alloys of great strength and lightness.

There were two big problems to be solved, one pertaining to the frame, the other to the envelope and gas bags. The costly and long continued experiments of Count Zeppelin and his corps of engineers were finally successful and the modern airship is the result of years of development on their part. The illustration at Fig. 1 outlines a recent British type, while one of the German rigid dirigibles known as the L-33 is shown at Fig. 2. The frame of the latter may be considered typical of this design and is shown in simplified form without covering or gasbags at Fig. 3. As will be evident, the hull is built up of aluminum alloy or duralumin lattice girders of triangular section, as shown at Fig. 4. These girders are built up of three-corner rails of modified channel section, which are interconnected by X-shaped pieces of fluted cross section. Owing to the great number of these pieces, they were stamped in dies, and besides the flattened out ends provided for attachment to the longitudinal channel section members, the center was also formed so it could be joined to a similar pad on the other member of the pair of rivets, as clearly shown at Fig. 5.



View of hull of British dirigible, showing framework very clearly as outer covering is removed at various points

The alloy used undoubtedly varies in different craft, but a metal sample taken from a Zeppelin that was brought down during the war analyzed as follows: Aluminum, 91.92 per cent.; copper, 4.13 per cent.; iron, 3.27 per cent.; silicon, 0.65 per cent., and tests showed that it had a tensile strength of 40,000 lbs. to the square inch. The thickness of the metal used varied from 0.5 to 1.0 millimeter, depending upon the strength required of the part. The strongest girders weigh about 2.2 pounds for each 40 inches of length. The cross section of the girders is an isosceles triangle measuring 0.27 meters in height and 0.14 meters at the base. The hull comprises twenty-five longitudinal girder elements and thirty-six polygonal frames besides the minor braces and fairing members. The cross section of the hull is a twenty-five sided polygon and while it is not exactly circular, it approximates that ideal cross section sufficiently for all practical purposes. The nose is blunt and the stern is distinctly conical, as shown at Fig. 6, which also outlines the symmetrical control and stabilizing members. The transverse frames are of two types, one a simple girder member; the other is more complex, as it is braced with a King post truss. These frames alternate along the length of the hull, as shown at Fig. 3.

An interesting feature is the keel which runs along the base of the

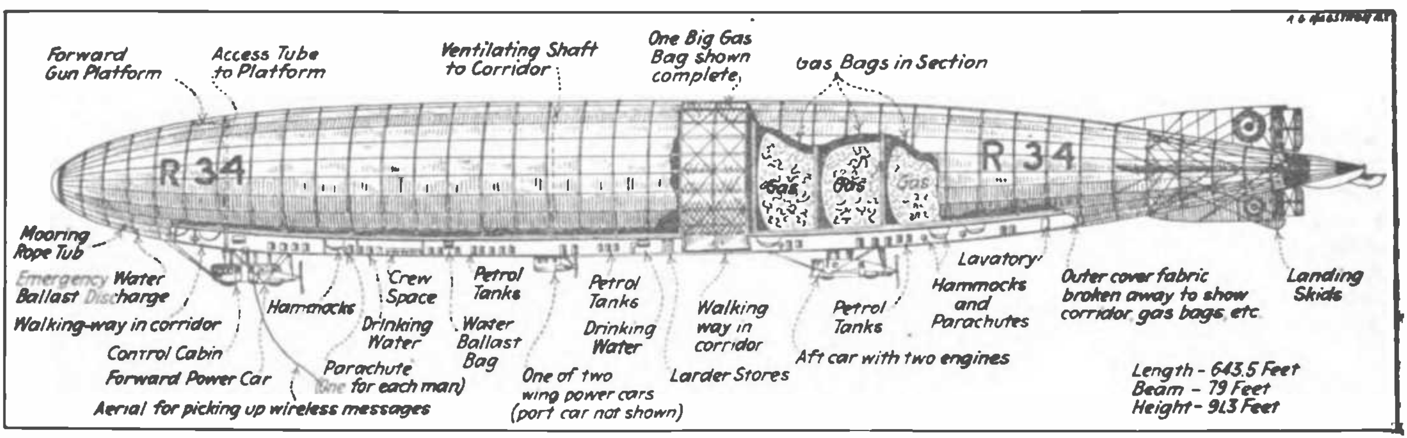


Fig. 1. Part sectional view of latest type dirigible airship, showing arrangement of gas containers, location of power cars, etc.

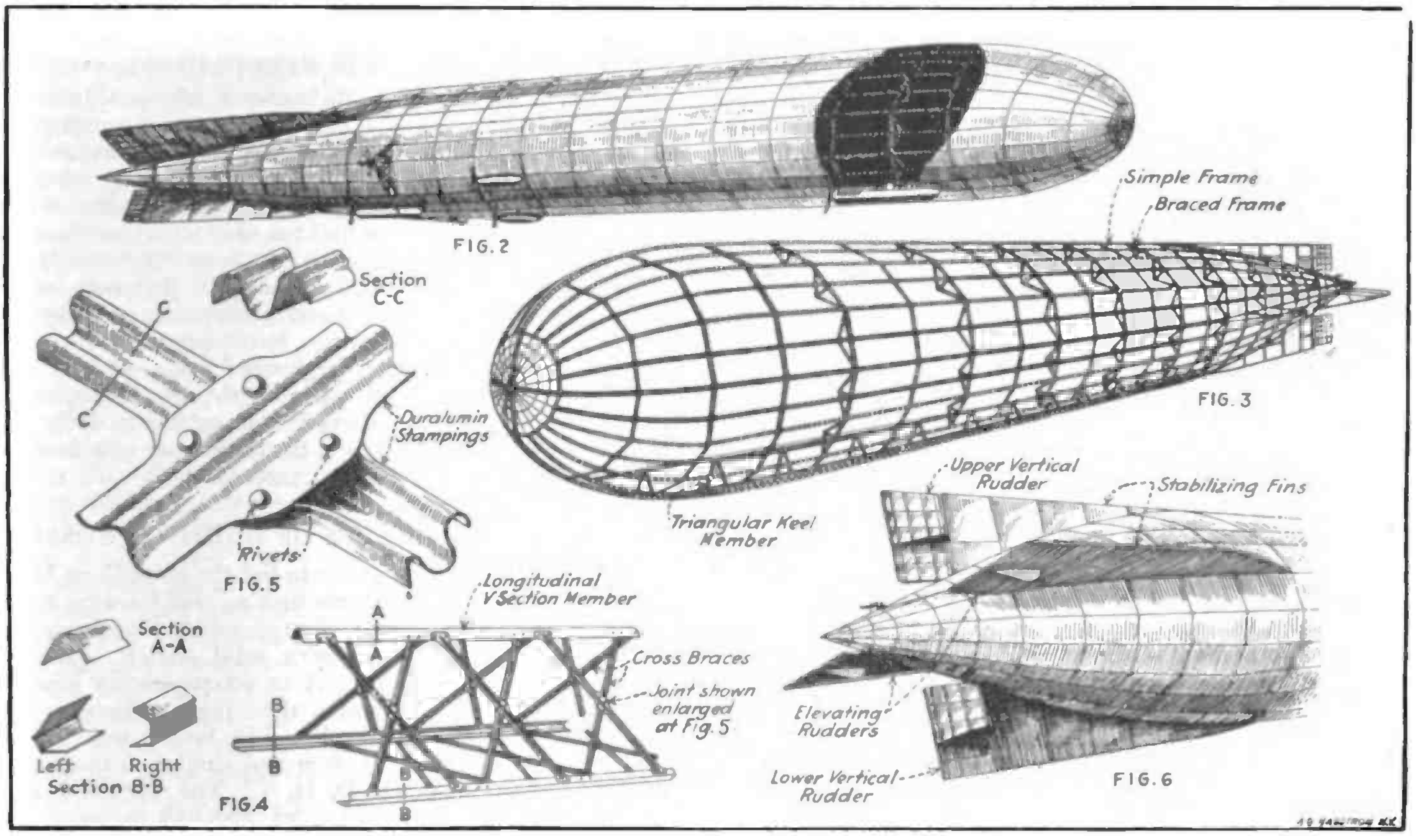
frame. This is triangular in section, as the illustration at Fig. 7 shows. It is formed of two main longitudinals, which are the base, and one situated about ten feet overhead, which forms the apex. The space thus secured is a large corridor, which is utilized as crew space and which provides a means of communication from one end of the main portion of the ship to the other, besides greatly strengthening and stiffening the frame. The way portions of this space are utilized in the R-34, the famous British dirigible, is clearly shown at Figs. 8 and 9. The section of the keel corresponds to the letter A, the crossbar serving as additional bracing. A running board or "cat walk" extends from one end of the keel to the other.

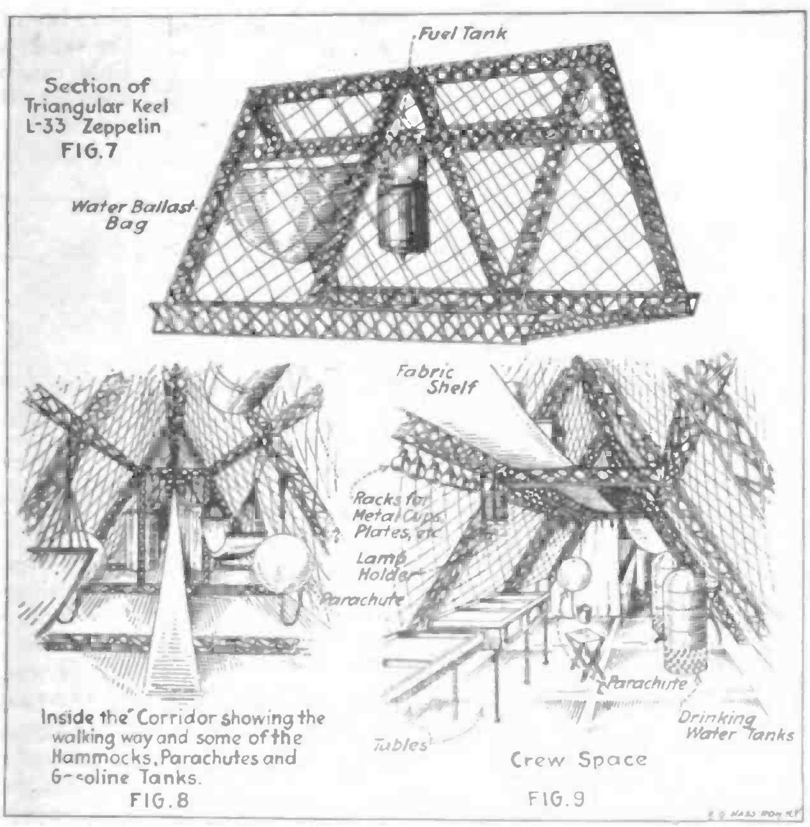
The frames for the control surfaces are also duralumin structures which are composed of smaller girders of rectangular cross section similar in construction to the main frame members.

The envelope of the hull or outer cover is a linen fabric which is doped with black compound on the under side and gray on the upper, and it is composed of strips laced into position on the frame girders. The gasbags are of a special cotton fabric which is lined inside with gold beater's skin, which is said to have resistance to gas penetration superior to the rubberized fabric also used for this purpose.

A netting of special cord surrounds each gas container and holds it in shape to insure against its bulging out into the keel or chafing against the envelope or hull frame. The bags are cylindrical except for the piece which is cut out to fit over the keel structure. Eighteen gasbags are used in the L-33, though the number varies with the length of the airship. In the L-49 the weight of the frame has been estimated at about 8 tons, the outer cover at 2.6 tons and the gasbags at 3.5 tons. The hull is trussed by diagonal stays and special truss members which join the keel to some of the upper longitudinals. The power cars carrying the engines are secured to the main frame and are carried below it, as clearly shown in the illustrations.

The United States Navy has acquired a large dirigible from the British authorities which is larger than the R-34 and which is reported to be the R-38 and to have a number of improvements over the earlier types. This will give our naval authorities the opportunity to become familiar with the features of this type of aircraft and to train personnel for their navigation and care.



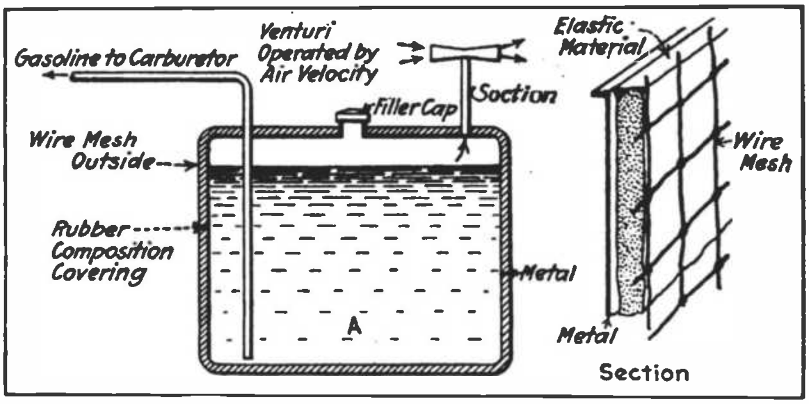


AVIATION BRIEFS

A SPECIAL FUEL TANK FOR AIRPLANES

A gasoline tank that cannot leak or burn is of great value in aircraft work, especially in times of war when it may be punctured by numerous bullets. The tank illustrated is the invention of Mr. F. Weinberg, an automotive engineer of Detroit and it has been perfected to a high degree.

Primarily, this container is an ordinary metal tank of any dimensions, having two connections and its filler cap. The suction connection is intended to provide a partial vacuum above the liquid of sufficient strength to prevent its escape through any hole that may be shot through the tank wall. The necessary suction can be got in various ways, but probably most simply by the venturi shown, which operates by virtue of the stream of air created by the movement of the plane. The fuel reaches the carburetor through the second opening by overcoming the vacuum created through the former—which may be accomplished by maintaining a greater suction, or by positive feed pumps.



Fuel container designed for aircraft use that is said to be fireproof and puncture proof to a high degree

To insure proper functioning at all times, the tank is enveloped in a rubber material under tension which plugs up whatever holes may be shot in the tank as it possesses sufficient elasticity to return to its former state after being pierced, leaving a hole so small as to almost defy detection. The tank may have a number of holes shot in it and still refuse to leak. The application of this principle to render the tank leak-proof makes it at the same time explosion-proof. To cause an explosion there must be a combustible mixture of air and fuel; but in the Weinberg tank no such mixture can be created anywhere.

MAN POWER AIRPLANE FLIES

For some time past a group of experimenters in France have been trying to fly with combinations of bicycles and light wings, the usual pedaling gear being attached to a small aerial propeller, as well as to the rear wheel of the bicycle. So much interest obtains that a substantial prize has been offered for the first man to fly 30 yards by his own power. It is reported that Poulain, a French cyclist, recently made a flight of 12 yards at a height of one yard by a man power aviette. Through reports of this flight Poulain has been accepted as a contestant for the Peugeot prize of 10,000 francs for the first 10 metre flight, the prize to be awarded by the Aero Club de France. Such a feat is little more than an acrobatic stunt because a man cannot exert the power required to maintain flight for more than a few seconds at the most with the aerofoils and propellers available with our present knowledge of aerodynamics.

SUPERCHARGER ON RECORD MAKING PLANE

In an airplane equipped with a supercharger for the Liberty engine, Maj. R. W. Schroeder, of the Army Air Service, recently broke the altitude record for a passenger carrying flight. He is said to have reached 30,000 feet in a Le Pere fighter at Dayton, Ohio. The supercharger is a mechanism that supplies air to the carburetor at high altitudes to compensate for reduced density of the atmosphere and thus maintains power output by insuring that as full charges of mixture will be inspired by the motor at high altitudes as at sea level. Several forms of superchargers have been experimented with but no mechanism of this type has been developed that is entirely satisfactory.

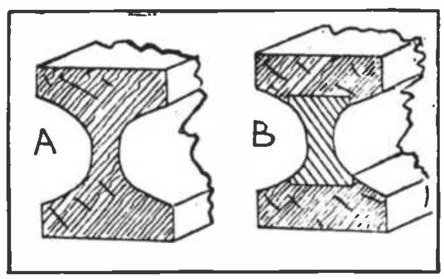
NEW ZEPPELIN AIRSHIP

The Bodensee, a new airship made by the Zeppelin interests, covered the distance between Friedrichshafen and Berlin at the rate of 75 miles per hour on its maiden trip. The familiar cigar-shaped hull has been abandoned and the new aircraft is a more efficient streamline hull shape. The Bodensee is 400 feet long and accommodates thirty-five passengers. It is equipped with wireless telegraphy and has a spacious passenger cabin with all conveniences. The aircraft is to go into a daily service and is the forerunner of a fleet for passenger transport.

TESTS OF BUILT-UP BEAMS

In order to test the strength of built-up I-beams such as used for wing spars, a series of experiments have been carried on with solid section beams as shown at A in accompanying illustration and a three-piece section as outlined at B. The beams were of the same section and similar to those used in the D. H. 4. The specimens were constructed of matched material, the solid beams and the flanges of the three-piece beams being cut side by side from the same plank of clear Sitka spruce. Cold casein silicate glue was used in securing the parts of the built-up beams.

Under four-point loading, which approximates the application of stresses in service, the loads sustained by the two types were about the same. The difference in favor of the built-up beams was too slight to be considered of any value.



Sections of one piece and built up I beams tested

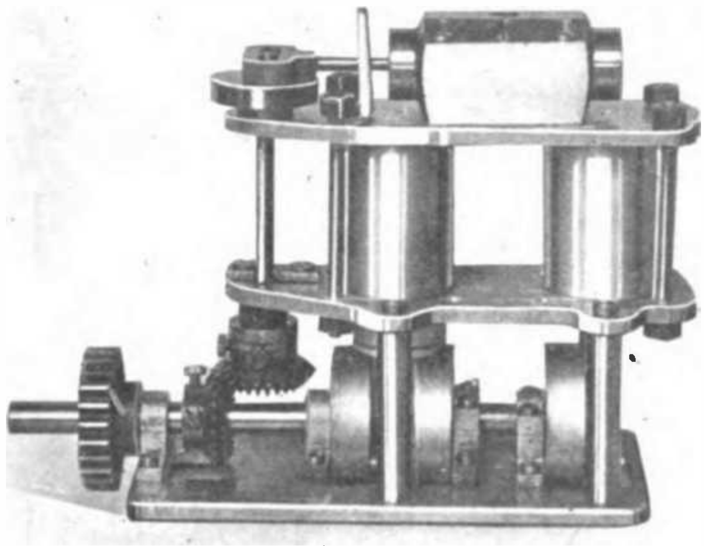
The construction of I-beams of more than one piece offers certain obvious advantages. It enables the builder to use cross-grained material in the web, and since smaller pieces are required than in the case of the solid section, more beams could be produced from a definite amount of lumber.

A High Speed Flash Steam Engine

By George Bender

Designed and Constructed by the Author.

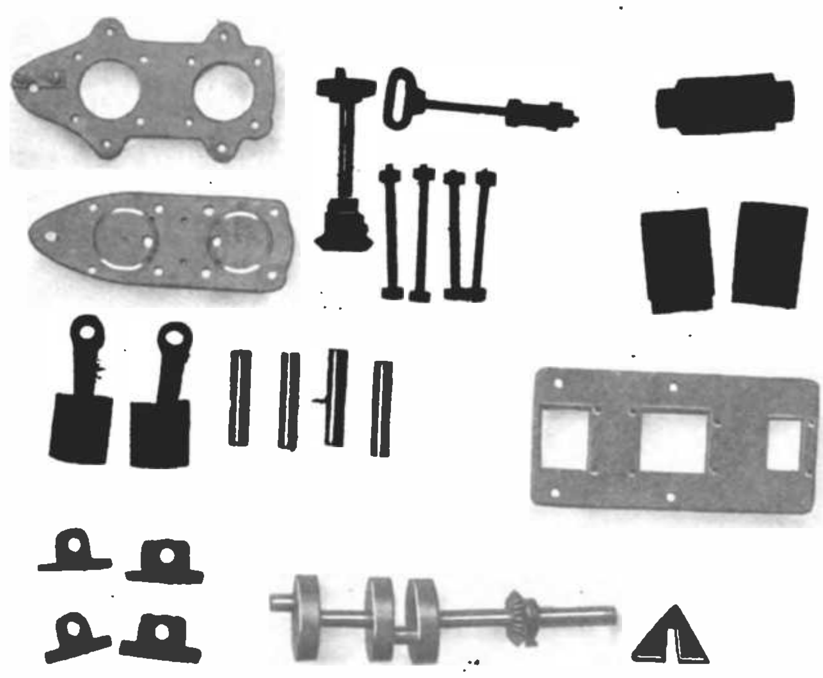
THERE were two reasons for the writer to construct the engine shown in the drawing and photographs and these were cheapness and ease of construction. Regarding cheapness, it can be said that there was not one casting used and everything, with the exception of the bevel gears, was made of scrap material. Regarding ease of construction, it will be seen that most of the parts do not require the use of a lathe but those that do are easily machined with the smallest and crudest piece of machinery. This does not make any exception of the crankshaft which the writer believes is quite novel in construction and very efficient. This engine has been run steadily for over one hour without the least sign of distress.



The engine assembled. Although of very simple construction this engine will prove very suitable to use in connection with flash steam

In construction, let us start by making the three plates which form the cylinder top plate, cylinder bottom plate and bed plate. First lay out the shape of the piece and position of all the holes in the cylinder bottom plate. After the plate has been filed to shape all holes can be drilled and this plate can then be used as a jig for the top and bed plates. After all plates have been drilled and filed to shape, the cylinder bottom plate must be turned out to fit the shoulders which have previously been turned on the cylinder tubes. In the cylinder top plate two grooves are turned about 1/32 inch deep to fit the top of the cylinder tubes and after driving the cylinders into the bottom plate, the top plate can be put on and the whole bolted together with eight bolts and nuts of which only four are shown in the photograph.

The valve chamber is of the piston type with inside steam admission and has both ends open and free to exhaust. This was made from a solid piece of cold rolled steel 3/4 inch square. The steam ports are 1/8 inch square and piston valve diameter 3/8 inch. The valve itself was also made of cold rolled steel and was ground into the valve block for a perfect fit. The valve is actuated by a sliding pin in a disc driven by a bevel gear from the crankshaft. The pistons were also made of cold rolled steel and turned to fit the 3/4 inch inside diameter of the cylinder tubes which were made of Shelby steel tubing. The pistons were bored out inside to take the connecting rod and wrist pin, three water seal rings were turned on the outside of each piston. The connecting rods were made of 1/8 inch thick brass plate and the shape can be seen by referring to the drawings.

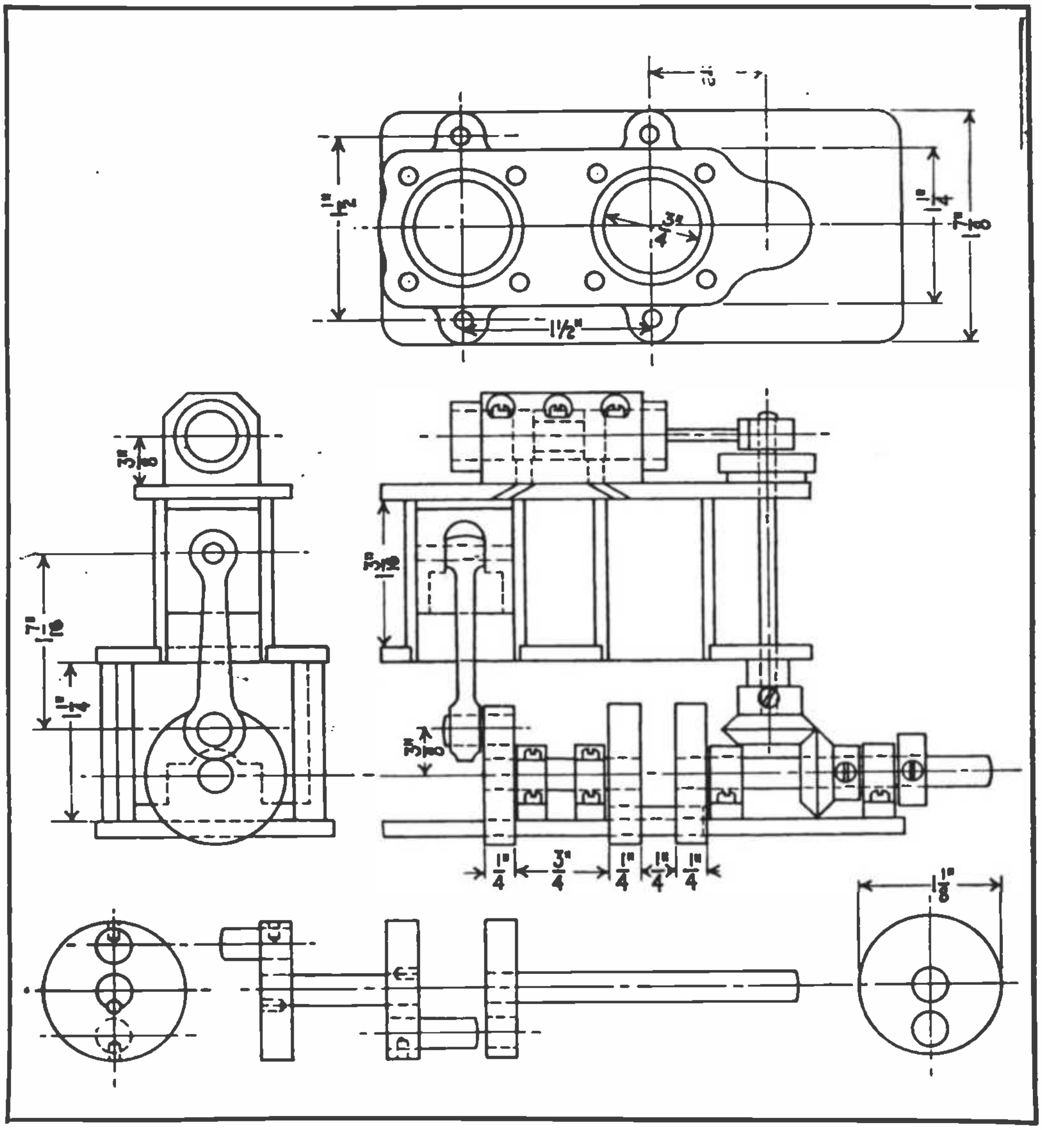


The finished parts of the engine ready to assemble

And now we come to the crankshaft. To see whether this method of crankshaft construction would stand up under severe usage was another reason the writer had for the building of this engine. The crankshaft is built in two sections; one long and one short section. It consists of three circular pieces of cold rolled steel 1 1/8 inch diameter and 1/4 inch thick. These pieces were sawed from a piece of shafting 1 1/8 inches in diameter in slices about 3/8 inch thick. They were put in the chuck and faced off at each side down to the thickness of 1/4 inch. Before removing the pieces from the chuck, carefully center and drill with a 1/4 inch drill. If a drill can be found that is about two one-thousandths of an inch undersize it will be an advantage when fitting the shaft. Now take one disc and drill another ¼ inch hole exactly ⅜ inch away from the center. This one disc can now be used as a jig for drilling the other two discs. Two of the discs are now taken and driven onto a piece of ¼ inch drill rod of the required length, making sure that the crank pin holes are exactly opposite each other. Small holes are drilled into the ends, half being in the crank disc and half in the shaft, and then small pins are driven into these holes to securely fasten discs to the shaft. Crankpins, one short and one long, are next driven in their relative holes and secured with pins driven through the rim of the crank discs. The other long section of the crankshaft is simply one disc securely fastened and pinned. When assembled on the bed plate the long crank pin enters hole of the long section of crankshaft and does all the driving. These crank discs also answer the purpose of a flywheel and therefore no flywheel is necessary. The crankshaft bearings, of which there are four, were made from some 3/16 inch thick brass plate sawed out and filed into the desired shape. The two bearings of the short section of crankshaft must be split bearings but the other two for the long end can be left solid. The split bearing will be found necessary when the engine is assembled. It is very simple to line up the crankshaft bearings. After the necessary clearance holes have been cut into the bed plate, take a piece of ¼ inch steel rod and slip all the bearings on the rod in their relative positions after which set them on the bed plate and mark out the fastening down screw holes. After drilling and tapping the holes, fasten the bearing to the bed plate. If this work has been carefully done, no trouble will be experienced with the crankshaft binding when the long and short sections are put together.

The photographs of parts and finished engine will clearly show details of construction and it can easily be seen that this engine will give a good account of itself, whether put into a speed boat or just a good cruising model.

The engine weighs finished 1 lb. 4 ozs. without boiler or pumps. The engine can be used very successfully with flash steam as well as with saturated steam. It is a powerful engine well adapted for racing models. Like all flash steam engines it is capable of making a tremendous speed and it will stand up under heavy loads considering the labor necessary to produce this engine, it is a serviceable, good machine.



Book Review

Practical Dry Cleaner, Scourer and Garment Dyer. By Brannt-Gray. 368 pages with illustrations. Size 5 x 7½ ins., bound in cloth. Published by the Henry Carey Baird Co., Nassau Street, New York City.

This book is a well arranged and clearly written treatise on the science of cleaning and dyeing. Its pages include every conceivable process that has proven to be of practical value. The treatment is entirely practical rather than theoretical, and the information is imparted in clear, understandable terms. French Cleaning; Removal of Spots and Stains of Various Kinds; Wet Cleaning; Finishing Cleaned Fabrics; Cleaning and Dyeing of Various Kinds of Materials; Renovating; Garment Dyeing; Stripping Colors; Analysis of Textile Fabrics; and a concluding chapter on Practical Chemistry for the Cleaner and Dyer, form the subject matter of the book. This book will give great practical information as a reference and guide.

Induction Coils in Theory and Practice. By Prof. F. E. Austin, E. E. 64 pages, size 5¼ x 8½ ins., bound in cloth. Published by the author at Hanover, N. H.

This book is a very involved treatment of the induction coil and includes a mass of advanced mathematics concerning its theory. It is a splendid volume for those who wish to go more deeply into the subject than the average text book takes them. Prof. Austin, the author of the treatment, is specially qualified to prepare such a book, and we have reason to believe that it will be widely read by those who are able to digest its contents. The forepart of the book is devoted to the theory of the induction coil, while the latter part is given over to practical problems in connection with the construction and operation of coils. Some very valuable data in connection with interrupters and condensers is also included, together with a chapter on Tesla coils and choke coils. Magnetic circuits are also explained in detail and the information necessary for a thorough understanding of induction coils and their theory, operation and construction is covered.

EXPERIMENTAL CHEMISTRY

METALLURGY—ELECTROCHEMISTRY PHYSICAL CHEMISTRY

Metallurgy for Beginners

By E. Hurley

In the last issue of EVERYDAY ENGINEERING, *the author discussed the analysis of aluminium, cobalt, nickel, copper, bismuth, barium and chromium. This list will be extended in the present treatment to include all the common elements.*

Lead

GALENA, a heavy gray mineral, is the most important ore of lead, containing 86% of the metal. Cerusite, another lead ore, has a white gray color and contains 83% lead oxide. There are several other lead mineral bearing ores.

Take a gram of the finely pulverized ore in a porcelain dish and add 10 cc. nitric acid and boil until one-half of the acid has evaporated. Then add 5 cc. hydrochloric acid and boil to a complete dryness. Cool and add 5 cc. hydrochloric acid; heat and dilute the solution to 100 cc. with water. Heat again to boiling point and filter while hot. Pass hydrogen sulphide gas through the hot solution and continue to pass the gas until the solution is cold. Absence of a black precipitate shows no lead present. If a precipitate is obtained, wash with ammonium sulphide and then treat the remaining residue with hot nitric acid which will dissolve any lead present. Filter and to the solution add a few drops of concentrated sulphuric acid and if lead is present a heavy white precipitate will slowly settle to the bottom of the test tube.

Manganese

The principal ores of manganese are pyrolusite, which contains about 63% and rhodachrosite, which contains 62%. There are other ores of lesser importance. The principal use of manganese is in the iron and steel industry with a small amount being used as a coloring agent in the manufacture of glass and pottery.

Mix a small quantity of the finely pulverized ore with equal parts of sodium carbonate and potassium nitrate and fuse before the blow pipe. If manganese is present, the mass assumes a bright green color which turns bluish green on cooling. Dissolve the residue in water and boil the solution and if manganese is present the solution will show a purplish-red coloration.

Molybdenum

The principal ore is molybdenite. It has a lead-gray color and contains about 59% molybdenum. Another ore of importance is wulfinite and it contains approximately 35% molybdenum. Its chief use is in the manufacture of steel and in the preparation of ammonium molybdate. Other uses are to color pottery, leather and to dye silk and woolens.

Treat a little of the finely pulverized ore in a porcelain dish with 20 cc. nitric acid. Heat and evaporate to dryness. Cool and add 3 cc. sulphuric acid and again heat until the acid is almost gone. Cool, and add a few drops of alcohol and if molybdenum is present the solution and sides of the dish are colored an intense blue.

Thorium

The principal ore of thorium is monazite, color brown to brownish red. It has been found in the West but the principal production in the states comes from the sands of the many creeks in the Carolinas. Its principal use is in the manufacture of incandescent mantles for gas lamps, etc.

Fuse about one gram of the finely pulverized ore with five grams of potassium sulphate in a porcelain crucible. Heat until the mass is in quiet fusion and cool. Place the crucible containing the melt in a porcelain dish and dissolve the residue in 10 cc. of hydrochloric acid and add 50 cc of water. Boil until everything has passed into solution and filter. Treat the residue on the filter with a little hydrochloric acid, heat and again dilute with water and filter. Unite the two filtrates which now contain all the thorium and heat. Pass hydrogen sulphide gas through the solution and remove any precipitate by filtration and boil the resulting solution. Then add ammonia in excess and if any thorium is present, a white precipitate will be formed. Filter this precipitate off and wash it. Add to it a few cc. of dilute sulphuric acid to dissolve and to this solution add boiling concentrated solution of potassium sulphate and a white crystalline precipitate will be formed if thorium is present.

Tin

The chief ore is cassiterite, a heavy brown and black mineral which contains 75% tin. It is found in many localities of the United States in veins of granite. Another important tin ore is stannite with a steel gray and black color and contains 30% tin. The ores running very low in this mineral can be treated very profitably by the wet concentration method and prospecting and investigating for tin should claim serious attention of the amateur prospector.

Fuse before the blow pipe one gram of the finely pulverized ore with four grams of sodium peroxide. Dissolve the melt in hot water and filter. Acidify the filtrate with hydrochloric acid and to this solution add a piece of zinc. When tin is present, it will be deposited on the zinc in a spongy mass. Remove this deposit and dissolve in a porcelain dish with the addition of 3 cc. hydrochloric acid. Add to this solution a little mercuric chloride solution and if tin is present, it will be thrown down as a white precipitate.

Tungsten

The principal ores are wolframite, which contains 50% tungsten. Scheelite contains about 64% tungsten. It is used in the manufacture of high speed tool steel and in the making of filaments for incandescent lamps.

Place a little of the finely pulverized ore in a porcelain dish. Now add 15 cc. of strong hydrochloric acid and a small piece of metallic tin. Boil a few minutes and if tungsten is present the solution will be colored a beautiful blue. Small quantities of this mineral in the ore tested responds readily to this test.

Uranium

Uranium ores are of special interest since it is from these ores that radium is obtained. The principal ores are uraninite (pitchblende). Carnotite has a canary yellow color. Uranium is also used in the steel industry and in the making of glass.

Put one gram of the finely pulverized ore in a porcelain dish and add 10 cc. of nitric acid and 3 cc. of water. Heat and add 5 cc. of sulphuric acid and dilute with water to 50 cc. Add in excess a saturated solution of potassium hydroxide and if uranium is present a deep yellow precipitate will be formed which will be insoluble in water.

Vanadium

The principal ore is vanadinite. Carnotite (see uranium) is also an ore that has a small content of vanadium. Its principal uses are in the manufacture of steel and in the dyeing industry.

Fuse a little of the finely pulverized ore in a porcelain dish before the blow pipe with a little sodium carbonate and potassium nitrate. Dissolve the melt and filter. Make acid with hydrochloric acid. Put a small quantity of this solution in a test tube and add two drops of hydrogen peroxide. When vanadium is present, the solution will assume a brownish red color.

How to Make a Chemical Balance

FOR serious chemical work the experimenter should have a small balance in his laboratory. Such a balance, however, is very costly and, therefore, many experimenters find it necessary to work without one.

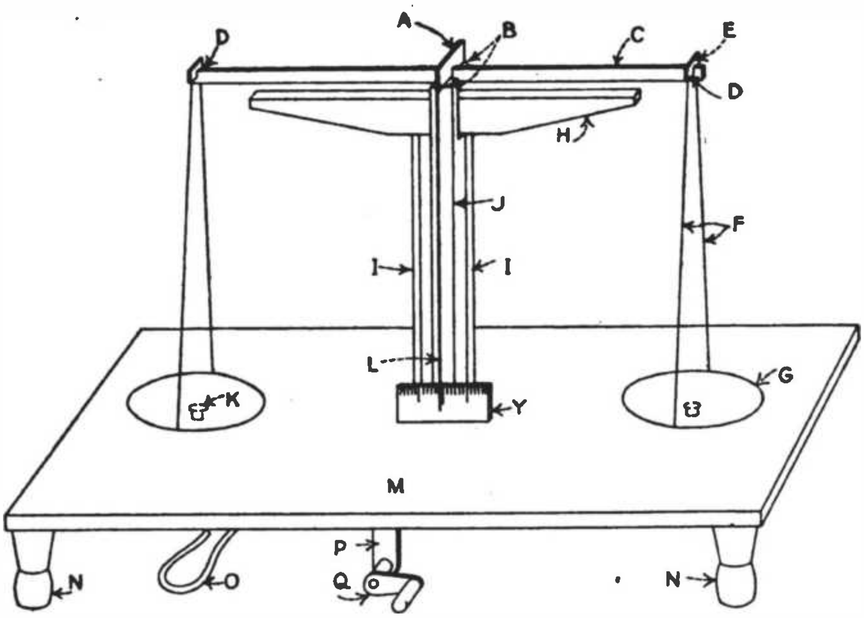


Fig. 1

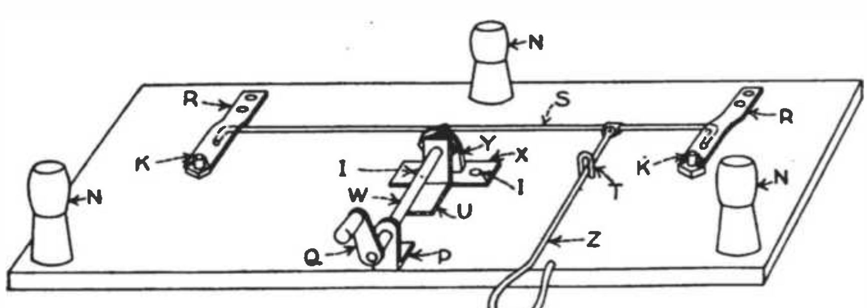


Fig. 2

The balance described in this article is very inexpensive and easily constructed. The materials necessary are not uncommon and all of the parts can be made with little labor.

Fig. 1 illustrates the completed balance. In this figure all of the necessary details of construction are shown. The handle (Q) raises the beam lift (H) and thereby not only removes the weight from the bearing, but also prevents the beam from swinging. The lever (O) permits the stop (K) to drop and allows the pans to swing. The bearings are made from an old hack saw blade.

The beam of the scale will be considered first. This is made of either brass or aluminum and is ⅛ in. thick, ½ in. wide and 10 ins. long.. (See C, Fig. 1.) In the center of the beam a ⅛ in. slot is sawed. A ½-in. hack saw blade is then ground to a knife edge. A piece 1½ ins. long is soldered into the slot. (See A.) This forms the main bearing of the beam. Exactly ¼ in. from each end of the beam a small V shaped groove (D) is made.

The base of the balance (M) is cut from a piece of ½ in. hard wood. It is 7½ ins. wide by 13 ins. long. In the center of the base the upright (J) is placed. This upright is ½ in. thick, 1 in. wide and 8 ins. long. At the top of the upright or standard the slot for the beam lift (H) to slide in is made. This slot is ⅜ in. wide and 1¾ ins. long. The bearings (BB) are screws, the slots of which are filed out to a V shape.

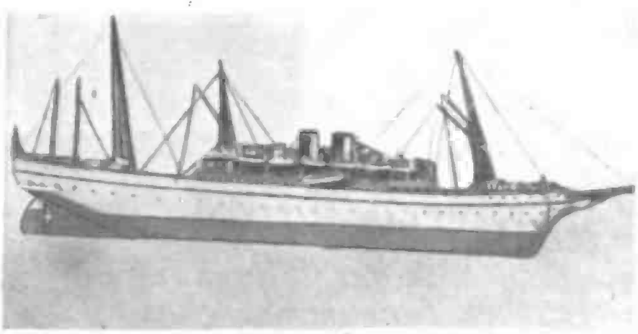
The beam lift (H) is made of ⅜ in. stock. It is one in. wide and 6½ ins. long. 2½ ins. from each end it begins to taper. At the end it is ⅜ in. wide. The brass rods (II) pass through the base and are soldered to the brass strip (X). The cam (Y) causes these rods to be either raised or lowered. This cam is bolted or soldered to the rod (W) which is attached to the handle (Q). The rod (W) is held in place by the brass strips (U, P) which are screwed to the base.

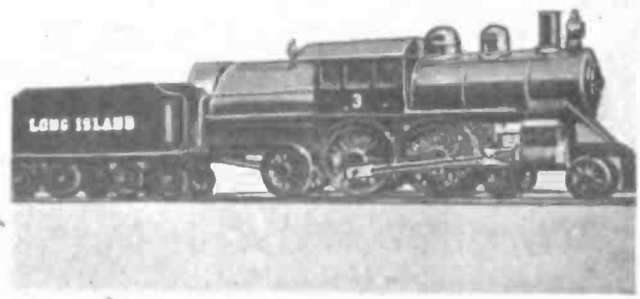
The pieces (KK) prevent the pans from swinging. The nuts adjust them so that they will come to the proper height. These bolts are 3/16 in. in diameter and 1½ ins. long. The springs (RR) hold these bolts in position. These springs should be made very weak. The handle (Z) causes the rod (S) to turn. The hooks on this rod lift the spring and thus allows the bolts to drop. The writer used a rib from an umbrella to make the rod and handle. The guide (T) holds the handle in place. The legs of the balance are turned to shape on a lathe, although square ones would serve the purpose just as well. The pointer (L) is a fine knitting needle. Scale (Y) shows when the beam is in balance.

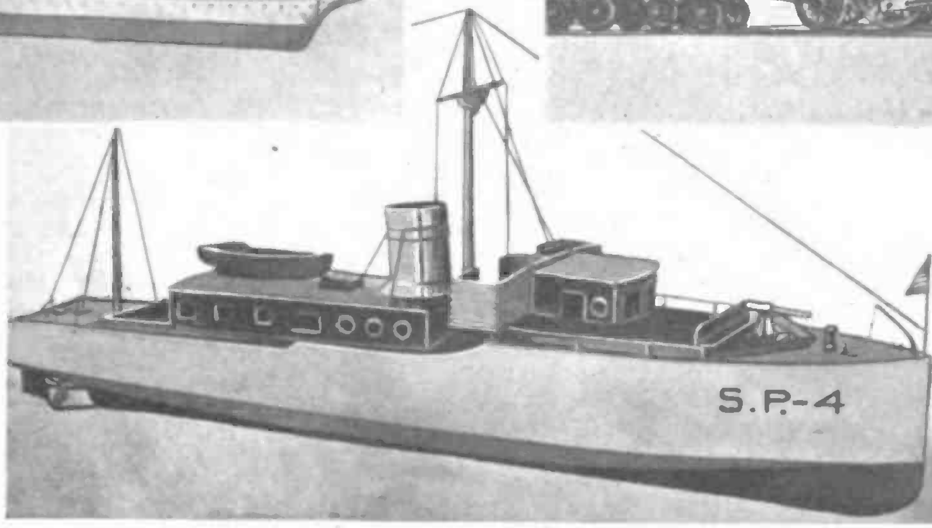
The pans are of aluminum or nickled brass. They are attached to the beam by the two knitting needles (FF). These needles are soldered to the bearings (E), which are made of a hack saw blade. These bearings swing in the groove previously produced in the beam.

The more carefully this balance is made the more accurate and sensitive it will be and the smaller the quantity it will register. The base may be made large enough to enclose the balance in a glass case. If such a case is used the front should have a door that opens. If a case is used, a small beaker of sulphuric acid or calcium chloride should be kept in it to prevent moisture from attacking the balance.

MODELS MADE BY OUR READERS

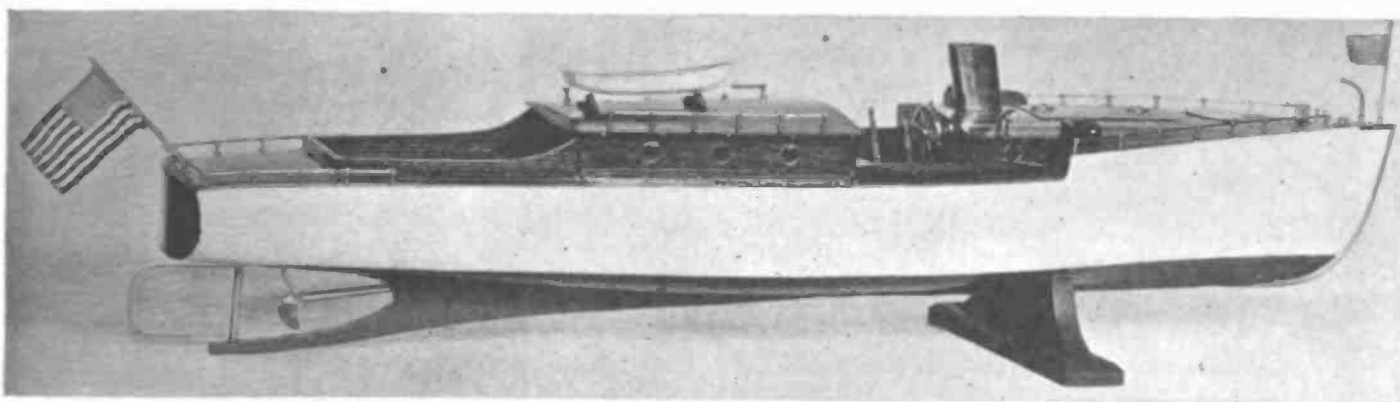




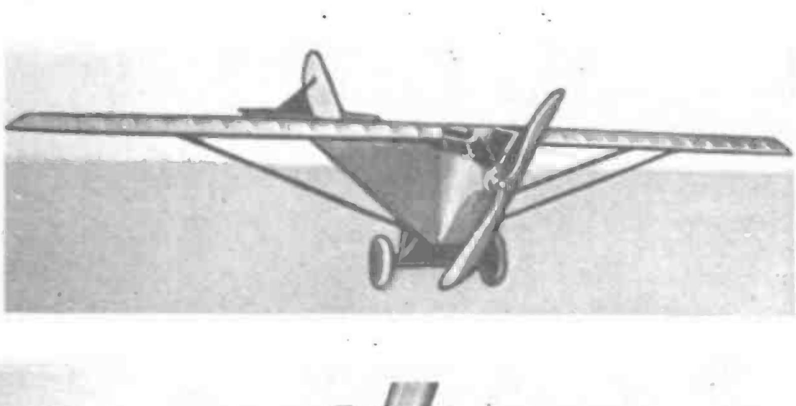


A model steamer of splendid construction built by one of our Canadian readers, Mr. S. Shand, of Edmonds, B. C. This vessel involves a tremendous amount of labor

A model locomotive constructed by Mr. J. S. Pearsall. The center picture shows a submarine chaser made by Mr. Zimmerman, of Detroit, Michigan

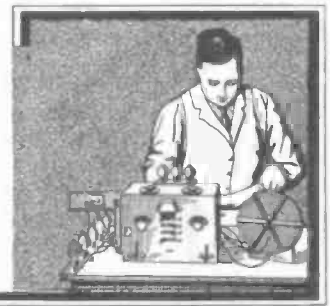


A beautiful model pleasure yacht made by Mr. E. J. Stroud of Fort Wayne, Ind. The painstaking work on this model is made evident by the photograph



A model Loening monoplane made by members of the Aero Science Club, New York. Another boat by Mr. E. J. Stroud is shown below

RADIO
TELEPHONE AND TELEGRAPH APPARATUS



Standardized Audion Control Panels

There is Nothing out of Date about a Station Which has Interchangeable Apparatus, nor is it Necessary to Discard Instruments.

By M. B. Sleeper

CARRYING out the ideas given in the April and October 1919 issues of EVERYDAY, additional instruments have been made. The two particularly described in this article are the audion panel and rheostat panel. In the October issue the loose coupler and condenser sections were taken up in detail, and the purpose and advantages of this system of construction were discussed.

The set illustrated here, designed for wavelengths from 200 to 700 meters, shows the versatility of Standardized Panel equipment. Without making a change in the coupler and condenser, the crystal receiver, described in October, has been made into an audion set.

Fig. 1 shows the front of the audion control panels, and Fig. 2 the arrangement of the rear. At the left of Fig. 2 the audion mounting is shown in detail. It comprises a de Forest type audion socket, grid condenser, and four Fahnestock binding posts.

The panel is of bakelite, 5 x 5 ins. Two inches from the top, a 1-in. circle is described and ¼-in. holes are drilled, with another at the center, to give a view of the lighted filament. Each hole is slightly countersunk at the front to improve the appearance. Holes are drilled at each corner, ¼-in. from the edges, with a No. 18 drill. These are to take the mounting straps. Also, holes of the same size are made along the lower part of the panel for the binding post screws.

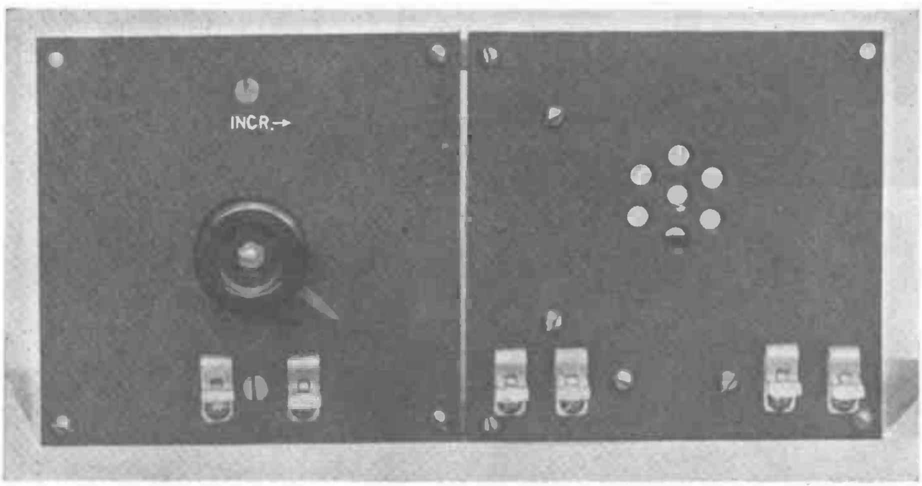


Fig. 1. Always ready to fit into any kind of a set are these standardized audion control panels

Drilling details for the audion socket will not be given, for some may have the Marconi type socket instead of the one used here. The illustration shows clearly that the socket is held by brass angle brackets made of ⅜ x 1/16-in. strip. Connections are of No. 14 bare copper wire. This was a little too large for the screws on the socket. Accordingly, the wire was hammered square and bent to form hooks to fit under the screw heads. Plate and filament wires run directly to the binding posts.

The grid connection goes to a grid condenser secured to the rear of the panel. It will be seen that one set of screws serves only to hold the bakelite clamping strips to the panel, while a separate set act as terminals for the condenser. The bakelite plates are 3 x 1½ ins. and 3/16-in. thick. Condenser plates were cut from No. 30 gauge brass, though tin foil will do, to a size 1½ x 1 in., with a No. 18 hole in the center line, ¼ in. from one end. Next, the two bakelite plates were drilled along the center line ¼ in. from each end. The top plate has two more holes ½ in. in from the others. These last holes are deeply countersunk. When the copper and parafine paper strips were put in place, flat head screws were put through them and the inner holes of the upper plate. As the screws were

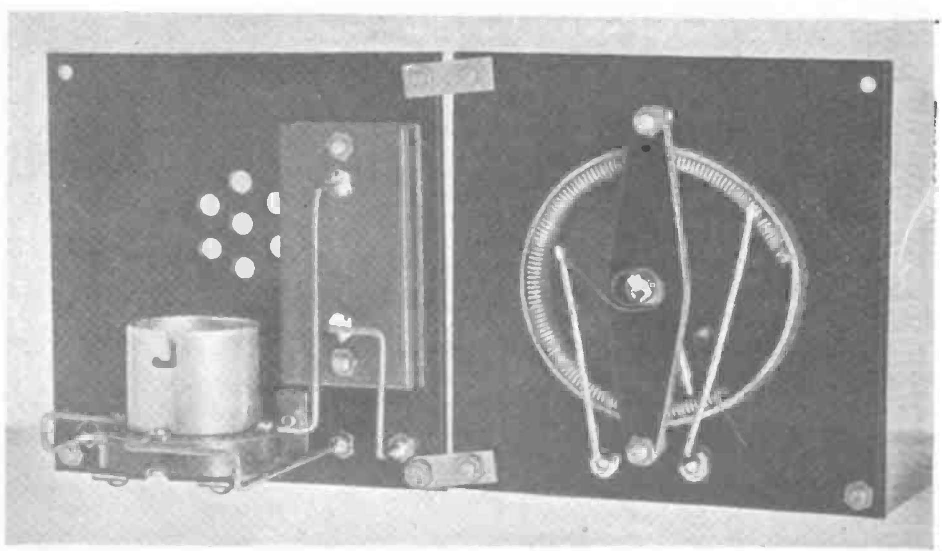


Fig. 2. The neatness and simplicity, upon which efficiency depends, will commend this method of construction to radio men

tightened, the heads went down into the countersunk holes, leaving the tops flush with the condenser plates.

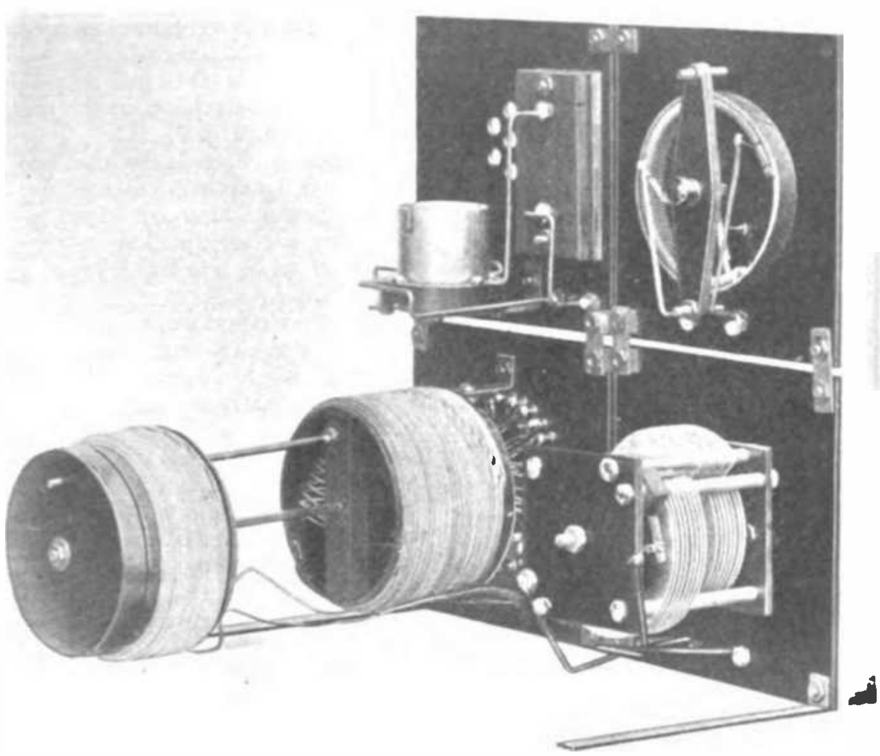


Fig. 3. The audion panels in combination with a simple short wave receiver. Loading coil panels can be added for longer waves

It is advisable to immerse the condenser, with the bottom plate clamped on, in parafin. However, a mistake made when this instrument was built should be avoided. The parafin was boiling hot, and bubbles rose profusely from the condenser. In fact, they did not stop at the end of ten or fifteen minutes. When the condenser was removed for inspection, it was found that the bubbles were coming from large blisters which had formed in the bakelite pieces. Another condenser was made and left in the parafin only one minute. This proved satisfactory in use, and did not injure the bakelite plates.

Numerous methods for building the rheostat were considered. The easiest way seemed to be to mount a regular 10-ohm Mesco rheostat on the back of the panel. However, it was very difficult to take out the screw which held the contact arm. In fact, during the course of operations the base was cracked. Another solution suggested itself. The remaining parts of the base were knocked away until only the resistance element was left. Then it was put inside a short length of cardboard tubing 3 ins. in diameter. Just the thing! It could be arranged with an internal contact.

The next step was to cut off a piece of brass tubing 1½ ins. long with a ⅛ in. hole, and to solder it to a length of 6-32 threaded rod which served as a shaft for the handle. A small brass spring was inserted in the tube, and a ⅛-in. rod put in for a contact. Another difficulty came up. How could the rheostat circuit be opened at the point of minimum resistance? Finally, the wire was cut ¼ in. from the end, and a lead brought out as shown in Fig. 2. Without sticking over the wires, the contact can be run past the lead onto the disconnected end.

A clamping strip of 3/16-in. bakelite was put over the resistance unit and tube to hold them in place. Connection was made to the shaft with a thin strip of brass. Fig. 1 shows the handle and indicator.

These audion mounting and control panels represent a cost of less than five dollars, yet they are equal in efficiency and appearance to purchased sets which cost more than twice as much. Moreover, this equipment has the great advantage of universal use for any type of equipment.

Figs. 3 and 4 illustrate the method by which panels are combined to make a complete set. When front connections are used, care must be taken in wiring the instruments for, otherwise, the appearance of the panels will be spoiled. No. 14 bare wire, preferably covered with black Empire cloth tubing, can be used. Each bend should be at right angles, and the wires pushed up close to the panels.

Next month there will be an article showing these instruments with other new ones, applied to a telegraph or telephone transmitter of a simple design such that any experimenter can readily build it in his own shop.

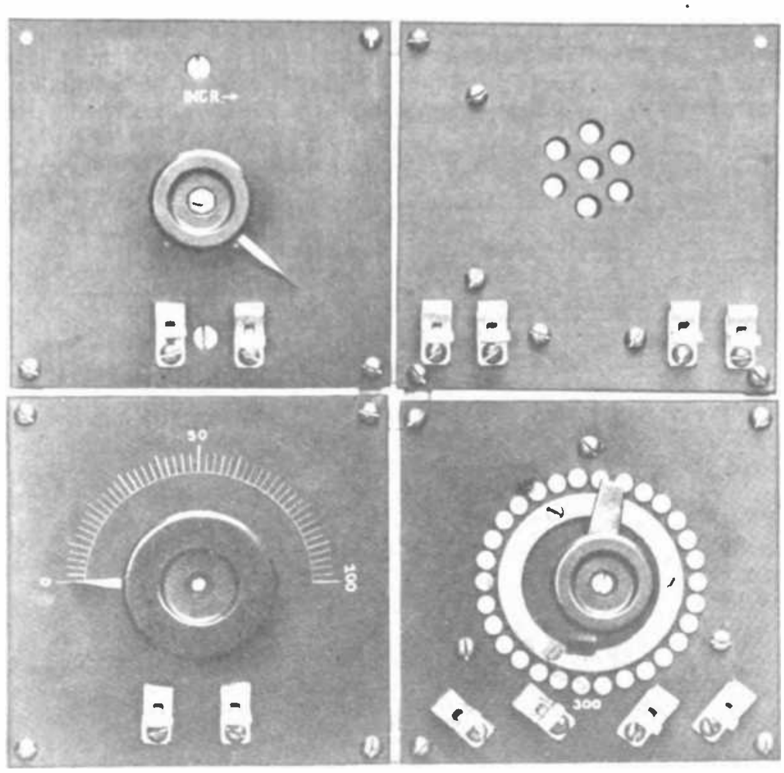


Fig. 4. It is far easier to make good looking equipment by this method than when the instruments are all mounted on one panel

Why Tickler Coils are Inefficient for Long Undamped Waves

Although widely used, the tickler coil method of heterodyning causes a very considerable loss of energy on wavelengths over 5,000 meters

WHEN you are copying a station operating on 18,000 meters, you wouldn't knowingly tune your secondary circuit to 17,000 meters, or 19,000 meters—would you? But have you ever stopped to think, when you do this very thing when you use a tickler coil or other means for making the secondary circuit oscilate locally to receive undamped wave stations, that is exactly what happens.

To make this point clear, consider the theory of heterodyne reception. A frequency is impressed upon the incoming signals, the result of which is a note in the receivers of a frequency equal to the difference in frequency between the incoming and impressed or local oscillations.

In practice, the primary circuit is closely tuned to the transmitter. The secondary is *detuned*, to give an audible frequency. So it is that the secondary circuit is not adjusted to the frequency of the received signals.

At short waves, a slight detuning in wavelength makes a large difference in frequency, so that this affect is not pronounced. Long waves, however, have a low frequency. Thus a small difference in frequency requires a considerable change in wavelength.

Consider Fig. 1. This shows the signal strength when a receiver is tuned above and below the wavelength of the transmitter. A maximum amount of energy flows in the secondary when it is adjusted to 18,000 meters, but, at 17,000, the wavelength for a 1,000-cycle beat note, only 55% of the available energy is being used. This is obviously a considerable loss, of special importance when the signals are weak.

That this percentage of loss decreases with the wavelength is shown by Fig. 2. Here the curve shows the energy in the secondary when it is tuned above and below the wavelength of a 200-meter transmitter. The detuning to produce 1,000-cycle beats is less than 1 meter, and practically no energy is lost.

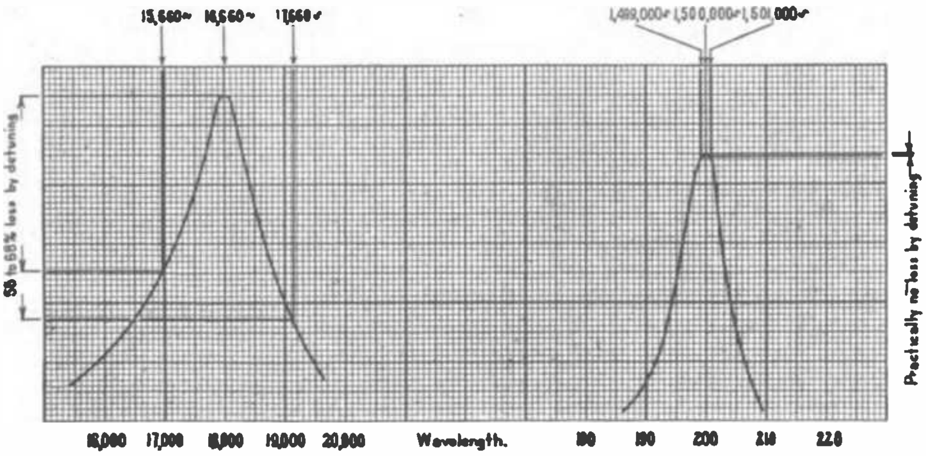


Fig. 1. There is a considerable loss by detuning on wavelengths over 5,000 meters

Fig. 2. As the frequency is lowered, the loss decreases. At 200 meters it is negligible

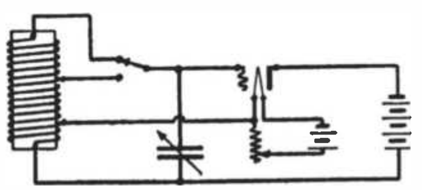


Fig. 3. Circuit for separate oscillator using a tubular coil.

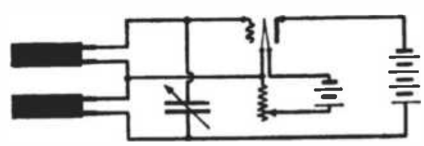


Fig. 4. Honeycomb coils can be used in place of the tubular inductances

On wavelengths above 5,000 meters, heterodyne reception should be accomplished by means other than the use of a detuned, oscillating circuit. The simplest method is to set up a separate oscillator, coupled to a straight receiving set.

Fig. 3 shows the connections for a simple and powerful oscillator which, without any auxiliary adjustments, will oscillate at any wavelength depending only upon the sizes of the coil and condenser. For reception between 5,000 and 25,000 meters, using a 0.001 mfd. condenser, the coil should have an inductance of 125 millihenries, tapped at 50 millihenries for tuning down to 4,000 meters. A coil of this size should be wound for 11½ ins., with two banks of No. 28 single silk-covered wire on a tube 5½ ins. in diameter, 1¼ pounds of wire are required. This may sound like a tedious job, but, as a matter of fact, small wire is not hard to bank. The 50-millihenry point is 5½ ins. from the start of the coil.

Also a tap is taken off 3 ins. from the start, for connection to the filament of the audion, Fig. 3.

Another method is to use two 65-millihenry honeycomb coils for the long range. Connections are given in Fig. 4. They are set up close together, so that they act as one coil, tapped at the center.

For short-range work only a crystal detector is needed to receive undamped waves if this oscillator is used, or for long distance, an audion detector is required.

To operate the set the oscillator is set up near the receiving inductance, so that the axes of the two coils are parallel. The receiver is tuned to approximately the wavelength of the transmitter to be copied, and, as the receiver is adjusted, the condenser of the oscillator is swung back and forth until the proper conditions for heterodyning are found.

While this system introduces a new adjustment, it does away with all oscillating secondary troubles and greatly increases the efficiency of the set.

The Use of B Batteries

THERE seems to be some prejudice among experimenters against the use of the Signal Corps and Navy type B batteries. They feel that they must have a means for adjusting the voltage. As a matter of fact, the Marconi-de Forest tubes now sold need no plate adjustment; 22.5 volts is none too much, and, for receiving, nothing is gained by using a higher plate potential.

It is surprising that experimenters do not recognize the advantages, both in point of economy and apparatus design, offered by Standardized B Batteries. Possibly it is because the average radio man has no means of testing batteries that he does not realize how much greater service is given by 22.5 batteries than by individual flashlight cells. The latter type are designed differently, and are not made by the same formulas which are used for B batteries. The manufacturers know that flashlight cells cannot give the same service as these intended for radio work.

Over a period of one year, it costs twice as much to use flashlight batteries as B batteries.

The efficiency of a set is decreased by the former type, for they do not hold out as steadily or as long. For short distance transmitting, several Navy type B batteries in series cost less and produce better results than the others.

The Radio Department

Do radio men ever meet without asking the preliminary question, "What's new?" Then, after agreeing that there is only the same old stuff, they proceed to disclose developments.

The delay caused by the printers' strike makes the announcement of open transmitters rather late, though from the inquiries which are coming in it seems as if the news has not been thoroughly broadcasted. Page 108 gives the details, with some other thoughts which experimenters and others should bear in mind.

It is to be hoped that experimenters, instead of acclaiming the successful conquest of their rights, will think a thought of thanks in the direction of Washington, D. C. People in general seem to think, in these days, that the capitol is a politicians' Baden-Baden. So it is for some of our anti-American labor representatives.

In all events, the experimenters' long period of watchful waiting is over.

And, speaking of this watchful waiting business, the Army did a little about which most of us knew nothing until it was disclosed by Major Tinsley at the first fall meeting of the Institute of Radio Engineers. Little Silver turned out in good form to support the Major, but the announcements of the meeting were so late that the attendance was far below that merited by the paper.

Major Tinsley gave the results of a long-continued 24-hour watch on the radio compass. This set of experiments, made to determine the errors of the compass, is one of the most complete and accurate set of observations ever made on receiving effects.

The result of these experiments makes possible a new and more satisfactory theory for the propagation of waves, and affords an explanation for radio compass errors.

The Post Office Department, not to be outdone by the others, is taking up radio work. Just what the plans are, no one wants to say, but there are ground stations and a number of airplane direction finders going into commission. It is understood that these sets are going into the largest airplanes ever built in this country, and that they will carry mail from coast to coast.

An important step in the popularization of the radio telephone is the new de Forest set which operates on 110 volts, A. C. The set includes a step-up transformer from which current is put through a vacuum tube rectifier. Thus it is possible to put up the equipment in any place where A. C. is available.

There has been much controversy in regard to the expense of various means for producing the potential necessary to operate audion transmitters. This method from de Forest adds another possibility. Already we have the 110-volt motor-generator, and the storage battery operated dynamotor. They seem to be fairly even in the matter of initial cost. Just which one is the least expensive is not settled.

On at least one point, manufacturers of radio apparatus agree—radio business was never as good. Reports all summer, in fact, were that the orders came in faster than ever before, with a positive promise that this winter will be the biggest season the industry has known.

Prices of complete apparatus are high, but, in the equipment of the reliable concerns, there is a marked improvement in design and workmanship over apparatus sold by the same companies before the war.

As was predicted in previous numbers, one-horse companies are coming back to worry the experimenters and the Post Office Department. It may be said, for the benefit of those who have unsatisfactory dealings with such concerns that the best way of handling them is by Post Office complaints. No one ever argues with that Department. Sometimes, however, trouble arises through mistakes, even with first-rate companies. Where there is an actual attempt to keep money without shipping the goods, it is a service to all the experimenters to see that the company does what is right.

Experimenters can make sure of the reliability of an advertiser in one way at least. The criterion of responsibility is the advertising pages of Everyday. If a company is represented there, it has measured up to the most critical standards.

By the way, are you having any difficulty in getting any kind of supplies for your work? It seems as if some things are not sold by any company, but Everyday is always glad to help when you have trouble. Call on us.

In the spring of 1917, Philadelphia found the likelihood of alien disturbances imminent, and various means of protection were considered. The peculiar arrangement of the city would have made it possible, by cutting the lines of communication at certain points, to create isolated sections. It was planned to put up radio equipments in the police stations, so that communication could be established by wireless if necessary.

Permission to operate such stations was not granted at that time, however, and fortunately the need did not arise.

Now, with the growing viciousness of strikes and labor uprisings, there are many cities which may find themselves in the plight against which Philadelphia wished to guard. With the Army demobilized, it will be more difficult to get troops quickly than in 1917.

Every locality where there are large factories employing foreign labor should have radio equipment in the police stations and armories. The cost of the apparatus is not great, it is an easy matter to interest men in the operation of stations, and the saving that might be effected in time of need would pay for the apparatus and the interest on the investment for a hundred years.

City officials will find the local experimenters more than willing to co-operate in putting up stations and training operators, or, if necessary, a radio reserve could be organized. Members of the reserve would keep the sets in operating condition, and take charge of them in emergencies.

Everyday Engineering will furnish any data required as to the equipment and available experimenters.

The enlarged Magazine, with the increased space devoted to the Radio Department, indicates the continued advance and improvement which is always the aim of Everyday.

Next month starts a campaign for better transmitters. It has been thought advisable in the past months to favor receiving equipment since experimental activities were principally in that direction. With the approach of sending permission, however, transmitters will be given their share of space.

The small Simon set which will be described in January will give some new ideas. Also, an audion telegraph set is being worked up for the next issue. There are also a number of suggestions on receiving apparatus which the active experimenter will want to try out.

Mr. Clement only winked his eye when he was asked about his next contribution, but, if he writes it, it will be too good to miss.

The Radio Registry

All kinds of opportunities are coming up in radio work, not only in the United States but in foreign countries as well. Men to fill these positions cannot be located readily, but they will be found through the Radio Register. Is your name among the others?

There are obvious uses of such a listing. The data required is:

Name.
Address.
Engineer or Experimenter.
Age.
Experience.
Special qualifications.
Radio station owned, if any.

Address your letters to the Radio Department, Everyday Engineering.

The LC Table and How to Use It

A Short Cut Method for Determining the Wavelength of an Oscillating Circuit

By means of the LC table, the long struggle with the wavelength formula can be avoided. This table gives the wavelength corresponding to the product of the inductance in cms., and the capacity in mfds. In other words, if the inductance and capacity are multiplied together, that value will be found in the table opposite the resulting wavelength. Or, if it is desired to find the capacity and inductance required for a given wavelength, in the table, opposite the required wavelength, a number will be found to which the product of the inductance and capacity must be equal.

The following examples illustrate the method by which the table must be used.

1. To find the wavelength of a circuit, knowing the inductance and capacity:

a. Multiply the inductance in cms. by the capacity in mfds. Locate the number in the table. If the number is not greater than 286.4, the first two numerals of the wavelength will be at the left-hand column, and the third numeral at the top of the row.

b. If the number is greater than 286.4, add an even number of decimal points until the number is smaller than 286.4. Then the first two numerals of the wavelength will be at the left-hand column, and the third number at the top of the row. Add as many 0's as there were pairs of decimals added to the original number.

Example a. What is the wavelength of a circuit having 1,000,000 cms. and 0.00023 mfd.?

First, 1,000,000 x 0.00023 = 230. In the table, 230 is across from 900 and under 4. Therefore, the first two numbers of the wavelength are 90 and the third, 4. Answer: 1,000,000 cms. and 0.00023 mfd. give 904 meters wavelength.

Example b. What is the wavelength of a circuit having 10,000,000 cms. and 0.0011 mfd.?

First, 10,000,000 x 0.0011 = 11,000. This number is greater than 286.4. Adding one pair of decimal points, this number becomes 110.00, which is less than 286.4. In the table, 110 is across from 620 and under 5. Therefore, the first two numbers of the wavelength are 62, the third is 5, and one 0 is added for the pair of decimal points put on the orignal number. Answer: 10,000,000 cms. and 0.0011 mfd. give 6,250 meters wavelength.

2. To find the capacity and inductance required for a given wavelength.

a. If the wavelength is under 1,009 meters, look for the number opposite the first two numerals of the wavelength and under the third. Such values of capacity and inductance must be used that their product will equal the LC value corresponding to the given wavelength.

LC TABLE

	0	1	2	3	4	5	6	7	8	9
0		.0002816	.001127	.002534	.00450	.007041	.01014	.01380	.01802	.02280
10	.02816	.03407	.04055	.04757	.05518	.06336	.07207	.08136	.09124	.1016
20	.1127	.1242	.1362	.1489	.1622	.1760	.1904	.2053	.2208	.2368
30	.2534	.2707	.2882	.3066	.3256	.3449	.3650	.3855	.4066	.4284
40	.4506	.4734	.4966	.5307	.5453	.5702	.5960	.6220	.6486	.6761
50	.7041	.7324	.7614	.7911	.8212	.8519	.8831	.9149	.9471	.9806
60	1.014	1.047	1.082	1.1108	1.153	1.190	1.227	1.264	1.302	1.341
70	1.380	1.420	1.460	1.501	1.542	1.584	1.627	1.668	1.713	1.757
80	1.802	1.848	1.893	1.940	1.987	2.034	2.083	2.131	2.181	2.230
90	2.280	2.331	2.383	2.435	2.488	2.541	2.595	2.650	2.704	2.759
100	2.816	2.872	2.929	2.986	3.045	3.105	3.163	3.224	3.284	3.345
10	3.407	3.469	3.532	3.596	3.659	3.724	3.789	3.855	3.921	3.987
20	4.055	4.123	4.192	4.260	4.329	4.399	4.471	4.541	4.613	4.686
30	4.757	4.833	4.906	4.982	5.056	5.131	5.207	5.284	5.363	5.441
40	5.518	5.598	5.678	5.757	5.839	5.921	6.003	6.084	6.169	6.252
50	6.336	6.421	6.504	6.592	6.677	6.764	6.852	6.940	7.031	7.119
60	7.207	7.298	7.389	7.452	7.571	7.667	7.759	7.852	7.947	8.042
70	8.136	8.233	8.330	8.426	8.528	8.622	8.722	8.822	8.921	9.024
80	9.124	9.226	9.328	9.432	9.532	9.638	9.740	9.845	9.954	10.06
90	10.16	10.27	10.38	10.49	10.59	10.70	10.81	10.92	11.04	11.15
200	11.27	11.38	11.49	11.61	11.71	11.84	11.95	12.07	12.18	12.29
10	12.42	12.54	12.66	12.77	12.89	13.01	13.14	13.26	13.39	13.50
20	13.02	13.75	13.88	14.01	14.13	14.26	14.38	14.51	14.63	14.77
30	14.89	15.03	15.16	15.29	15.42	15.55	15.66	15.81	15.95	16.08
40	16.22	16.35	16.49	16.63	16.77	16.90	17.04	17.18	17.32	17.46
50	17.60	17.74	17.88	18.02	18.17	18.31	18.45	18.60	18.74	18.89
60	19.04	19.18	19.33	19.48	19.63	19.77	19.93	20.07	20.22	20.38
70	20.53	20.68	20.84	20.99	21.14	21.29	21.45	21.61	21.76	21.92
80	22.08	22.23	22.39	22.55	22.71	22.87	23.03	23.19	23.35	23.52
90	23.68	23.84	24.01	24.17	24.33	24.50	24.67	24.84	25.00	25.18
300	25.34	25.52	25.68	25.84	26.02	26.19	26.36	26.54	26.72	26.89
310	27.07	27.24	27.42	27.58	27.76	27.94	28.12	28.30	28.47	28.65
20	28.82	29.01	29.20	29.38	29.55	29.75	29.92	30.10	30.30	30.48
30	30.66	30.84	31.03	31.22	31.41	31.59	31.78	31.98	32.17	32.36
40	32.56	32.75	32.94	33.13	33.33	33.52	33.71	33.90	34.10	34.30
50	34.49	34.69	34.88	35.10	35.29	35.48	35.68	35.89	36.09	36.29
60	36.50	36.69	36.90	37.10	37.31	37.52	37.72	37.93	38.13	38.33
70	38.55	38.77	38.95	39.17	39.40	39.59	39.81	40.01	40.24	40.43
80	40.66	40.87	41.10	41.30	41.52	41.75	41.96	42.17	42.38	42.60
90	42.84	43.05	43.27	43.49	43.71	43.93	44.16	44.38	44.61	44.83
400	45.06	45.27	45.50	45.73	45.96	46.19	46.40	46.65	46.88	47.10
10	47.34	47.55	47.79	48.04	48.26	48.49	48.73	48.95	49.20	49.43
20	49.66	49.91	50.14	50.37	50.63	50.87	51.09	51.34	51.57	51.83
30	52.07	52.31	52.55	52.79	53.04	53.28	53.53	53.78	54.03	54.28
40	54.53	54.75	55.00	55.26	55.51	55.71	56.01	56.26	56.52	56.75
50	57.02	57.28	57.51	57.79	58.05	58.29	58.56	58.80	59.06	59.32
60	59.60	59.84	60.00	60.37	60.61	60.89	61.15	61.41	61.66	61.94
70	62.20	62.46	02.72	63.01	63.27	63.53	63.80	64.06	64.33	64.60
80	64.86	65.13	68.17	65.67	65.95	66.22	66.49	66.77	67.05	67.33
90	67.61	67.89	68.17	68.42	68.71	69.00	69.28	69.57	69.82	70.11
500	0.41	70.66	70.96	71.25	71.52	71.81	72.11	72.38	72.68	72.95
10	73.24	73.52	73.82	74.09	74.40	74.67	74.96	75.26	75.54	75.86
20	76.14	76.42	76.74	77.02	77.31	77.62	77.91	78.20	78.48	78.81
30	79.11	79.39	79.69	79.98	80.28	80.61	80.91	81.21	81.57	81.82
40	92.12	82.41	82.71	83.03	83.33	83.64	83.95	84.26	84.57	84.87
50	85.19	85.51	85.78	86.10	86.42	86.74	87.06	87.38	87.66	87.98
60	88.31	88.63	88.92	89.25	89.58	89.86	90.20	90.53	90.82	91.16
70	91.49	91.79	92.12	92.47	92.76	93.11	93.42	93.76	94.06	94.41
80	94.71	95.06	75.37	95.72	96.03	96.38	96.70	97.01	97.36	97.68
90	98.06	98.35	98.68	99.04	99.36	99.68	100.00	100.30	100.70	101.00
600	101.40	101.70	02.10	102.30	102.70	103.00	103.40	103.80	104.10	104.40
610	104.7	105.1	105.4	105.8	106.2	106.5	106.9	107.2	107.5	107.9
20	108.2	108.6	108.9	109.2	109.6	110.0	110.4	110.8	111.1	111.4
30	111.8	112.1	112.5	112.8	113.2	113.6	114.0	114.2	114.7	115.0
40	115.3	115.7	116.1	116.4	116.8	117.1	117.5	117.9	118.2	118.6
50	119.0	119.3	119.7	120.0	120.4	120.8	121.2	121.5	121.9	122.3
60	122.7	123.0	123.4	123.8	124.2	124.6	124.9	125.2	125.7	126.0
70	126.4	126.8	127.2	127.6	127.9	128.3	128.6	129.0	129.4	129.8
80	130.2	130.5	131.0	131.3	131.7	132.1	132.5	132.9	133.2	133.7
90	134.1	134.5	134.8	135.2	135.6	136.0	136.4	136.8	137.2	137.6
700	138.0	138.4	138.8	139.2	139.6	140.0	140.4	140.7	141.1	141.6
10	142.0	142.3	142.8	143.2	143.5	144.0	144.3	144.7	145.2	145.5
20	146.0	146.3	146.8	147.2	147.6	148.0	148.4	148.8	149.2	149.6
30	150.1	150.4	150.9	151.3	151.7	152.2	152.5	153.0	153.4	153.8
40	154.2	154.6	155.0	155.4	155.9	156.3	156.7	157.1	157.5	158.0
50	158.4	158.8	159.2	159.7	160.1	160.4	160.9	161.4	161.8	162.2
60	162.7	163.1	163.5	163.9	164.4	164.8	165.2	165.7	166.2	166.5
70	166.9	167.4	167.8	168.3	168.7	169.1	169.6	170.0	170.4	170.8
80	171.3	171.8	172.2	172.7	173.1	173.6	174.0	174.4	174.8	175.3
90	175.7	176.2	176.6	177.1	177.5	178.0	178.4	178.8	179.3	179.7
800	180.2	180.6	181.1	181.6	182.1	182.5	182.9	183.4	183.9	184.3
10	184.8	185.2	185.7	186.1	186.5	187.1	187.5	187.9	188.5	188.9
20	189.3	189.8	190.3	190.7	191.2	191.7	192.2	192.6	193.1	193.5
30	194.0	194.5	194.9	195.4	195.9	196.3	196.8	197.2	197.7	198.3
40	198.7	199.2	199.6	200.1	200.5	201.1	201.6	202.0	202.5	203.0
50	203.4	203.9	204.4	204.8	205.8	205.9	206.4	206.8	207.3	207.8
60	208.3	208.7	209.2	209.7	210.2	210.7	211.2	211.6	212.1	212.6
70	213.4	213.6	214.1	214.6	215.1	215.6	216.1	216.6	217.1	217.6
80	218.1	218.6	219.1	219.6	220.1	220.5	221.0	221.5	222.0	222.5
90	223.0	223.6	224.1	224.6	225.0	225.5	226.0	226.6	227.1	227.6
900	228.0	228.6	229.1	229.6	230.1	230.5	231.1	231.6	232.1	232.7
910	233.1	233.6	234.2	234.7	235.2	235.7	236.2	236.8	237.2	237.8
20	238.3	238.9	239.3	239.9	240.4	240.8	241.4	241.8	242.4	243.0
30	243.5	244.0	244.5	245.1	245.6	246.1	246.7	247.2	247.7	248.3
40	248.8	249.4	250.0	250.3	250.9	251.4	252.0	252.4	253.0	253.6
50	254.1	254.7	255.2	255.8	256.3	256.8	257.4	257.8	258.4	258.9
60	259.5	260.0	260.6	261.1	261.7	262.2	262.8	263.2	263.8	264.3
70	265.0	265.5	266.1	266.6	267.2	267.7	268.1	268.7	269.3	269.9
80	270.4	271.0	271.5	272.1	272.7	273.2	273.8	274.3	274.9	275.4
90	275.9	276.6	277.1	277.6	278.3	278.7	279.4	279.0	280.4	281.0
1000	281.6	282.1	282.6	283.1	283.8	284.3	284.8	285.4	285.9	286.4

b. If the wavelength is over 1,009 meters, look for the number opposite the first two numerals of the wavelength, and under the third. Take off a pair of decimal points for each numeral, over three, of the wavelength value. The product of the inductance and capacity must equal the LC value found.

Example a. What inductance and capacity must be used to give 793 meters?

The LC value, opposite 790 and under 3, is 177.1. If it is decided to use a 0.001 mfd. condenser, the inductance will be 177.1 ÷ 0.001 or 177,100 cms.

Example b. What inductance and capacity must be used to give 18,200 meters?

The LC value, opposite 180 and under 2, is 9.328. Since there are five numerals to the wavelength value, two pairs of decimal points must be taken away, making the number 93280. If it is decided to use a condenser of 0.002 mfd., the inductance will be 93280 ÷ 0.002 or 46,640,000 cms.

A New Transformer and Oil Condenser

Two new and interesting transmitting instruments are shown in the accompanying illustration. At the left is a closed core, non-resonance transformer specially designed for use with the usual type of non-synchronous rotary gap used by experimenters.

The secondary winding can be seen at the top of the transformer, wound on the main closed core. Below the panel are two impedances which regulate the primary supply current. They are wound on a separate core.

If the power leads are connected to the left and center terminals, both impedances are in series with transformer primary. Across the center and right terminals, only the larger impedance is in. When the secondary is practically short-circuited by the rotary spark gap, the increased impedance of the regulating coils limits the primary current.

A commendable feature of the three sizes now supplied is that they are rated in kilowatt-amperes, with stated power factors. This may require an explanation. On direct current work, the power in kilowatts is given by multiplying the voltage by the amperage. Not so with alternating current, for the product of the voltage and amperage is only the apparent power. An A. C. circuit may be carrying 100 volts and 10 amperes though it accomplishes only 0.5 kilowatts of work. The 100 volts times 10 amperes means only 1 kilowatt-ampere. To find the true power, the K. V. A. rating must be multiplied by the power factor. To determine this factor is beyond the means of most experimenters.

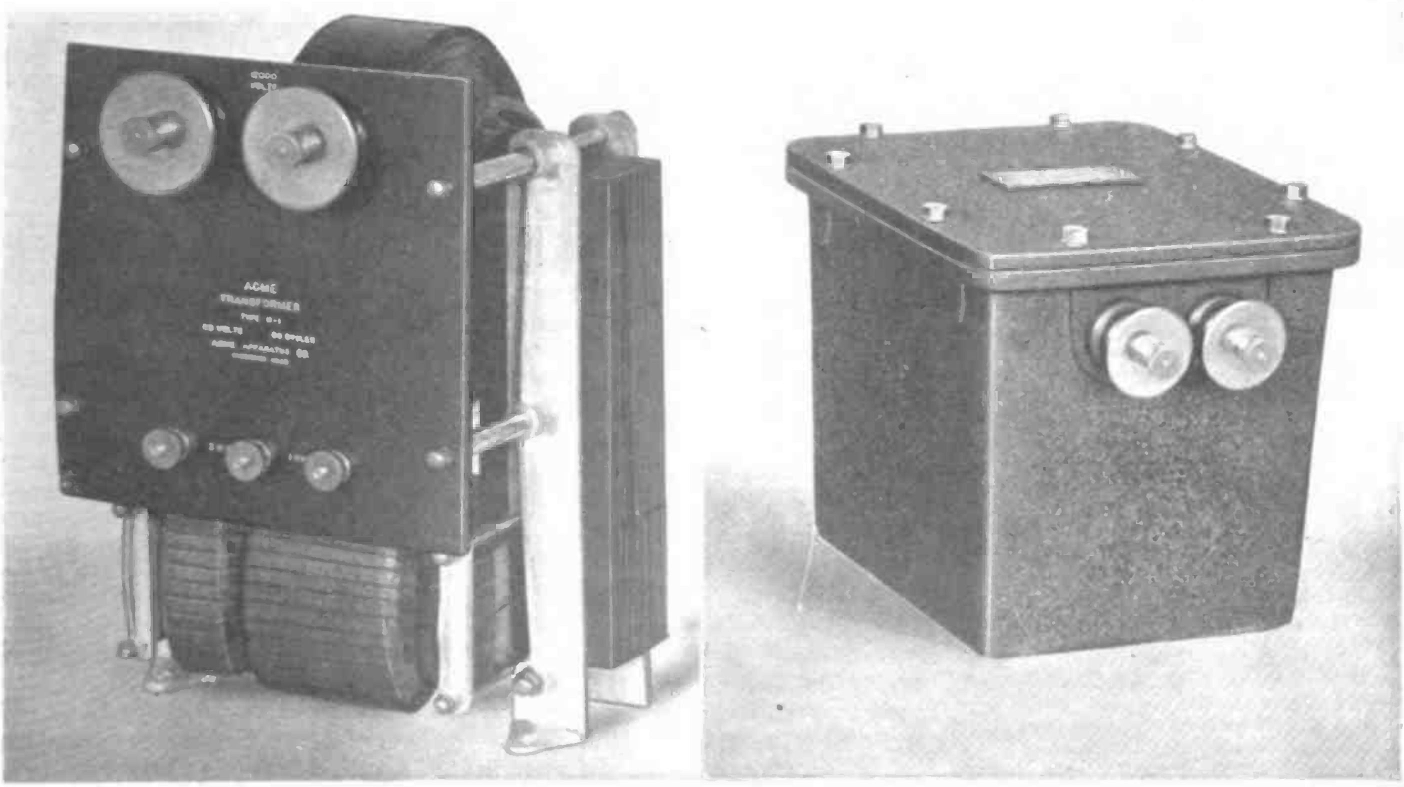
When, as should be done always, the K. V. A. rating and power factor are given, it is easy to determine the true power. For example, the transformer illustrated is rated at 1.15 K. V. A. and 0.345 K. V. A. With a power factor of 0.75 at high power, this means 0.76 K. W. or 760 watts. On low power, 0.345 K. V. A., at a power factor of 0.87, is 300 watts. Reduced power, when possible, means less QRM.

An excellent protective spark gap is fitted to the transformer. It will be seen that the gap length cannot be increased unless the discs are actually removed. The secondary voltage ranges from 6,000 to 12,000 for the three sizes. With a condenser of 0.006 mfd., the spark has a note of approximately 800 cycles.

The oil condenser, at the left of the illustration, is rather new for experimental work. Inside the aluminum case, the metal plates are held by sturdy insulation. Transil oil is used for the dielectric. This gives a capacity of 0.0035 or 0.007 mfd., according to the size. The break-down voltages for the two sizes are 10,000 and 8,000 respectively. Creeping of the oil is prevented by oil-tight covers.

Resistance losses are surprisingly low in a condenser of this type. At 300 meters, for example, the resistance was only .05 ohms.

Don't forget your lightning switch. It is one of the most important possible sources of lost energy from the receiver. The ordinary slate base, fastened to the side of the house, allows energy to leak through the base itself over the dust layer on the surface, and through moisture which may collect on the under side.



Experimenters are making rapid preparations for transmitting. Although there is no promise, there is a good chance that stations will open within a month

Radio Experimenters Back On Old Status

All War-time Restrictions Lifted from Stations Used Only for Private Experimental work

HARDLY a branch of the United States Government has escaped criticism and blame on one account or another. Among radio men, at least, the Navy Department has had its share. Even the experimenters, chafing under restrictions which, they thought, should have been removed soon after the signing of the Armistice, have harbored a feeling against the Naval authorities.

On October 1st, 1919, radio experimenters were allowed to resume transmitting provided, as was the case before the war, they have amateur operating and station licenses. Those who are all ready to use their transmitters should apply to the Radio Inspector, Customs House, of the city at which their district office is located. In writing, ask for application blanks for operator's examination, station license, or both, as the case may be. All licenses were revoked at the beginning of the war. New call letters are now being assigned.

This action applies to amateur, technical, training school and experimental stations which do not carry on paid traffic. It will not be possible to issue operators' and station licenses immediately because of the volume of applications. However, temporary permits will be issued on applications which indicate that the equipment and operators comply with the law.

A list of the radio districts is given below, so that each man can locate his district office:

1. Boston, Mass.

Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.

2. New York, N. Y.

New York (county of New York, Staten Island, Long Island and counties on the Hudson River to and including Albany, Rensselaer and Schenectady) and New Jersey (counties of Bergen, Passaic, Essex, Union, Middlesex, Monmouth, Hudson and Ocean).

3. Baltimore, Md.

New Jersey (all counties not included in second district), Pennsylvania (counties of Philadelphia, Delaware, all counties south of the Blue Mountains and Franklin County), Delaware, Maryland, Virginia, District of Columbia.

4. Savannah, Ga.

North Carolina, South Carolina, Georgia, Florida, Porto Rico.

5. New Orleans, La.

Alabama, Mississippi, Louisiana, Texas, Tennessee, Arkansas, Oklahoma, New Mexico.

6. San Francisco, Cal.

California, Hawaii, Nevada, Utah, Arizona.

7. Seattle, Wash.

Oregon, Washington, Alaska, Idaho, Montana, Wyoming.

8. Cleveland, Ohio

New York (all counties not included in second district), Pennsylvania (all counties not included in third district), West Virginia, Ohio, Michigan (Lower Peninsula).

9. Chicago, Ill.

Indiana, Illinois, Wisconsin, Michigan (Upper Peninsula), Minnesota, Kentucky, Missouri, Kansas, Colorado, Iowa, Nebraska, South Dakota, North Dakota.

NAVY DEPARTMENT

UNITED STATES NAVAL COMMUNICATION SERVICE

OFFICE OF

DISTRICT COMMUNICATION SUPERINTENDENT

THIRD NAVAL DISTRICT

44 WHITEHALL STREET

NEW YORK CITY

October 1st, 1919.

The Editor,
Everyday Engineering Magazine,
2 West 45th Street, New York City.

Dear Sir,

Effective October 1st, 1919, all restrictions on amateurs and amateur radio stations are removed.

This does not apply to any station handling commercial business of any character, including business of owner.

Attention is invited to the fact that a Department of Commerce radio station license is necessary before amateur radio stations can transmit. Applications should be made to the nearest radio inspector.

R. B. Coffman
Lieutenant Commander, USN.

This act of the Naval authorities suggests a review of the present radio situation. Word regarding transmitting came through just as the Magazine was being closed, so that it is impossible at this time to say how it came about that restrictions were lifted. At the same time, there is enough information available to throw a different light on some matters which have been discussed by the radio publications in such an emphatic manner.

First off, Everyday wants it understood that it believes the Navy Department to be made up of very human men, men who are trying to do what is right, and as quickly as possible when the right time comes. In other words, we believe that the Navy is one of the strongest supporters of the radio experimenters. However, these men are serving a greater purpose than the control of experimental radio—they are in the service of the United States of America.

When they appear to fail the people of the country, it is sometimes because the people fail them. Take the radio operating system which has been so widely condemned. It is obvious that permanent Government control will fail, if it is put into operation, but, as they are conducting the service until definite action is taken, they are doing it under tremendous handicaps.

If you could see the Naval Communication Office at New York, you would understand that, try as they may, they cannot handle the present tremendous traffic with the reduced personnel now employed. Moreover, it is a different matter, with hundreds of ships, than in the old days when the total number of ship stations did not amount to over five hundred. And, as a matter of fact, the service now is not as bad as some would have us believe.

A little careful thought, with a knowledge of the facts, shows that actually, the people of this country are being very well served by the Navy Department.

Consider the situation in other countries. America, condemned by every sort of destructive agitator, is the only country in which the rights of radio experimenters are recognized. This means more than than the statement indicates at first glance. It means that, as far as the public, which is primarily responsible for emergency acts of the Government, will allow, the authorities are making it possible for them to have what they want as fast as the people take the constructive steps on which the work of the Government depends.

The Navy Department has actually shown a sincere appreciation for the radio experimenters. It has done more than it promised when the stations were closed. As soon as conditions made it practical, on April 15th, 1919, receiving was permitted. Now, though peace has not been declared, experimenters have been put back on their pre-war status. Beside that, the Navy is encouraging radio work by sending out an evening code practice.

Instead of hampering the experimenters, the Department is doing all it can to help them. Perhaps if a spirit of gratitude replaced the grumbling which has been directed toward the authorities, they might do even more for us.

The U. S. Navy Radio Compass

PART 1

What the Radio Compass Is, How It Works, and for What It Is Used

THROUGH the courtesy of the U. S. Navy Department, Bureau of Steam Engineering, and the co-operation of Commander H. C. Hooper, complete details are now available on the theory, design and operation of the Radio Compass or direction finder. The development of this apparatus was one of the most important accomplishments of the Navy, and information concerning it, one of the most carefully guarded secrets.

In the first part of this article, the general theory and operation is taken up; the second part deals with the instruments and circuits employed.

The Bilateral Compass

The operation of the radio compass, known more widely as the direction finder, depends chiefly on the action of the loop antenna. Although varying in shape and size, they are usually wound as in Fig. 1, more often in the box type form. A circular shape can be used as well, and in some cases the turns of the box type are bunched together. Inductance requirements determines the number of turns and their size. There is a relation between the turns and area enclosed which give maximum signal strength, but for ordinary purposes, it is safe to make the box type from 3 to 5 feet on a side, with enough turns to give the inductance necessary.

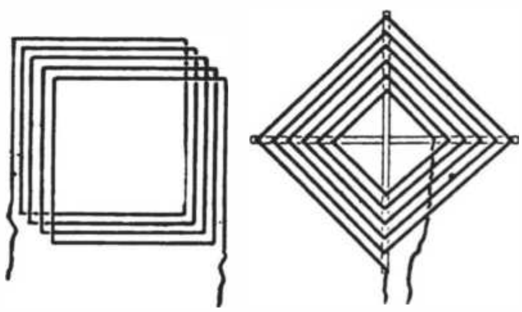


Fig. 1—General design of loop antennas, showing the box and flat types

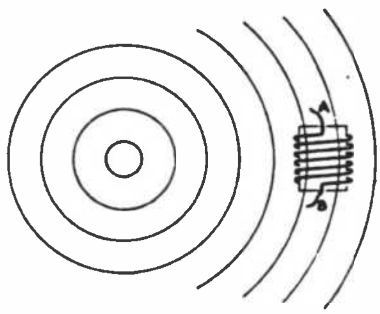


Fig. 2—In this position the turns of the coil are cut at right angles and signals are heard

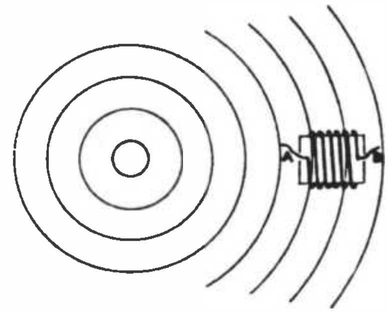


Fig. 3—Here the lines of force are parallel to the turns and no current is set up

For short wave reception, a coil of 5 turns, ¼ in. apart, on a frame 4 feet square will give good results. Wavelengths up to 20,000 meters can be received on a loop of 40 turns, ¼ in. apart, on a frame 4 feet square. Either bare or insulated wire can be used, but particular precautions must be taken to prevent leakage between the turns.

To illustrate the theory of operation of the loop, let us consider Fig. 2. As is well known, magnetic waves travel out radially from a wireless transmitting station. If a coil, whether round or square, is placed in this field in the position shown at Fig. 2, the lines of force cut through the turns of wire on the coil at right angles, setting up a current in the winding. In Fig. 3, however, the lines of force are parallel with the turns, and induce no current.

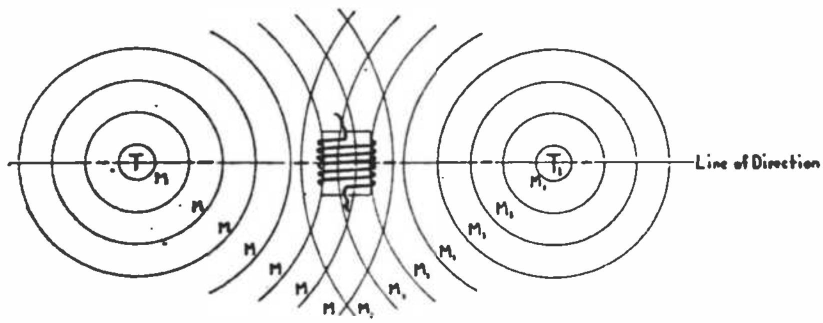


Fig. 4—When the horizontal part of the turns point at two opposite transmitters, signals are heard from both stations

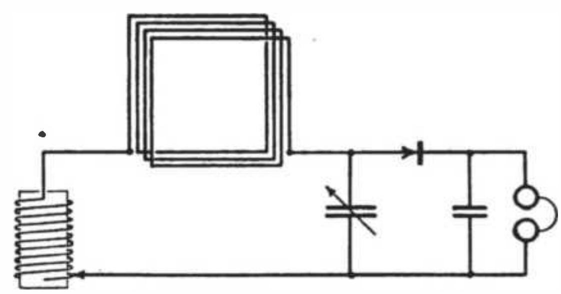


Fig. 5—The connections of a simple loop receiver for bilateral work. An audion must be used to cover any great distance

If, then, a receiving set is connected to the coil or loop, and signals are sent out from the transmitter, they will be heard when the loop is in position Fig. 2, but no signals at Fig. 3. This effect can be used to show the line of direction of the origin of the signals. It will be seen that the horizontal part of turns lie in the line of direction when the signals are at maximum intensity.

This system does not show the absolute direction, as will be seen from Fig. 4. Suppose that a transmitter is set up at T, and the loop A B adjusted for maximum signals. Now, if the transmitter is moved to T, diagonally opposite, the loop will still receive maximum signals at the same position.

Under actual working conditions, the apparatus is connected as in Fig. 5. The loop is in series with a loading coil and both shunted by a 0.0005 or 0.001 mfd. variable condenser. A crystal detector can be used for short distances, but an audion is needed for long range receiving. Where both a loop and a regular antenna are used with a loose coupler, Fig. 6, the antenna may be connected in the usual manner, and the loop inserted in the secondary circuit, with a short circuiting switch. For standly or long distance work, the loop is short circuited, and signals received on the coupler by means of the antenna. When signals are heard, the loop switch is opened, the secondary coupling made as loose as possible, and the signals retuned while the position of the loop is varied.

Fig. 7 shows a method for obviating the necessity of retuning when the loop is thrown in. A S. P. D. T. switch is wired so that it short circuits either the loop or a small variable inductance, A. When once adjusted, it will need no further attention. This initial adjustment is obtained in the following manner:

Signals are first received on the large antenna, with A short circuited and the loop open, but not in a position to pick up signals; then the loop is shunted and the signals tuned in again by varying A. Now A is equivalent to the loop. If a station is tuned in on the antenna, wtih the loop out, A will be in the circuit. When the switch is changed over, A will be cut out, but the wave length will not change, for the loop will be in.

Uses of the Bilateral Compass

The bilateral compass, though it does not indicate the absolute direction of a transmitter, has many inportant uses. Take, for example, a ship nearing port in a heavy fog or storm such that lights are not visible. At either side of the harbor, there is a direction finder, Fig. 8, at which signals are received from the ship. Station T determines the direction of the ship and finds angle C, T_1 the angle D. Then, by simple trigonometry, the exact location of the ship can be found, and the captain informed as to his position.

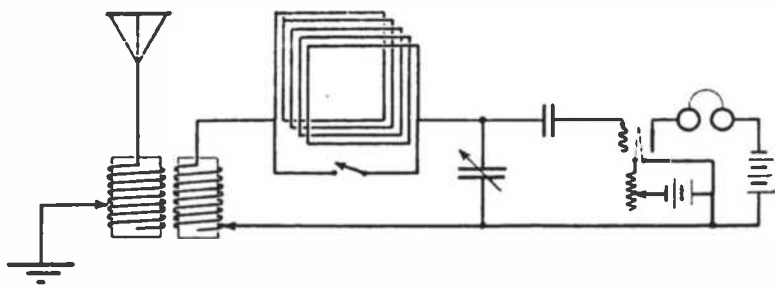


Fig. 6—Standby work is done with the antenna, and the direction determined by using the loop

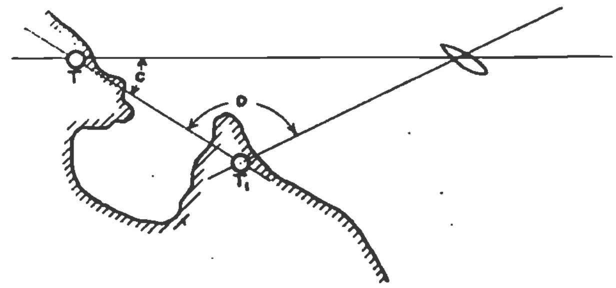


Fig. 8—A ship at sea can be located by using two direction finding stations on the coast

The same system serves to locate an experimental station which is not licensed, or does not meet the Government requirements. During the war, enemy radio stations were discovered by this method.

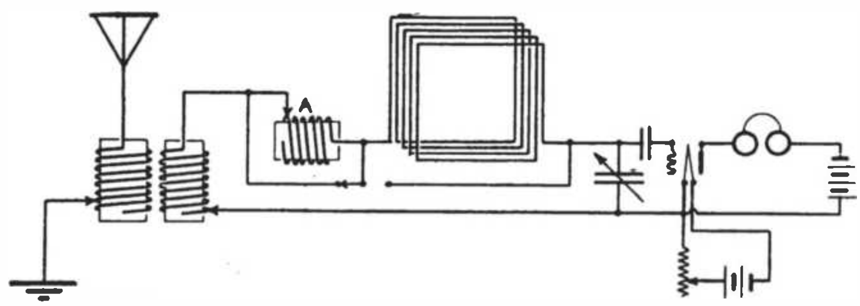


Fig. 7—The loop can be used or cut out without changing the wavelength of the secondary

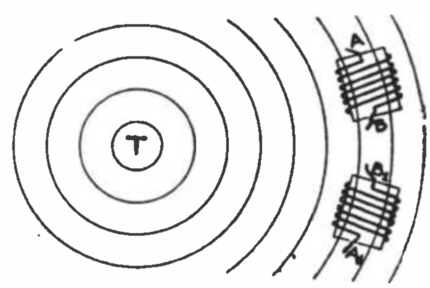


Fig. 9—Turning the coil 180° changes the direction of the current but the signals are still as strong

Another use of the direction finder is in cutting out interference. A high powered transmitter may be sending nearby, yet, if it is not in the line of direction of the loop, it will not be heard. This is a particular advantage in cities where there are many experimental stations.

On airplanes, the compass serves to guide the pilot toward his objective or home field. The magnetic compass shows the general direction, overcoming the disadvantage of the bilateral effect.

The Unilateral Compass

Having reached an understanding of the action of the loop and the bilateral compass, the next step is the unilateral or absolute direction type. This shows in which radial direction the transmitting station lies, instead of a diametrical direction.

It is well known that the ordinary T, L, umbrella, and similar forms of antennas are practically non-directional. However, regardless of the direction from which the signals come, the current induced in the antenna is always in the same direction.

Keeping this last statement in mind, let us examine Fig. 9. Coil A B is placed in the position for maximum signal strength and current flows through the winding. It is then turned 180° to the position A_1 B_1. The signal strength has not been changed, but the current flows in the opposite direction. In other words, moving the coil 180° does not change the amount of current, yet the direction is reversed.

The unilateral effect is produced by combining the actions of the antenna and loop. Fig. 10 shows the method employed. Signals are received on the antenna which is connected to the ground through the primary of a loose coupler. At the same time, the signals are picked up by the loop which is inserted in the secondary circuit. In one of the maximum positions, the currents in the antenna and loop will be in the same direction and will aid each other giving a louder response in the telephones. In the other maximum positions, 180° from the first, the loop current will oppose that in the antenna, so that they will produce no signals in the phones.

Since the current is greater in the antenna than in the loop, the coupling must be adjusted until the antenna current in the secondary circuit is the same as that put in by the loop. Otherwise, the signals from the antenna would be so strong that no variation in strength would be noticed as the loop is moved

The Compass Under Working Conditions

In operation, there are two effects not brought out in the theoretical discussion. First, the sharpest indications, with the bilateral connections, are at minimum signal strength. Second, sharp indications cannot be obtained with the unilateral compass.

It is necessary, therefore, to use both effects for accurate absolute direction finding. The method is as follows:

1. Signals are first received with close coupling between the primary and secondary, with the compass switch at Bilateral, Fig. 11. This gives a non-directional effect and maximum receiving efficiency.

2. When a station has been tuned in, the coupling is reduced, the switch put at unilateral, and the loop turned until the position for maximum signals is found. This will indicate the absolute direction approximately, Fig. 12.

3. Finally the loop is turned 90° from its former position and the compass switch is put at bilateral. Now the direction can be determined accurately, adjusting the loop for minimum signals.

Since there is nothing about the loop itself to show on which side the maximum effect is obtained, it is necessary at first to make a determination on some station whose direction is known. This side should be marked, as it will be always the same, provided that no connections are reversed.

Compass Faults and Troubles

Certain difficulties may arise which will make the direction finding effect inoperative. The symptoms and remedies are listed here:

1. Lack of sharp turning at minimum position, bilateral connection.

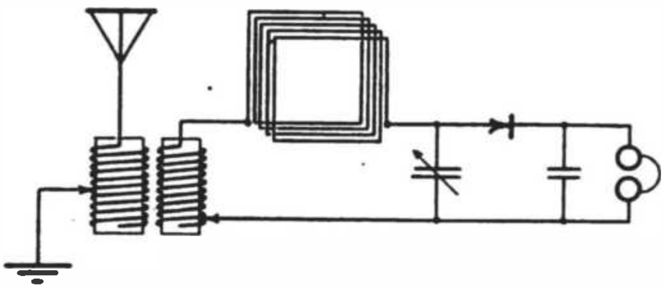


Fig. 10. Combination receiving for unidirectional work

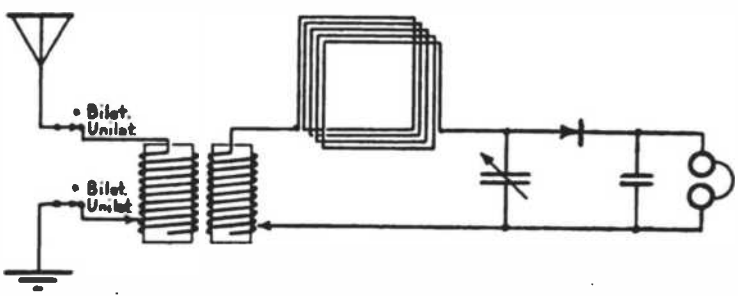


Fig. 11. Either system can be used by changing the compass switch

a. If any connection is made between the receiving apparatus and the ground, this trouble will result.

b. The grounding may be due to excessive distributed capacity between the secondary and the ground or large metal objects in the operating room. All apparatus must be kept away from such objects.

c. Leakage or excessive distributed capacity between the loop and antenna leads.

2. Minimum signals always at the same position, bilateral connection.

a. Neighboring antennas not disconnected from the ground.

3. Readings reversed 180°, unilateral connection.

a. Antenna and ground and coil connections reversed. This can be connected by locating a known station and reversing connections until a correct reading is obtained.

Calibration for Distortion

At stations where metal buildings or structures are located nearby, it may be found that distorted directional readings are obtained. The distortion of the electrical waves by metal objects is comparable to the bending of light or sound waves.

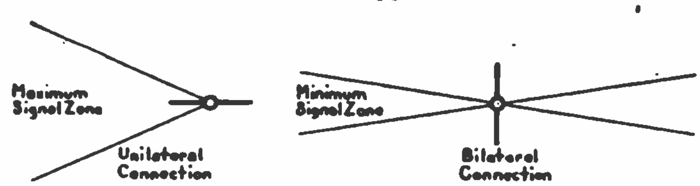


Fig. 12. By listening in both ways, the transmitter can be located accurately

This effect increases with the wavelength, so that if a loop is used over a long range of frequencies, determinations for distortion should be made at several wavelengths. In the case of a ship, the work is easy, since the station and metal structures, the ship itself, can be swung around in various directions.

A land station, however, presents greater difficulties. The only way by which it can be calibrated is to carry an adjustable transmitter around the receiving station. In general, this is not necessary, even in a metal framed building unless the limit of accuracy is required.

The second part of this article will appear in the November issue. It will describe the apparatus used by the Navy Department, and will give photographs, circuits, and details of the instruments.

LOOP ANTENNA USED THIRTEEN YEARS AGO

THE loop type antenna has come to general notice only within the last year, since the necessity for secrecy regarding Government activities was removed. As a matter of fact, Prof. G. W. Pickard filed a patent in June, 1907, covering the use of the loop, operating on magnetic wave components.

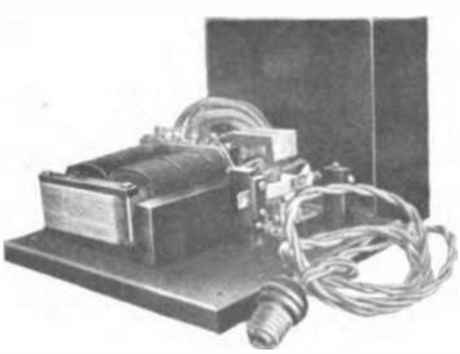
Possibly because of the limitations in equipment, results obtained were of little practical import. It is interesting to know, however, that Prof. Pickard was well aware of the possible use of the loop, and carried out many experiments to determine various directional effects.

This patent is number 876,996. Copies can be obtained from the Patent Office, Washington, D. C., at a cost of five cents.

RECTIFIER FOR STORAGE BATTERY CHARGING

IT can be truly said that the electrical engineer's work is never done. There are always improvements and refinements to make.

The new Clapp-Eastham rectifier is a product in keeping with the continuous advance in electrical devices. The illustration here shows the storage battery charging outfit, consisting of a



step-down transformer and vibrating rectifier.

When the connecting plug is put into any light socket on an A. C. line the voltage is reduced, and the low tension current is put through the rectifier, which allows it to pass into the storage battery in one direction only. An interesting feature is that if the A. C. current fails the battery cannot discharge back into the transformer. Moreover, the battery can be connected to the rectifier in either direction, yet the current will always flow into the battery in the right direction.

It will be seen that the instrument is as nearly proof as it can be made, a great advantage to the unskilled man who takes care of his own car. Two sizes are made, one for charging a 6-volt battery at 7 amperes, and one for a 12-volt battery at 4 amperes. These types are made for 110 volts or 220 volts.

Using this rectifier, the cost for charging the ordinary 6-volt battery is only ten to fifteen cents.

RADIO CLUBS

EVERYDAY invited all radio clubs throughout the country to send in announcements of activities, or other matters of general interest for publication in the Radio Department.

We are still looking for methods by which clubs can increase the balance of the exchequer. If you have used any plan successfully, let the others know about it. Get together a few of those good ideas. We know you have them!

The Problems of Vacuum Tube Circuits

An Explanation of the Problems encountered in the Design of Detectors, Amplifiers, and Undamped and Modulated Telegraph and Telephone Transmitters

By L. M. Clement

THE AUDION AS A DETECTOR

BEFORE discussing this subject, it may be well to show the action of a detector and the necessity for its use in the reception of radio signals.

When an alternating current is applied to the terminals of a telephone receiver, the diaphragm is alternately attracted and repelled from the receiver magnet at the rate equal to the frequency of the applied current. This to and fro movement of the receiver diaphragm sets up a corresponding movement of the air. The human ear is so constructed that these air vibrations, if they take place between 15 and 15,000 times per second, affect the ear and produce a sensation known as sound. Such vibrations give rise to sound waves. The ear is unable to detect air vibrations outside of this range. If currents of higher frequencies than the upper limit are applied to the telephone receiver, no sensation of sound will be produced on the ear. In radio telegraphy and telephony, currents varying in frequency from 15,000 to 7,000,000 cycles per sound are employed, and are generally referred to as radio frequencies, to distinguish them from the group of frequencies which are known as audio frequencies.

In order to illustrate how the radio frequencies are made audible, let us consider the following example. Suppose an ordinary spark radio station, Fig. 39, is transmitting electromagnetic waves of 200,000 cycles per second in groups occurring 1/200ths of a second apart. There will be introduced across the inductance coil of the receiving station a voltage similar in every respect to the transmitted current of Fig. 39. Suppose this voltage were impressed on a telephone receiver, Fig. 39, no movement of the diaphragm would result, due to its inertia. If the diaphragm would follow the 200,000 cycles current, it would set up air vibrations which would be outside the range of audibility.

If now a device R, which will allow the current to pass in one direction and not in the other, is placed in the circuit as shown, the current wave will be rectified and appear as shown in 2 of Fig. 39.

The added effect of the resulting distorted high frequency currents will cause the diaphragm to be displaced to and from for each group of oscillations as shown in 2, Fig. 39, by the inside dotted lines. Since these groups follow one another at a rate within an audible range, namely, 200 per second, the air wave set up by the diaphragm will be audible. Very little of the high frequency current will pass through the telephone receivers because of their high reactance. The condenser is provided to shunt these high frequencies around the telephone receivers; the low or group frequency currents pass through the telephone receivers. This telephonic current is shown graphically in 3, Fig. 39.

The audion, as we have seen, can be made to function as an amplifier with but little distortion by arranging the circuit so that the signal voltage is applied to the straight portion of the E_c, I_b—grid voltage, plate current—characteristic of the tube. By applying radio frequency voltages to the grid-filament circuit of a tube, the circuit of which is so arranged that distortion results, apparent rectification takes place and the tube can be used as a detector. This is accomplished by making use of the curved portion of the E_c, I_b curve of the tube to produce distortion. This is exactly the effect to be avoided in using the tube as an amplifier.

For normal operation of the audion as a detector or amplifier the voltage applied to the grid circuit does not exceed the permanent negative voltage applied to the grid, E_c, Fig. 40.

For this reason the grid never becomes positive with respect to the filament and no current can flow between the filament and the grid during any part of the cycle. From this we can see that no rectification of the signal takes place in this circuit.

Possibly the best explanation of this action can be had by taking a specific example. Suppose a constant potential E_c, Fig. 40, is applied to the grid of the tube, of such a value that the incoming signal voltage will be applied to the curved portion of E_c, I_b curve.

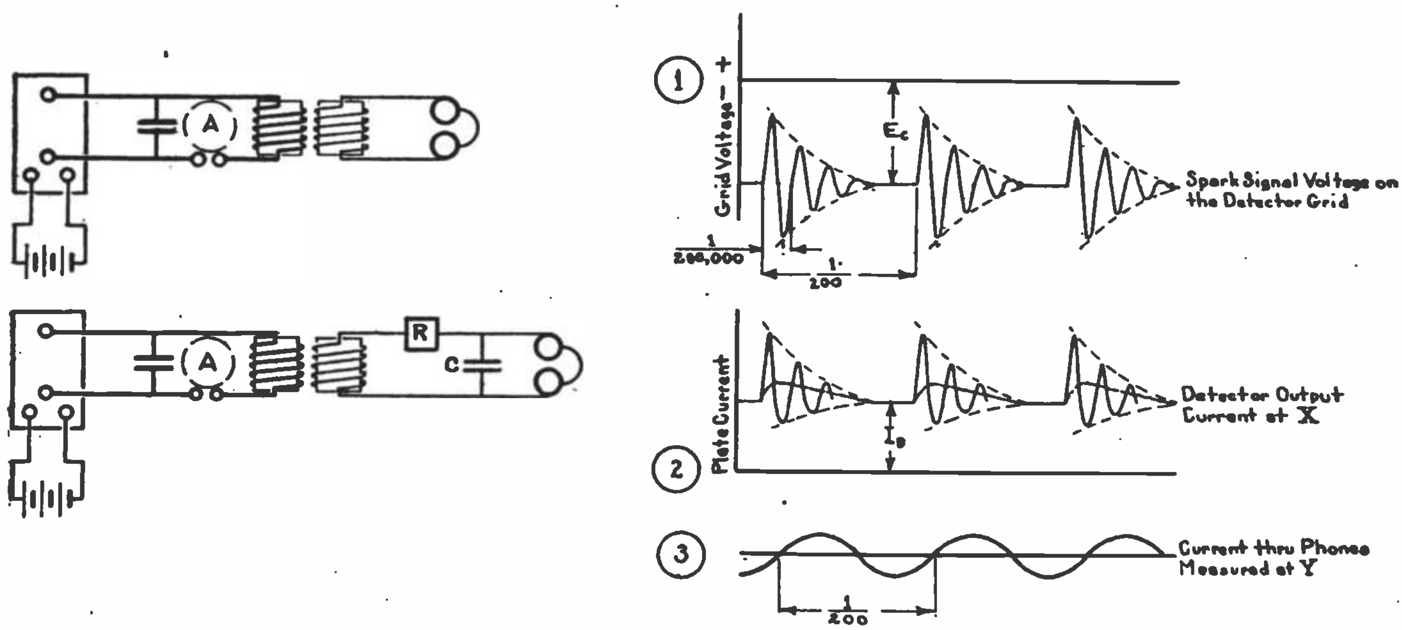


Fig. 39. Left, a transmitter and receiver with and without a rectifying device. Right, current actions as they take place in the different parts of a receiving set

If now the signal voltage of the form 1 of Fig. 39 is applied across the condenser C_1, Fig. 41, it will be superimposed on the negative grid voltage E_c, from the grid battery. Referring to Fig. 40, the steady value of the plate current with the steady value of grid voltage E_c, will be X'. If the grid voltage is increased from E_c to $E_c + XM$, the plate current will be reduced by a value X' M' and if the grid voltage is reduced by the value XN the plate current will be increased by the value X' N'. X' N' is much larger than X' M', due to the curvature of the E_c, I_e curve, although X N and X M are equal.

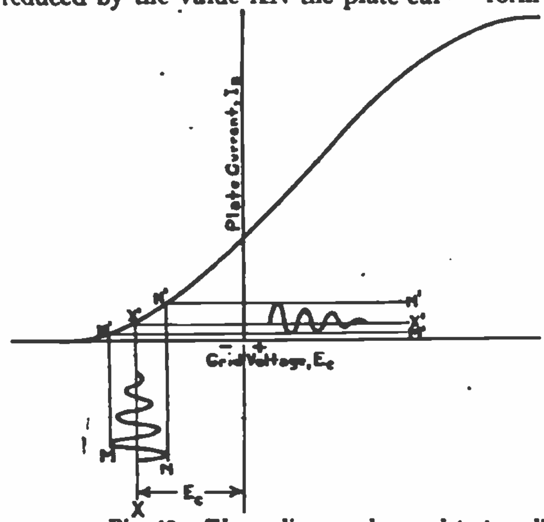


Fig. 40. The audion, used as a detector, distorts the incoming waves

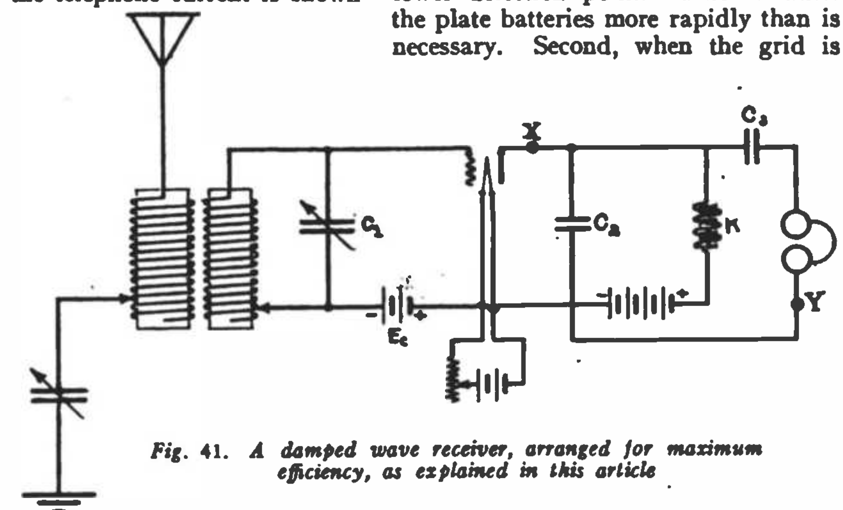


Fig. 41. A damped wave receiver, arranged for maximum efficiency, as explained in this article

This leads to the conclusion that other things being equal, maximum detection is obtained when the curvature of the E_c, I_e characteristic is greatest. Obviously, then, for best detection, E_c should be so chosen that the signal can be applied to the part of maximum curvatures of the characteristic curve just referred to.

The current in the output circuit of the detector would then look something like 2, Fig. 39, if measured at the point marked X in the circuit diagram, Fig. 41.

The mean value of this current is indicated by the dotted line of 2, Fig. 39. The current through the telephones approximates this, but is smoothed out to a certain extent by the high inductance of the telephone receivers. The final form of the telephone current is shown in 3. In order to prevent the plate current from passing through the telephones, the choke coil K, of high impedance, and the condenser C_3, of low reactance to the signal current, are employed and connected as shown in Fig. 41. The number of impulses passing through the telephones per second determines the note of the signal received. In the case of the example, there are 200 impulses per second which correspond to the note produced by each spark transmitter sending out 200 groups of waves per second.

It is seen that the E_c, I_e curve bends near its upper as well as its lower extremity. Obviously, detection can take place around this curved portion, but the average plate current will be reduced upon the arrival of the wave trains.

This detection point is seldom, if ever used for two reasons. First, the plate current is many times that at the lower detection point. This exhausts the plate batteries more rapidly than is necessary. Second, when the grid is maintained at such a positive potential, a considerable amount of current flows in the grid circuit of the tube, which causes a reduction of the signal voltage across the tuning condenser, giving the same effect as a series resistance, namely, to reduce the current flowing in the tuning circuit and consequently the voltage across C_1, in addition to decreasing the sharpness of tuning in the circuit.

The eight articles of this series will be a further discussion of damped wave reception with a grid condenser and heterodyne reception.

This Announcement is Repeated for the Benefit of Those Who May Not Have Seen It Before

BY authority of the Director Naval Communications, commencing October 5th, a code broadcast schedule, addressed to all amateurs, will be transmitted by the Naval Radio Station, 44 Whitehall Street, on 1500 meters. This broadcast will be transmitted immediately following the 9:00 P. M. press schedule.

Various items of interest to amateurs, such as the establishment of new stations and changes in wave lengths of high power stations, will be transmitted in this broadcast schedule.

Copies of the code to be used may be obtained by any amateur by sending a request to the District Communication Superintendent, 44 Whitehall Street, New York City. When writing this request an amateur should give the following information:

1. Name.
2. Address.
3. Age.
4. Date concerning any military service.
5. Commercial experience, if any performed.
6. Class of operator's license, if any.
7. Number of words per minute he can copy.
8. Education.
9. Size and power of transmitting set, if any erected.
10. Type of undamped wave receiver, if one installed.
11. Name of any radio organization or club to which he may belong.

The object of this radio broadcast is to maintain the interest of radio amateurs and to train them in receiving code.

A Warning

Many amateurs are also under the misapprehension that if they have low power transmitting sets which, they believe, cannot transmit beyond the limits of the state in which they are located, they do not require licenses. This is not the fact, inasmuch as the law includes stations which can interfere with messages from outside the state in which the station is located. This proviso, therefore, includes every transmitting station.

Licensed stations require licensed operators. There is a penalty of $500 provided for the person operating an unlicensed radio station, and an additional penalty of $100 and imprisonment of not more than two months or both for an unlicensed operator, and unless some of the offending amateurs promptly realize the necessity for station and operator's licenses, there is a possibility of their being prosecuted for violating the law.

Constructional Details of the Double Condenser

A Design by Which the Capacity of a Variable Condenser is Doubled Without Occupying Any Additional Space

ALTHOUGH the peculiar constructional problems of the double condenser has prevented its wide use, for apparatus where expense is not a primary consideration it has the advantage of giving double the capacity of the usual types of condensers without an increase in the overall dimensions.

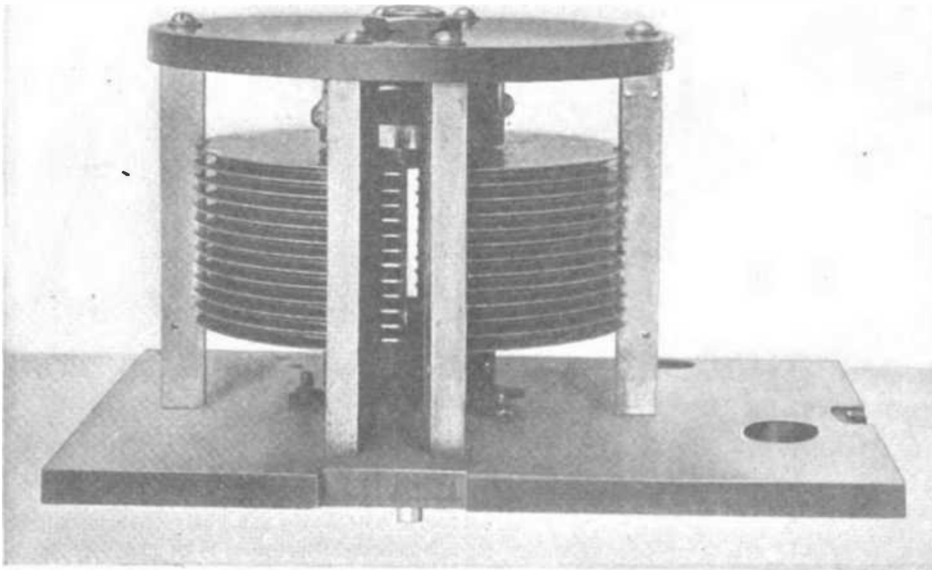


Fig. 3. The condenser inverted, showing the assembled instrument

Fig. 1 illustrates the principle of the instrument. There are two sets of semi-circular fixed plates and two sets of semi-circular rotating plates. The sets of rotating plates are insulated from each other, but by the use of commutators and brushes, one movable set is connected to one fixed set, and the other movable set to the other fixed set.

When the rotating plates are in the position shown at Fig. 1, they are inside their corresponding fixed plates. Consequently, the only capacity in the condenser is from the edge affect across the straight parts of the semi-circular plates. It should be kept in mind that sets No. 1 and 1 are the same as a group of plates on an ordinary condenser and No. 2 and 2 act as the other group.

Then, when the movable plates are rotated, variable plates No. 1 go inside fixed plates No. 2, and variable plates No. 2 go inside fixed plates No. 1. The result is the same as that obtained with the single variable condenser. At maximum capacity, opposite plates are intermeshed.

Fig. 2 shows the separate parts of the double condenser, with the assembled instrument in Fig. 3. This particular type was used for a large number of wavemeters built for the U. S. Signal Corps. The use for this purpose called for extraordinary stability and permanence. Because the wavemeters were used for portable work in the field, it was necessary to make the condensers so sturdy that rough handling would not change the calibration.

The plates are of thick brass, set in milled brass posts and soldered in the slots. Brass posts which hold the movable plates are supported on bakelite washers, to which the shafts are clamped. Accuracy was carried to an extreme by using jigs and fixtures in drilling and machining the parts. Details of the rotating plates and commutators are shown in Fig. 2.

The idea of soldering plates to the uprights is not new, though it is not done for experimenters' equipment. However, standard condensers, such as those made by the Leeds-Northrup Company, are made in this way. It is not practical, with aluminum plates, to use solder, but brass plates can be secured in that way. Aside from the added rigidity, there is an advantage over the washer separated plates in that the latter are liable to offer considerable resistance due to poor contacts between the plates.

Stopping pins on the under side of the panel intercept short arms projecting from a brass piece on the upper part of the movable plate assembly. Thus, the plates are prevented from turning more than 180°.

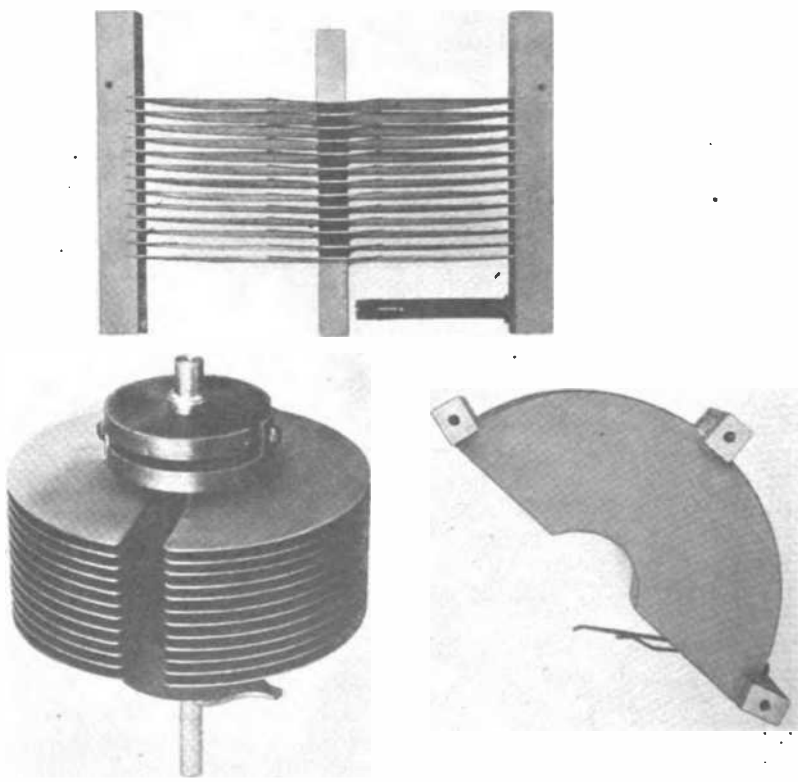


Fig. 2. Views of the fixed plates and the rotating plates, bottom up, illustrating the commutator

Bearings for the upper part of the

steel shaft are provided by a brass bushing set in the hard rubber panel. The use of a drilling jig made possible the accurate location of the bushing hole through the panel. There is a shoulder on the shaft which bears against a heavy phosphor bronze spring washer.

the upper shaft against the spring washer. When the rotating plates are accurately centered between the fixed ones, the lock nut is tightened and the plates are maintained securely in position.

A conical bearing for the lower end is more satisfactory than a pointed

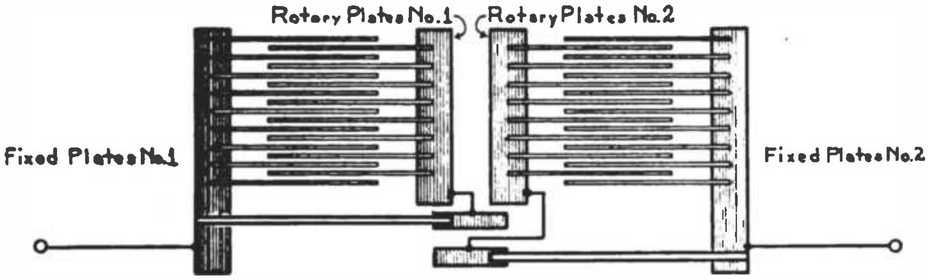


Fig. 1. In this position the capacity is minimum, for each rotary set is within its own fixed set

At the lower end, a thick bakelite panel is screwed to the brass plate supports and carries, at its center, an adjustable bearing of conical shape. The conical shoulder on the lower shaft centers itself in the bushing. This bushing is threaded and fitted with a lock nut. In adjusting the position of the movable plates, the lower bearing is screwed up, pushing the shoulder on

screw adjustment, because the former has a large bearing surface, while the latter operates entirely against the point of the screw. On heavy condensers of this type, such a point would wear away quickly, and wearing, permit the plates to drop. This would change the capacity of the condenser and the wavelength calibration of the meter.

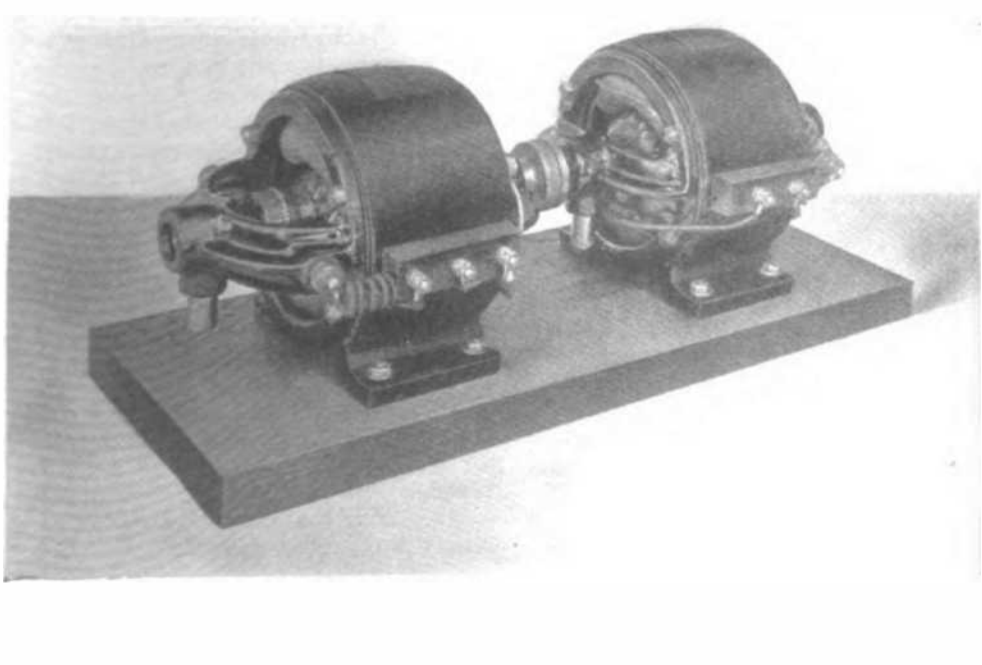
A 200 to 500 Volt Generator for Vacuum Tube Work

The greatest drawback to the use of vacuum tube transmitters for long-distance work has been the difficulty in getting a high-voltage direct-current generator. A motor generator set operating on 110 volts a.c. or d.c. has been brought out by the International Radio Company.

This set gives 200 to 500 volts at 0.2 ampere. At a speed of 1,750 r.p.m. the 48 commutator segments of the generator give a smooth current from which the ripples can be taken out with a small iron core choke and shunt condenser.

The voltage is regulated by a separate rheostat, making it possible to control the input to the tubes and to obtain the proper operating potential. Motor and generator, connected by a flexible coupling, are mounted on a heavy wooden base approximately 19 in. long by 9 in. wide. Rubber feet on the base absorb any vibration.

Now that power tubes are available, a number of undamped wave telegraph and telephone sets have been erected, and others are under way. In some cases audio frequency modulation is used because of the difficulty in heterodyning 200-meter undamped waves. This can be done without any trouble however, with a rotary tone condenser at the receiving station. A coming article will describe the construction and use of the tone condenser.

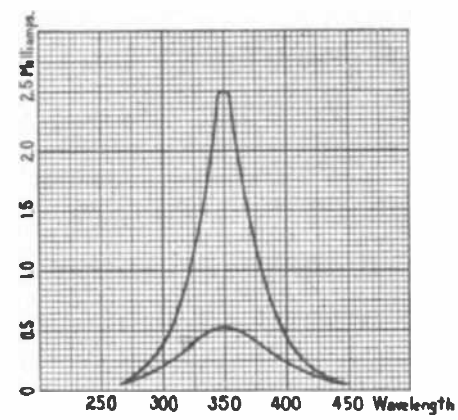


The Advantages of High Frequency Cable

A NUMBER of experimenters have sent in inquiries as to the advantages of using high frequency cable. They say, "Of course, I know it has less resistance, but does a small change in resistance have any appreciable effect on the signal strength of tuning?"

The curve accompanying this article shows more clearly than words the actual effect of resistance in the radio receiver. A coil was used first which had a resistance of 17.5 ohms at 350 meters, connected with a variable air condenser and a thermo-couple operated ammeter. Loosely coupled to this circuit was a calibrated oscillator. As the wavelength of the oscillator was varied, current readings were taken in the circuit under test.

The results, when plotted, gave the lower curve in the illustration. It will be seen that the tuning was very broad, and the maximum current at resonance through the 17.5-ohm coil was 0.5 milliampere.



A coil of high frequency cable, measuring 4.9 ohms at 350 meters, was then tested. At resonance, the current was 2.5 milliamperes—five times greater than with the other—and gave a sharp resonance peak. Thus an increase of current equal to that of a one-step amplifier was obtained, with far sharper tuning, by using high frequency cable to cut down the resistance. When radio currents are so minute at best, the experimenter can see for himself why cable should be used in place of solid wire.

Undamped audion transmitters also require cable-wound coils, for losses due to solid conductors are very pronounced, particularly at such high frequencies as 200 meters.

Standardization of Receiver Wavelength Ranges

A Method of Classifying Radio Receiving Sets According to the Wavelength Range for Which They Are Designed

ALTHOUGH the old practice of indicating the tuning range of a loose coupler or receiver by some wavelength value, such as a "1,000-meter loose coupler," has been condemned, no practical alternative has been suggested.

The persistence of some companies in keeping to this old method of designation has done more to confuse or prevent the proper understanding of tuning circuit design than anything else. Particularly the beginners are led to think that there is such a thing as the wavelength of a loose coupler, as applied to the tuning range, and many experimenters who are older in the game have clung to the idea.

Unfortunately, matters were not set aright at the start, as shown by the volume of answers to the query, "What is the wavelength of my loose coupler? It has coils . . ., etc.," in the Question Boxes of radio magazines, even up to the present time. To tell a man the wavelength of a coil is like telling him where to find the four-foot yard stick. The difference is that the latter case is only a joke, while the former is a misleading statement and a discredit to the publication.

Every experimenter should burn into his mind that the wavelength to which a coil will tune depends entirely upon the capacity connected with it. For example, a coil of 1,000,000 cms. inductance will tune to 596 meters when shunted by a condenser of 0.0001 mfd., but, with a condenser of 0.001 mfd., the wavelength is 1,885 meters.

Classification of Wavelength Ranges

Since there was no practical natural basis on which to determine the wavelength ranges, an arbitrary standard was created. Such a standard must be operative under the present communication schedule, it must also be suited to possible future schedule changes, and, at the same time, it must adapt itself to the design of tuning circuits.

The range of wavelengths, from amateur to commercial, might have been divided into a large number of small steps, or the steps divided according to the communication schedule now in use, but these methods offered no special advantages. Finally, a number of wavelength ranges for inductances and condensers were worked out, of which the following table offered the solution which has been adopted:

L cms.	0.0001 *mfd.* condenser	0.001 *mfd.* condenser
12,000	65	206
120,000	206	653
1,200,000	653	2,065
12,000,000	2,065	6,529
120,000,000	6,529	20,650

The wavelength ranges, then, are:

A range, 65 to 206 meters.
B range, 206 to 653 meters.
C range, 653 to 2,065 meters.
D range, 2,065 to 6,529 meters.
E range, 6,529 to 20,650 meters.

This can be modified slightly to

A range, 60 to 200 meters.
B range, 200 to 600 meters.
C range, 600 to 2,000 meters.
D range, 2,000 to 6,000 meters.
E range, 6,000 to 20,000 meters.

Which have been adopted as the standard wavelength ranges.

These ranges fit into the present operating schedule, and include a class of stations in each one. The A range is for short, undamped wave experimental stations. Short wave commercial stations are included in the B range. Most commercial traffic comes in the C range. Long wave spark transmitters and undamped stations operate in the D and E ranges.

Letters have been used to designate the ranges, as they are more suitable than names. Although the Navy uses letters to indicate certain wavelengths, no confusion will arise on this score.

Classification of Receivers

Particularly manufacturers of experimental equipment have been slow to take steps toward standardizing their apparatus, in some cases because they do not wish to bring technical consideration into their catalogs for fear of confusing those with only a slight knowledge of radio, and in other cases because the companies are run by non-technical men who only know what sells and what does not.

Objections may be raised that, while the secondary circuit of a loose coupler can be standardized, the different kinds of antennas used make it impossible to follow such practice in the antenna circuit. Of course, the impossible cannot be done, but even here, by striking an average, serviceable standards can be applied.

The standard short, long and super range antennas, of a single wire 30 ft. high and 100, 200 and 300 ft. long, respectively, have approximate capacities of 0.0002, 0.0004 and 0.0005 mfd., respectively. To put this in the form of a table:

Standard Single Wire Receiving Antennas, 30 ft. High.

Types	*Length*	*Capacity*
Short Range.......	100 ft.	0.0002 mfd.
Long Range.......	200 ft.	0.0004 mfd.
Super Range.......	300 ft.	0.0005 mfd.

Resultant Capacities with Series Tuning Condenser

Type	½ *C antenna to* 0.0005 *mfd.*	½ *C antenna to* 0.001 *mfd.*	½ *C antenna to* 0.0015 *mfd.*
Short Range........	0.00006 to 0.00014	0.00006 to 0.00017	0.00006 to 0.00018
Long Range........	0.00013 to 0.00022	0.00013 to 0.00028	0.00013 to 0.00032
Super Range........	0.00016 to 0.00028	0.00016 to 0.00033	0.00016 to 0.00038

Resultant Capacities with Shunt Tuning Condenser

Type	0.0001 *to* 0.0005 *mfd.*	0.0001 *to* 0.001 *mfd.*	0.0001 *to* 0.0015 *mfd.*
Short Range..........	0.0003 to 0.0007	0.0003 to 0.0012	0.0003 to 0.0017
Long Range..........	0.0005 to 0.0009	0.0005 to 0.0014	0.0005 to 0.0019
Super Range..........	0.0006 to 0.001	0.0006 to 0.0015	0.0006 to 0.002

From the data given in these tables, the primary of a loose coupler can be designed, allowing a 10 per cent. overlap of wavelength at the bottom and top of the range. Then, in stating the range of a loose coupler, it might be said, "B-C wavelength range on a long range antenna, no primary tuning condenser 0.00005 mfd. secondary condenser," for example.

This tells the whole story. The purchaser knows the antenna to use, the tuning condenser needed, and that the set will receive wavelengths from 200 to 2,000 meters. If experimenters and manufacturers would adopt this system, they would have accurate information on the requirements and performance of their apparatus.

Navy Code Practice Receiver

(*Continued from page* 92)

Connections for the set are given in the illustration. To tune in a transmitting station, the detector slider should be set at different points, and the antenna slider moved up and down. When a station is heard, it is tuned roughly with the antenna slider, then closely in the detector slider.

Data on the International Radio Oscillation Transformer

Cooperating with the ideas previously expressed in the Radio Department, the International Radio Company has supplied the data given in the accompanying curve on their oscillation transformer.

Primary inductance per turn is given by the lower left-hand curve, with the wavelength, using a 0.008 mfd. transmitting condenser. The inductance of the secondary is shown by the upper right-hand curve, with the wavelength, when operating on a standard transmitting antenna, below.

There is, of course, a change in the effective inductance when the coils are coupled, resulting in an upper and lower wavelength hump. As the upper wave is the more powerful, the wavelength adjustment should be made slightly lower than that given by the curve.

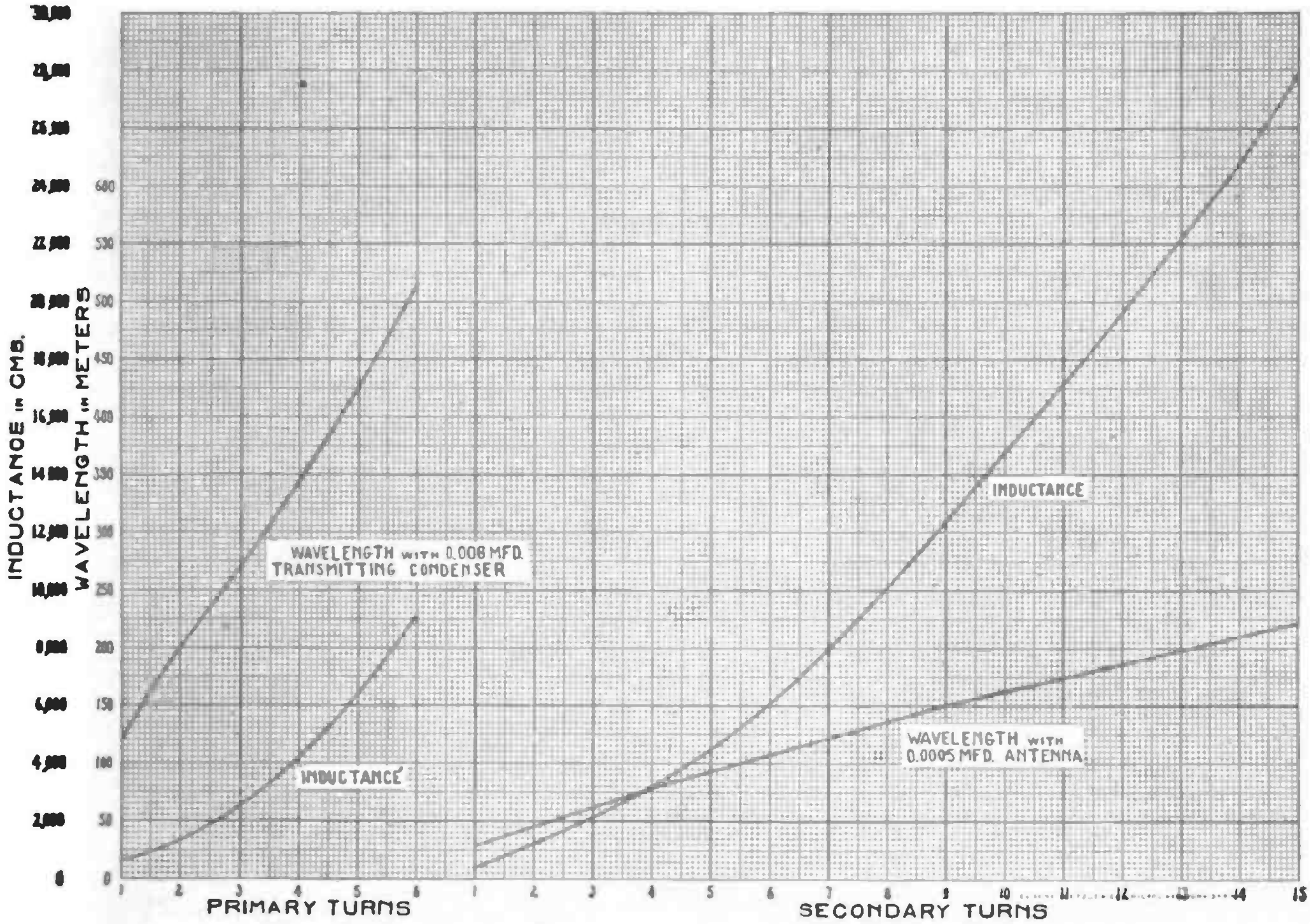
If a different condenser or antenna capacity is used, the required inductance can be determined by

$$L = \frac{\lambda^2}{3552C}$$

where λ = wavelength required in meters,

C = antenna or transmitting capacity in mfds.,

and L = inductance required, in cms.



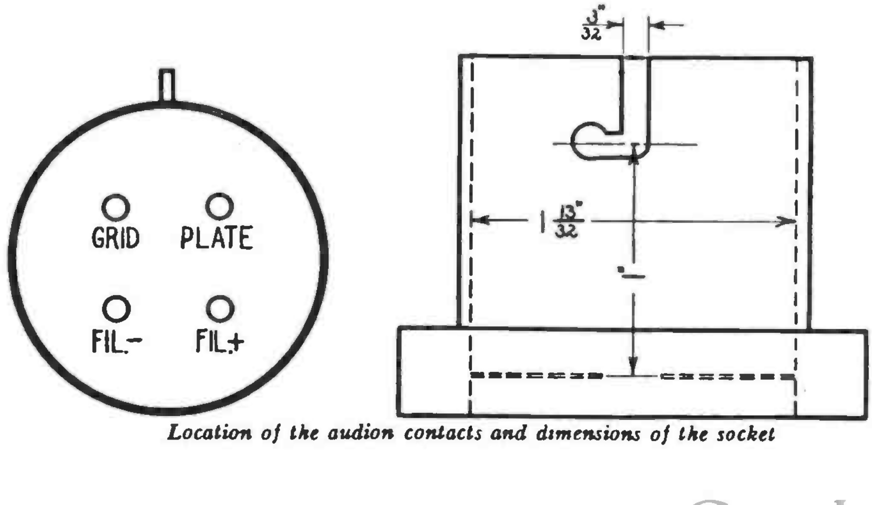
Audion Socket Dimensions

THERE seems to be some question about which is which of the audion base contacts. At the left of the illustration here the arrangement, as it appears when looking at the bottom of the base, is shown.

An easy way to remember is that the locking pin at the side of the base is between the grid and plate contacts. Holding the bulb with the contacts up, the grid is at the left and the plate at the right.

The polarity of the filament points has been fixed arbitrarily. As a matter of fact, the battery can be applied in either direction to the tube, though the polarity does make a difference in respect to the receiving circuit as is shown by reversing the connections at the battery.

The right-hand illustration indicates the general design for a socket. Any method can be used for mounting the spring contacts and for holding the tube in place. The important dimensions are the inside diameter of the socket and the distance from the springs, when the bulb is removed, to the locking point at the side of the socket.



Location of the audion contacts and dimensions of the socket

The Still Gas and Steam Engine

A Combination Form That Increases the Efficiency of the Internal Combustion Engine by Utilizing Heat Energy Ordinarilly Wasted

By Prof. T. O'Conor Sloane

MUCH interest has been created in the gas engine world by the Still engine, a combined gas or oil and steam engine. Internal combustion engines, while they give high efficiency on account of the high temperature developed by the combustion within the cylinder, to some extent overcoming the second law of thermo-dynamics, in one aspect are very unscientific. The necessity of cooling the cylinder and sometimes even the piston with water involves a great waste of heat. A second loss of heat is due to the escape of the hot products of combustion. In the Still engine both these losses are diminished and a higher economy of fuel is obtained. More than this is done. The relation of the cooling system to the operation of the engine is such as to introduce new factors and produce a different operation of the explosion or internal combustion division of the machine.

The construction of the engine is shown in the diagram. The water in the water jacket surrounding the cylinder is kept at such a pressure as to be above the temperature of boiling. The effect of this is that it is a reservoir of steam, evolving steam at working pressure as called upon. The steam produced by this arrangement is admitted to the under side of the piston and expands and drives it up on its gas-expelling stroke. In the engine illustrated the gas engine is a two-cycle one; the admission of steam below the piston makes every stroke a working one, so that the combined steam and gas or oil engine has as many impulses as a one-cylinder steam engine. A two-cylinder, two-cycle engine with the Still construction would give four impulses for each revolution, two of steam and two due to gas combustion.

The following explanations giving the different steps of the Still mechanism may be taken as describing a true cycle. The description may be followed by the aid of the diagram herewith.

A. Steam and water are taken from the top of the gas-cylinder water jacket. The water in the jacket is kept at a temperature of 350°F. The gas cylinder is the primary source of heat, and the maintenance in it of one pressure and one temperature is due to the balance between the heat produced and the steam generated.

B. The steam and water from the water jacket are taken to a boiler entering at about the level of the crown-sheet. Here a pressure of 120 lbs. to the square inch is maintained.

C. From the top of the boiler steam is taken and by a slide valve is admitted below the piston, the steam end operating as a single stroke steam engine. The exhaust steam is preferably taken to a condenser and air pump with hot well.

D. Water from the bottom of the boiler enters the heater and thence circulates through the water jacket.

E. The loss of water due to the steam used in the steam end of the cylinder is replaced by feed water from the hot well. This water also passes through the heater and enters the jacket at a high temperature along with the circulation water from the boiler, against a pressure of 120 lbs. to the square inch.

F. The exhaust gases from the gas end of the cylinder pass through the tubes of the heater, imparting most of their heat to the water on its way to the water jacket. The combustion gases leave the heater at a temperature of about 15C" F.

The steam chest of the ordinary steam engine here becomes a steam jacket surrounding the lower end of the cylinder. Asbestos lagging or other non-conducting packing is used to retain as much of the heat as possible to further increase efficiency.

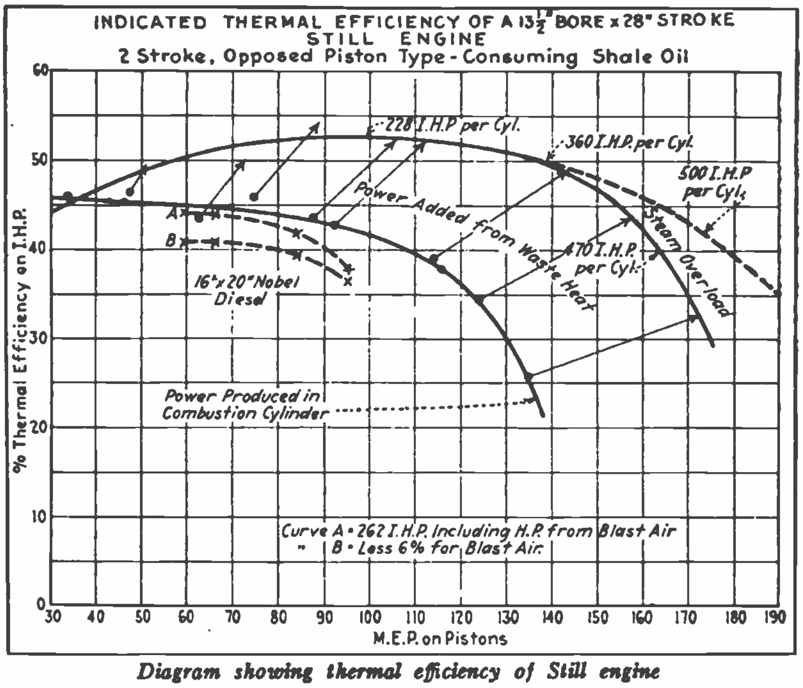


Diagram showing thermal efficiency of Still engine

The water in the water jacket being kept at a uniform and unvarying temperature, well above that of boiling water, the gas end of the cylinder is much hotter than when comparatively cold water is kept in contact with its walls as in the case of the ordinary gas or oil engine. The steam is evolved at constant pressure and its evolution in a sense takes the place of the water circulation of the ordinary engine. To make the cooling action of the water jacket efficient it is made of thin material and is braced by a series of ribs abutting against a steel band. The construction is shown in cross-section in one of the cuts. The action of the steam is different than in the ordinary steam engine because it enters a hot cylinder and gains heat from it as it expands. This is a minor source of saving heat, but it prevents any condensation of steam also. The normal steam pressure has been 14 pounds to the square inch. The weight of steam at full load is 7 lbs. per brake horsepower hour; at the minimum load it may be barely enough to balance the loss of heat due to radiation.

The range of temperature is excellent; the terminal or boiler stack temperature may be as low as 150° F., and this with the 2,000° in the internal combustion phase gives a range of nearly the full 2,000°.

Taking the mean effective gas pressure at 90 lbs. and the steam pressure at 14 lbs., the steam will add approximately 16% to the power. In a four-cycle engine, where the steam does double work in each cylinder, this ratio is doubled for an increase of about 30%. This is in power, based on pressures; a brake test showed 29% additional power. This was when the steam escaped into the air. Condensing the steam as in regular steam engine practice and with the air pump driven by outside power, the increase in power was as much as 40%. As regards efficiency the figures are taken to indicate a possibility of an increase of 15% or more.

The usual water jacket losses are eliminated because the cooling of the cylinder is done by the generation of steam which is used. Another point of advantage is that the entering steam cools the piston; no water circulation in the piston is needed for this as in other large gas power units. The system lends itself to various compounding arrangements. The compounding may be from high pressure independent steam cylinders to the gas engine cylinder or vice versa.

In Diesel or semi-Diesel engines the pressure in the gas end of the cylinder may be reduced 50% on account of the heat of the walls, which heat the entering charge and make it explode at a lower pressure than in the regular Diesel engine.

The gain from the use of steam more than balances the mechanical losses, so that it is safe to take the indicated horse-power as no greater than the brake horse-power. The boiler as shown in the cut may be heated by oil fuel in addition to the heat received from the water jacket, an oil burner discharging into a combustion chamber lined with refractory material.

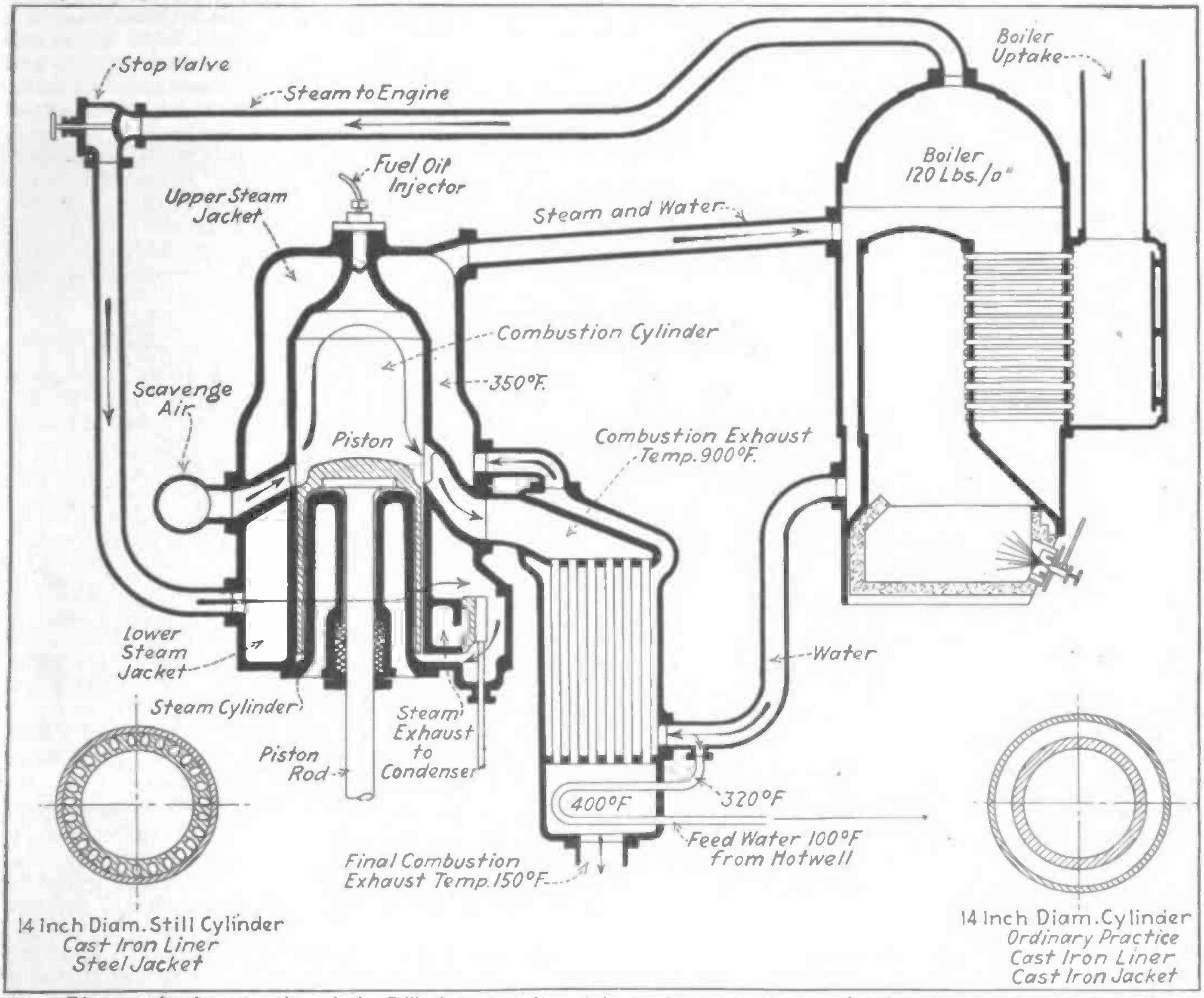


Diagram showing operation of the Still thermal cycle and how exhaust gases are employed to heat water to form steam

Aluminum Coating for Wood

A very effective agent for moisture-proofing wood has been found in an aluminum leaf coating. This material is said to practically insulate the wood it protects against any change in atmospheric conditions and is particularly valuable for use where accurate form and balance must be maintained, as would be necessary in an airplane propeller.

Zinc Wire in Germany

Owing to the shortage of copper, it is stated that German manufacturers are producing zinc wire which is but slightly inferior to copper wire from a mechanical standpoint. The new zinc wire is now authorized by the Electro-technical Union for electric wiring purposes, such as for insulated wires or cables employed in steel conduits for house wiring, or for larger conduits. Lead-covered cables are now made with the conductors of zinc.

The main advantage of zinc over iron lies in the fact that zinc has double the electric conductivity of that metal, and, besides, it is non-magnetic. Again, zinc wire is more flexible than iron, hence it works better upon insulators; and another point is that it does not need to be protected from rust. It lacks the strength of iron, however. It took some time for the new wire or cables to be introduced, especially as during the first stages the manufacture of it gave considerable trouble, but these defects have been eliminated and satisfactory results are now obtained.

Five Different Kinds of Ice

By W. C. Dumas

RECENT scientific work has shown that under certain conditions ice can exist in five different and distinct forms. The four additional forms of ice are very unstable under ordinary conditions, but they are of intense interest on account of their queer and unexpected properties. For instance, P. W. Bridgman, of Harvard, has found that under the enormous pressure of 44,000 pounds per square inch water can be made to freeze although it is nearly boiling hot. This reverses all our usual ideas of the meaning of freezing, but then our idea of this phenomenon is based entirely on conditions as they ordinarily exist under atmospheric pressure of approximately fifteen pounds per square inch.

Most of the properties of ordinary ice are familiar to everyone. Ice is lighter than water and floats because upon freezing at atmospheric pressure it expands and therefore its density becomes less than that of the water it is floating in. This expansion makes ice from 10% to 13% lighter than water.

Tammann, a German scientist, experimented to see what would happen if enough pressure were applied to water at the moment of freezing to prevent this expansion. The result was that he obtained an ice heavier than water which would not float in it. He named this modification Ice III. As would be expected, Ice III is very unstable, and upon even slight warming it swells up and breaks into a fine white powder which is nothing more than ordinary ice in very small crystals. The volume of this snow is from four to eight times that of the original Ice III.

Prof. P. W. Bridgman, of Harvard, and Prof. Tammann have made many observations on the behavior of water when it is cooled at the same time these extreme pressures are applied. The conclusion drawn from their investigations is that there are five varieties of ice.

In this work, enormous pressures had to be used which surpassed by far any pressure ever previously measured. Up until the time Bridgman began experimenting, the highest pressure that had ever been measured was 150,000 pounds per square inch produced by exploding nitroglycerin in closed vessels. But for his purpose such pressures were not sufficient, being only one-half of that required. In his work on ice, this experimenter used pressures as high as 300,000 pounds to the square inch.

The magnitude of such an unusual pressure can be better appreciated when he tells us that the average firing pressure of artillery is only about 30,000 pounds per square inch. The pressure in the ocean at a depth of six miles is about 15,000 pounds per square inch, so to obtain a pressure of 300,000 pounds, such as he used, it would take an ocean one hundred and twenty miles deep.

It would be a reasonable question to ask: What material can be found out of which to construct apparatus to be used in enclosing water under such pressures without breaking or leaking? The modern research experimenter is very ingenious. A glass hard steel was found that could withstand pressures of from 600,000 to 750,000 pounds per square inch. Cylinders were made of this material. Pistons of the same metal fitted into them and to avoid leaks around the pistons, an ingenious method of packing was devised, so that the higher the pressure became, the tighter the packing fitted. Special gauges were also devised for registering the pressures.

With such an apparatus as this, Bridgman cooled water under very great pressures. He found that water is not absolutely incompressible. At 180,000 pounds per square inch it decreases in volume about twenty per cent at ordinary temperatures.

Ordinary pressures applied to ice cause it to melt. For example, if a weight is placed on a block of ice, the ice will melt much more quickly under the weight than anywhere else on the block. But at such enormous pressures as Bridgeman used, the water sometimes solidified from the pressure alone.

As previously mentioned, Prof. Tammann in pursuing these investigations, found that when ordinary ice is subjected to about 5,000 pounds per square inch and at a temperature of 22° Centigrade, that it was no longer possible to melt it even under considerable pressure. Instead it changed in form to an ice denser than water. He named this Ice III, and called ordinary ice Ice I. Common ice and Ice III are analogous to the two forms of carbon, graphite and diamond.

A short table will give in an interesting and concise manner the temperature and pressure relations between the several varieties of ice obtained by these investigators:

At 142,200 lbs. per sq. in. and 0° C is formed Ice VI.

At 28,400 lbs. per sq. in. and 20° C is formed liquid water.

At 14,200 lbs. per sq. in. and — 20° C is formed Ice L (ordinary ice).

At 28,400 lbs. per sq. in. and — 20° C is formed Ice V, heavier than water.

These interesting transformations can be stated in another way. Commencing at atmospheric pressure and — 30 degrees C, Ice I or ordinary ice is obtained, and upon holding the temperature stationary and increasing the pressure, we get the dense form, Ice III, first obtained by Tammann. Still more pressure changes Ice III into Ice II, and a further increase changes Ice II into Ice V, and finally at the highest pressure Ice VI is formed. This variety is the heaviest modification.

It was observed that the transformation of these varieties takes place in a remarkable manner. We are accustomed to see water freeze slowly, and everyone knows how slowly ice melts. But under favorable conditions some of the above forms change into the others so rapidly that they almost explode. A concrete example of this sudden change is that of ordinary ice (Ice I) into Ice III. At — 25 degrees C, the reaction is so sudden that it was impossible to measure the pressure involved. A sudden explosive click was heard and the reaction was instantly over.

Now three of these modifications of ice (Ice II, V, VI) have never been seen, as they are formed inside steel cylinders under immense pressures. But all data obtained give indisputable evidence of their existence, and the experimenter has at his command a method of reasoning, known as the Phase Rule, which enables him to analyze the data he gathers.

Fire and Chemical Proof Paint

A FIRE and chemical proof paint, which leaves a nice looking finish is made by boiling 790 parts of Copper Sulphate, 790 parts of Potassium Chromate and 1000 parts water in the same container.

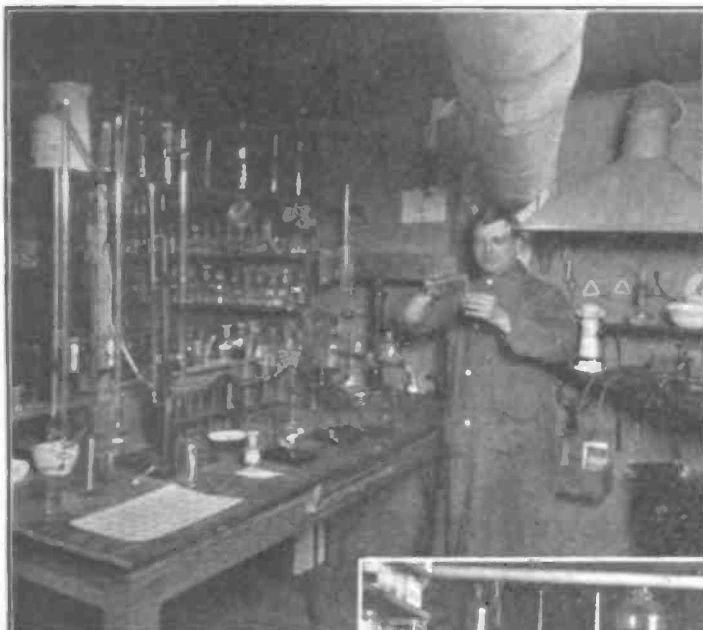
When the solution is boiling, apply one coat to the article to be finished. Allow the solution to dry one day, then boil the solution again and apply the second coat, allowing this to dry two days. Heat 100 parts of aniline oil. 100 parts of hydrochloric acid and 1000 parts water in another container to a high boiling point and apply one coat to the article, and let dry for one day.

Make a new solution of aniline oil, hydrochloric acid and water, like the previous one and apply in the same manner. Let the article dry two days. Wash the article in soapy water and let it dry thoroughly, then rub with linseed oil and it will leave a highly polished dark gray surface.

The parts used are taken by weight, and the solutions may be applied with a paint brush. Care should be taken not to mix the two solutions before applying. NOMAS TALLMAN.

The Winners of the Everyday Engineering Workshop Contest

As announced in the August number of Everyday Engineering, the workshop contest closed October 1st and the workshops of the following men have been selected for first, second and third prizes, respectively: W. Nushawg, Dayton, Ohio; Elmer Hutchison, Cleveland, Ohio; S. C. Swanson, Chicago, Illinois, and Edward H. Bitner, Harrisburg, Pa. The judges found Mr. Bitner's and Mr. Swanson's workshops so well arranged and possessing so many similar features



Mr. Nushawg at work in his chemical laboratory

Mr. Nushawg's study. This looks very cosy, "scientific" and neat

A general view of the laboratory, showing the biological equipment

that it was decided to award each of these men the third prize.

The pictures of Mr. Nushawg's laboratory were the first ones to be received and we believe that our readers will agree with us that he is in possession of a wonderful workshop. It is carefully planned, well kept, well arranged and contains a vast amount of equipment. However, the judges did not consider the equipment of the laboratory so much as its arrangement and neatness in arriving at the final decision. The idea was to reward the owner of a model laboratory in every way.

The photographs of the winners of the third prizes will be pictured in the January number of Everybody Engineering.

The description of Mr. Nushawg's laboratory which accompanied his photographs follows:

My Workshop, What Is in It, and How I Use It. Herewith are three views of my "Chemical Laboratory." I think it will be needless for me to give a description of the contents of the laboratory, as the views were so photographed as to cover that part. A brief outline or history of my laboratory, I think, would not be out of place. The "Lab.," as will be seen in the accompanying views, is an accumulation of five years' experimental work. My first laboratory consisted of an old wash-stand, of which a part can be seen directly behind "yours truly" in the view in which I am standing. Year by year I have added to the aforesaid wash-stand, as my finances would permit. To-day, I have what I consider a model "Amateur Chemical Experimental Laboratory."

The laboratory is not only a place which affords me much amusement, but also my "Study Hall" and my "College of Science," combined in one. I maintain a schedule of study, which embraces two hours each evening, including the study of chemistry, mechanics, electricity, biology, and other kindred subjects interesting to those contemplating a life of science.

The laboratory is located in the cellar of my home and is twenty-two feet in length by fourteen feet in width. It is constructed of plaster board and has a four-inch air cushion around it on three sides, so as to protect it against any dampness from the cellar. It is heated by a furnace pipe that you will notice running through the laboratory. It is fitted with electric lights for general illumination and a gas lamp for use in the printing of photos. I have gas and running water at hand. A hood is also among the apparatus. This serves in eliminating all obnoxious odors. Among the apparatus of my own construction I will mention an electric furnace, which I constructed of fire brick, using an arc as the source of heat, which gives me a heat of 3500°. This I have found very successful in the analysis of alloys. A hydrogen sulfide generator of my own design also will be noted among the apparatus. This I constructed of odds and ends found around any laboratory and have found it to give only the desired results.

As to the use to which I put my laboratory. I have before mentioned I use it for personal advancement in those subjects interesting and useful to one who has an ambition to get to the seat of those things around us that have as their fundamental principle some law or theory based upon science. I am a machine designer by trade, and with my present knowledge and that which I can gain by my experimental research work and study in my laboratory, hope to become an expert in foundry practice. I take a keen delight in trying some new experiment relative to these branches and look forward with expectation to the next issue of EVERYDAY ENGINEERING MAGAZINE, which I have found of great assistance and benefit to my researches and study. I have found it to be the best of its kind in the field and have recommended it highly to my friends, gaining it quite a few friends by so doing.

I think I have covered my interest in life and the description of my laboratory and its use and will close, trusting to your good judgment in finding me eligible for your contest on "My Workshop, What is in it, and How I use It."

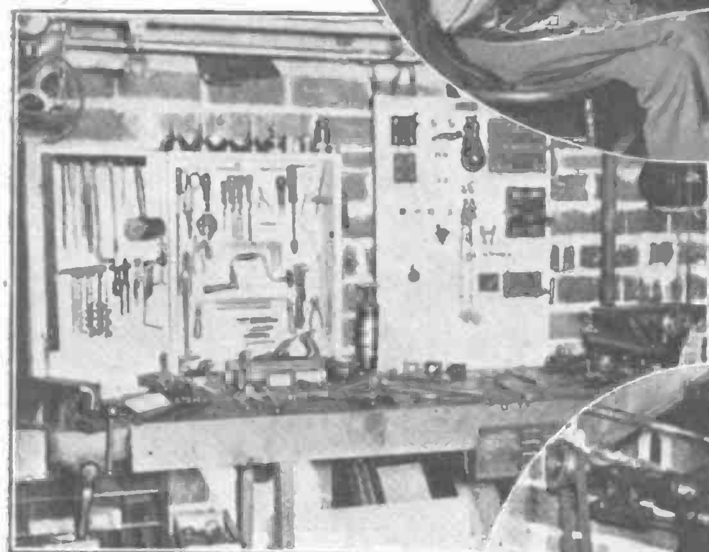
We hope that this contest will help create interest in home workshops and laboratories, not only among those who have a laboratory at the present time, but those who have no laboratory at all. The owners of laboratories will find many valuable suggestions by examining the photographs of the laboratories that are published.

The experimental research laboratory of Mr. Elmer Hutchison and Mr. Wilbert Hartle was found very deserving of second place. This particular laboratory is not limited to any special work, but has mechanical, electrical and chemical equipment. The following description of the laboratory accompanied the photographs and it is in the words of Mr. Hutchison:

"Sir, the parade is formed," is an expression to describe our shop. It is, of course, dressed up to have its picture taken. It does not look natural nor nearly as seaworthy as when wood chips are on the floor and the long steel curls climging up the lathe.

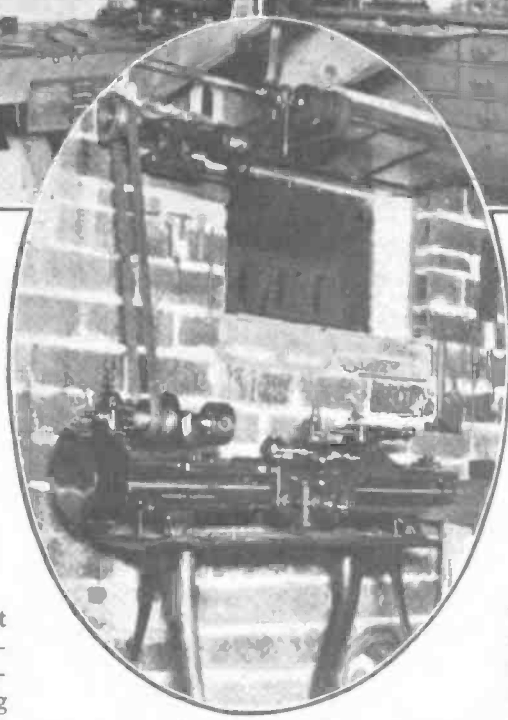
The "lab" belongs to Wilbert Hartle, 1293 Andrews Avenue, Lakewood, Ohio, and myself. We have been in partnership several years and are constantly adding things to our "lab." We have equipment for pattern and cabinet making, metal spinning and turning, and for making drawings and blueprints. We also make a few small castings.

My partner and I are both interested in chemical research work. For quantitative and qualitative analysis one of us can mix up something for the other to analyze. We also do most of our own developing, printing and enlarging of pictures. We have a vest pocket and a 4 x 5 inch kodak.



The mechanical workbench in the laboratory of Messrs. Hutchison and Hartle

A corner of the chemical laboratory owned by Mr. Hutchison and Mr. Hartle of Cleveland,, Ohio



The lathe which forms a very important part of the laboratory

In our physical research corner we have electrical meters and instruments, dynamo, electric arc furnace, microscope, micrometer, balance and other small apparatus. We also have many scientific books.

We have our "lab" in a corner of the basement. This has disadvantages as well as advantages. It is cool in summer and warm in winter, but the odors from chemicals rise and visit the people above. The pictures show the location and apparatus better than can be described."

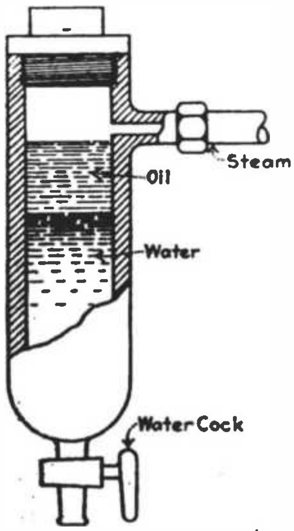
Next month there will be published more photographs of shops owned by our readers. The next two shops will be those that won the third prize, as the judges decided to make this award to two owners, owing to the fact that their shops possess so many similar features.

It has been decided to publish photographs and descriptions of readers' shops from time to time.

Displacement Lubricator for Model Engines

THE displacement lubricator is a convenient form to use on a small steam engine providing flash steam is not employed to drive the engine. If flash steam is used, the only device that will supply a sufficient quantity of lubricating oil in the cylinder is a small pump driven off the engine shaft.

Displacement lubricators are very easily constructed and positive in action—which cannot be said of all pumps when the check valve is con-



sidered as a part of the pumping unit. The operation of a displacement lubricator will be understood by referring to the sketch. It really consists of a small reservoir interposed on the steam feed pipe between the boiler and the steam chest. A small quantity of the steam passing through the lubricator condenses and the resulting water falls to the bottom of the reservoir, the oil floating on top. As the water accumulates in the bottom of the lubricator, oil is forced out into the steam feed pipe and carried into the engine cylinder. A cap screw is used on the top of the lubricator. A small petcock is placed on the bottom to run off the water. Such lubricators give very little trouble and the only attention they need is the occasional filling of the oil cup.

Making Wire Terminals

Suitable terminals for wire in electrical work can be made of brass or copper tubing cut to the proper length and pinched together at one end in a vice. A hole is then drilled in the flat end. If the copper or brass is too hard and cracks upon bending, it should be annealed first. Brass, unlike most other metals, is annealed by heating it and then plunging it into cold water.

The American Society of Experimental Engineers

Who's Who in the A. S. E. E.

JOHN GIFFORD.

Mr. John Gifford is an active member of the American Society of Experimental Engineers. At the present time he is employed as superintendent of the A. R. Mosler & Co. of New York City, having advanced to this position from apprentice in the machine shop, where he started in 1907. Mr. Gifford started his industrial and business career in the book bindery of I. Male & Sons, New York City, in the year 1906. During this year he resigned to assume the responsibilities of a position that would bring him in closer relationship with mechanical work. His next posi-

tion was with the Isaac S. Johnson Co., Spuyten Duyvil, N. Y., founders. Mr. Gifford served six months as a coremaker for this concern, and finally left its employ to start with the A. R. Mosler Co., where he is now located. Before becoming superintendent, he was foreman of the assembly department.

Mr. Gifford was born on July 21st, 1892. His parents died while he was in his youth. He was educated in the city schools of New York. The A. R. Mosler Co., where Mr. Gifford is now employed, is engaged in the manufacture of spark plugs and automobile ignition equipment. Mr. Gifford's experimental work is concerned entirely with refractories and insulators used in connection with automobile ignition apparatus. It was Mr. Gifford's job to make the spark plugs for the NC-4 at the start of the trans-Atlantic voyage.

Mr. Gifford is a careful student of military tactics and is a member of the First Company, Eighth Coast Artillery, New York Guard. Boating is also another hobby of Mr. Gifford's.

The A. S. E. E. in Canada

The American Society of Experimental Engineers is well represented in many parts of Canada. In the city of Toronto, the A. S. E. E. has a number of very enthusiastic members. The city of Winnipeg has formed a very successful local chapter. Mr. A. W. Dery is now the president of this organization, which promises to be a very successful one as well as a great help to the many experimental engineers in Winnipeg and vicinity.

The Winnipeg society is now contributing to a laboratory fund which will later be used in purchasing the necessary equipment for a modern workshop and laboratory.

Many of the members of the Winnipeg society are well advanced in the various phases of experimental engineering. These men have volunteered to act as instructors for the rest of the membership. This is a commendable plan and one which will do much toward making the society a success. This is a spirit of co-operation which is sure to further interest and ambition.

The A. S.. E. E. is also very well represented in the city of Montreal. The formation of a local chapter is now under way. A great number of A. S. E. E. members are in Canada, but aside from Toronto, Montreal, and Winnipeg, they are not in any definite locality.

NOTICE

The Mansfield, Ohio, chapter of the American Society of Experimental Engineers is now planning a large membership campaign. Mr. Richard Hautzenroeder, the Secretary of this live chapter, requests that all the experimental engineers in and around Mansfield communicate with him. The Mansfield Chapter was started some time ago and has been very successful. Those interested should not hesitate to get in touch with Mr. Hautzenroeder.

ELECTRICAL PROGRESS DIGEST

A Half Million-Volt Condenser

AN air condenser has been built at Palo Alto, Cal., for conducting tests with voltages up to 500,000 and frequencies up to 60,000. This condenser is probably the largest that has ever been built and it possesses many unique features. A special shed has been built to contain the condenser. The ceiling of the shed is of copper and forms one plate. The other plate rests on a bed of insulating material about four and a half feet below the ceiling of the shed. The distance between the plates is made adjustable by lowering or raising the lower plate. The bottom plate is formed by two copper plates about two feet apart. These are connected along the edges by copper sheets curved on a 12-inch radius.

A Poulsen arc converter of 30 k.w. capacity is used to supply energy for the tests with the condenser. One side of the arc is grounded and the other is connected to the insulated plate of the condenser on a coil of Litzendraht 9 feet long and 31 inches in diameter.

The air condenser has been designed and built by the Federal Telegraph Company, manufacturers of radio telegraphic apparatus.

A Giant Electric Ore Unloader

AN electrically operated ore unloader equipped with a 15-ton bucket has been brought into use at Ashtabula, Ohio. In fact, a battery of eight of these machines are employed in this locality for unloading ore-carrying lake vessels. The combined unloading capacity of the eight machines aggregates 76,000 tons in 24 hours; 76,000 tons would require six of the largest ore-carrying vessels in use on the lake. The unloaders are equipped with a total of 930 horse-power. The unloading cost ranges from two and a half to four and a half cents per ton. This cost includes superintendents, labor, materials and power.

Rivets Heated Electrically

AN electric rivet heating device has been perfected and is in operation in several of the large ship building plants and foundry companies. Two methods are used in rivet heating machines. In one method the rivet short circuits a welding transformer. The other method employs granulated carbon which short circuits the secondary of the transformer and radiates heat to the rivets. The capacity of the rivet heating machines depends entirely upon their size. They are made in sizes that will turn out from 25 to 250 lbs. of rivets per hour with a power consumption of 7½ k.w. to 300 k.w. and an energy consumption of 20 k.w. hours per 100 lbs. of rivets. The rivets can be heated in 30 seconds.

In an efficiency test on one of the machines 200 rivets were turned out per hour at a temperature of 2000° Fahr. No tendency to overheat was noticed and a power demand of 40 k.w. only was necessary. The initial cost of the welding type rivet heater is one hundred dollars per k.w.

Charging Storage Batteries with a Tungar Rectifier

A TUNGAR rectifier is a very simple and inexpensive device that has been brought out by the General Electric Co. It is used mostly for charging storage batteries from A. C. mains where the efficiency of the operation does not need to be over 40%. A Tungar rectifier is a vacuum tube device and has many advantages. It operates directly from 115-volt mains with an out-transformer and forms a very simple and compact device for storage battery use.

Mr. F. Keith D'Alton, electrical expert, has recently described the theory and application of Tungar rectifiers in a number of commendable articles which appeared in the Electrical News. He brings out the fact that having obtained a given efficiency and output from a single phase, 115-volt pair of mains, it is possible to duplicate the plant and obtain double the output from single phase 330-volt outside wires.

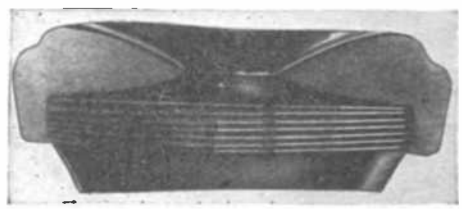
A Large Experimental Spot Welding Machine

ONE of the largest spot welding machines ever constructed has recently been built and tested by the General Electric Company. The machine has a capacity of 100,000 amperes at 20 volts. It is capable of exerting a hydraulic pressure aggregating 36 tons at the electrodes. An important series of experiments were carried out with this machine using plates from ¼ in. to 3 in. total thickness. The engineers working on the device demonstrated that satisfactory spot welds can be produced within this range. The necessity of providing a gap large enough to handle the width of the plates in ship work gave rise to a number of practical difficulties which were finally overcome.

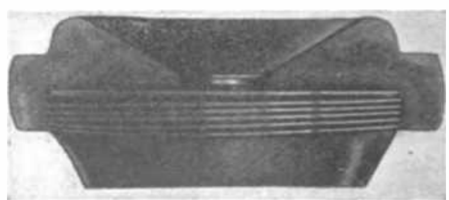
A New Telephone Receiver

A NEW telephone receiver cap has been brought out which seems to possess many advantages over the conventional form. The cross section of the new and old type of receiver cap are shown in the illustration.

The diaphragm seat of the new cap is ground scientifically true with the thread so that all rattling of the diaphragm through poor locking as well as harsh and undesirable sounds are prevented.



The new telephone receiver cap



The old type telephone receiver

A sound concentrating chamber of inverted convex formation guides and concentrates the entire sound wave that is thrown off or produced by the diaphragm with each vibration through the central opening. The contour of the sound concentrating chamber prevents distortion and insures the best possible results.

Melting Brass Electrically

BRASS is now being successfully melted in electric furnaces. It is claimed that brass melting furnaces, even more than steel furnaces, are proving their economic value in producing a better quality of product, minimizing metal loss and decreasing the amount of labor necessary.

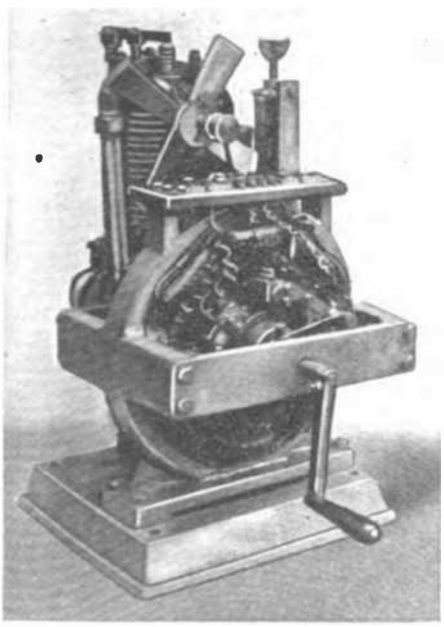
A 37,500 Horse Power Unit

THE Niagara Falls Power Company is now installing two units aggregating 65,000 H. P. or 37,500 H. P. each. The water wheel of this unit is placed in the path of a solid column of water 14 feet in diameter and a drop of 210 feet. The speed of this column of water will probably be in excess of 3 miles per minute at the foot of the drop.

About 14 years ago the Hydraulic Power Company installed 13,000 H. P. units and at that time these units represented the limit of engineering. The fact that a 37,500 H. P. unit is now made possible shows what tremendous progress has been made in hydraulic and electrical engineering during the past 15 years.

A Small Gasoline Electric Generator

ONE of the foreign readers of EVERYDAY ENGINEERING MAGAZINE, Mr. J. A. Armstrong, of Dublin, Ireland, has constructed a gasoline electric generator of rather novel design. The accompanying photograph pictures



the device which was made up of a 1 1/3 H. P. gas engine and dynamo capable of producing a current of 15 amperes at a pressure of 15 volts. Mr. Armstrong mounted his motor and generator on the same shaft and in this way produced a very portable and self-contained equipment for various uses, such as charging accumulators, isolated lighting, etc. When coupled to the generator the engine does not need to have a flywheel, as the armature of the generator will serve in this capacity. The engine turns over at a speed of 900 R.P.M., and of course, the generator is driven at the same speed.

An Apparatus for Testing Magnetic Permeability

By William G. H. Finch

THERE is a need in every electrical laboratory for an apparatus to test the permeability of the various grades of iron and steel in the make-up of cores used in electro-magnets.

The necessary parts for the apparatus are:

Spring balance
Brass rod
Wood base and standards
Binding posts
Electro-magnet
2 or 3 dry cells.

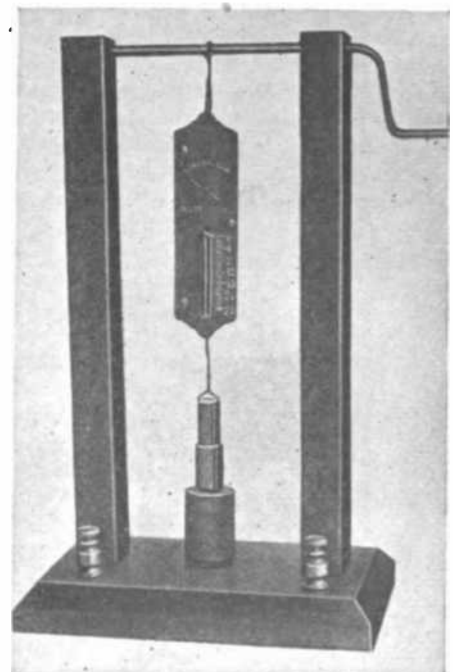
First, remove the spring from the spring balance and replace it with one that will respond to smaller weights. The new spring will be much more sensitive and a new scale should be made from cardboard for it. By the use of known weights of small value the new scale can be very easily calibrated.

Assemble these parts as shown in the photograph. Cut the various grades of iron into pieces having the same dimensions (preferably 1 inch cubes). Attach the piece to be tested to the spring balance, being sure to let the surface of same touch the core of the electro-magnet; watch the scale and raise the balance slowly until the cube of iron is separated from the magnet. The number of ounces or pounds pull it required to break away from the electro-magnet will be noticed. After the experimenter has tested the remaining samples, he will find that the permeability of each will rank as follows:

1. Wrought iron
2. Mild steel
3. Cast iron.

It is evident that if the permeability of the different grades of iron and steel can be tested in this manner, the magnetic pull of any electro-magnet can also be tested by mounting same on the base and using a cube of wrought iron in the same manner as in testing for the permeability of iron and steel.

An electro-magnet consists of a coil of wire carrying a current, and may possess a core of iron, or may not, as the case may require. It is understood that the production of magnetism depends upon the number of turns of wire carrying the current. It must be understood also that not only the number of turns are to be considered, but also the strength of the current they carry. Therefore, the greater the number of turns of wire, and the greater the current in these turns, the greater the pull or magnetic effect produced. It is also customary to speak of the combination of current and turns as *ampere turns.* It is to be seen that the ampere turns of an electro-magnet are most important considerations. These are obtained by multiplying the number of turns of wire by the number of amperes passing through the coil. For instance, if an electro-magnet consists of 500 turns carrying a current of 5 amperes, the ampere turns would be equal to $5 \times 500 = 2{,}500$. Then if we reduced the current to one ampere, the product



equals $1 \times 500 = 500$ ampere turns. Suppose there are 1,000 turns and 1 ampere, or 1 turn and 1,000 amperes. In either case, the total ampere turns equal 1,000.

Some very good experimental work can be performed with this simple but none the less workable device. With it the experimenter can plot many interesting curves showing the magnetic permeability of different metals and at different current values. The effect of variation in potential and current strength can be shown by a curve through all points up to the point of saturation.

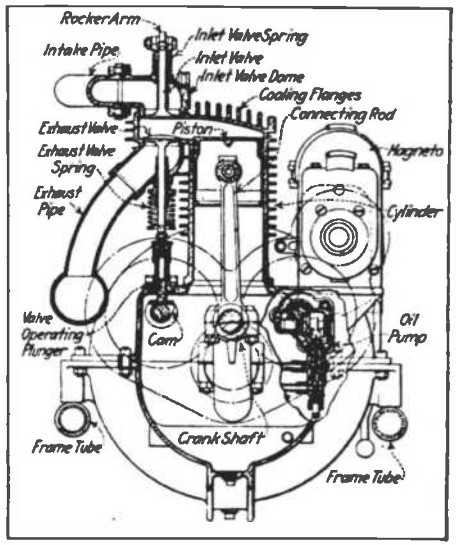
If the reader desires to construct a more elaborate device than the one described above, it will be very easy to make a few additions that will increase its efficiency. The device can be made larger to accommodate larger and more powerful electromagnets.

Motorcycle Lubrication

By Andrew Jackson, Jr.

ONE of the most important considerations, making for efficient action and promoting long life of the mechanism, is to provide proper lubrication. The lubrication of the power plant is the most serious proposition. The best oil is the only kind that should be used, as more good motors have been ruined by the use of lubricant of improper quality or insufficient quantity than have been destroyed by accidents. If a drip feed is used, a medium grade oil may be employed in warm weather, but a light grade will be necessary in cold weather. If the supply is by mechanically operated pump, a heavier bodied lubricant may be used than when the drip feed system is employed. When oil is introduced to the engine crank-case by means of a hand-operated pump, which means that lubrication is directly under the control of the rider (only on old-time machines), one pumpfull of oil, every 8 or 10 miles, at speeds of 20 miles per hour, will be sufficient. For a speed of 30 miles per hour it will be necessary to inject a pumpfull every 5 or 6 miles. It is better to over-lubricate a machine than not to supply enough. If the engine is over-lubricated, the exhaust will be smoky. If a mechanically operated oil pump is used and the hand pump is provided only as an auxiliary, it will not be necessary to supply oil except at such times that the engine is run exceptionally fast for extended periods.

Among some of the points that should receive oil every time the machine is used may be mentioned the valve lifters, or rocker arms, the free engine clutch, the steering head, and the various hinges and joints on the spring frame or spring fork. If a two or three speed gear is provided, the supply of lubricant should be renewed every 300 miles. Planetary gearing requires more lubricant and a lighter semi-fluid grease than either the sliding clutch or sliding gear forms. It is well to put a few drops of oil in the front hub and coaster brake oilers every day. About the only point on the motorcycle that can receive too much oil besides the engine interior is the magneto, and only a few drops are required every two or three

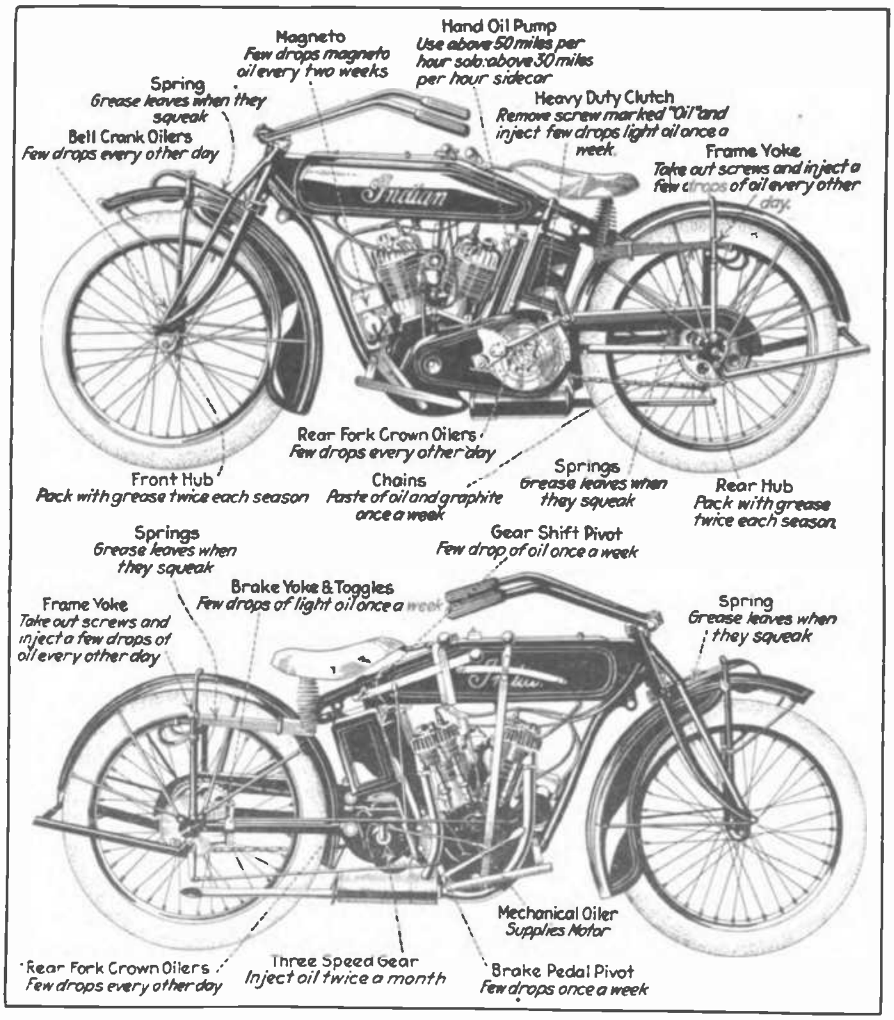


End elevation of Henderson four-cylinder motor, showing principal parts

months to insure adequate functioning of this device. A special light oil is necessary for the magneto, and a good grade of sewing machine or 3-in-1 oil will be found satisfactory for this purpose. The hand oil-can may be filled with cylinder oil which can be used on all points of the machine, because if it is good enough for the engine interior it is much better than needed for the various external parts. The ball bearings in the hubs, countershaft and steering head may be packed with grease once or twice a season, which will be adequate.

Keep Distributor Clean and Dry

Excessive oiling of a magneto can do nearly as much harm as insufficient lubrication. One thing it does is to cause the surplus oil to be thrown into the distributor, where it works all kinds of mischief. It gets between the brush and the contacts and either insulates them from each other entirely, causing missing, or it causes arcing. Arcing in turn burns the oil and forms soot which soon gums things up badly, and it also produces heat which disintegrates the carbon brush and causes it to crumble in time. All magneto manufacturers make their distributors so that they may be removed easily and wiped clean with a dry, clean cloth. Dixie magnetos, for instance, have their distributors held on by three little clips, retained by three thumb nuts. These may be loosened by hand. Other Dixies have three screws to retain the cover. Some have a central revolving brush and stationary contacts in the cover and others a revolving contact and individual stationary contacts in the cover. The brushes in either case are attached to small springs and may be slipped into or out of their sockets by hand.



Views of Indian power plus twin cylinder motorcycle, showing points needing periodical lubrication

Winter Care of Storage Batteries

Precautions to Be Taken to Prevent Depreciation of an Unused Storage Battery and How to Maintain Its Efficiency During the Period of Low Temperature

IT would not do simply to leave the battery in the car for a period of, say, four or five months without giving it any care or attention, for in that case at the end of that time it would be found to have its plates so thickly covered with lead sulphate as to make it practically useless. For storage batteries "to rest is to rust" and become ruined unless special precautions are taken. Automobile storage batteries are all or nearly all of the sealed-in type from which the elements cannot be removed without a great deal of trouble, as shown at Fig. 1.

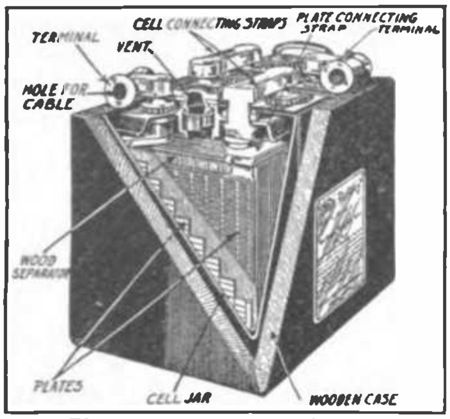


Fig. 1. Typical storage battery

The storage battery is made up of several hard rubber cells or containers for the active plates and liquid electrolyte. The whole is surrounded by a wood casing for mechanical protection and ease in handling. Each individual cell is provided with a screw cap for inspection and the addition of electrolyte or distilled water when necessary. (See Fig. 4.) The electrolyte must at all times cover the tops of the plates at least one-quarter inch. Insufficient electrolyte will result in warped or buckled plates, and an accumulation of sediment at the bottom of the cell. The battery will be ruined in a short time if the tops of the plates are not kept covered. Each cell must be inspected at least every two weeks in winter. All screw caps must be removed and distilled water added to each cell to make up for the natural evaporation. If distilled water cannot be had, use clean rain water which has not been in contact with metal or cement.

Never Add Acid to Battery Cells

Never add acid to the cells of the battery. If part or all of the electrolyte has been lost through accidental spilling or leakage get full instructions and advice from the maker. A hydrometer arranged with a rubber bulb to draw a portion of the electrolyte from each cell furnishes the best indication of the condition of the battery. The hydrometer shows the specific gravity of the electrolyte, which for a fully charged cell should be 1.280 to 1.300 on a specific gravity scale. If the car is out of service for a considerable length of time, as when laid up for the winter, it is necessary to charge the battery at regular intervals. The parts of a typical battery are shown at Fig. 2 and the construction should be easily understood.

The following advice concerning the care of batteries during a protracted period of idleness of the car refers especially to the batteries of starting and lighting systems of automobiles.

At intervals of two weeks the engine should be run until the electrolyte shows a specific gravity of 1.280 to 1.300. If this is done regularly the engine need not be run only about an hour each time. But if the owner should not be in possession of a hydrometer it is better to run the engine for two or three hours each time to be safe. To charge the battery properly the engine should be run at a speed corresponding to a car speed of about 20 mph on the direct drive. There may be cases, however, where the owner is compelled to store his car in a space where it is practically impossible to run the engine. Where this is the case it is recommended, if electric current is available, that the owner purchase a rectifier or small charging machine.

Periodical Charging Necessary

A charge over night, or for about twelve hours, every two weeks with this apparatus will be sufficient to keep battery in healthy condition. For those of our readers who are interested in chemistry, the action on charge and discharge is clearly shown at Fig. 3, which is presented through the courtesy of the Electric Storage Battery Co. Before beginning the charging the battery should be inspected to see if it is filled with solution. If the solution needs replenishing distilled water should be added until the solution fully covers the plates, which may be determined by removing the vent plugs and looking down into the cells.

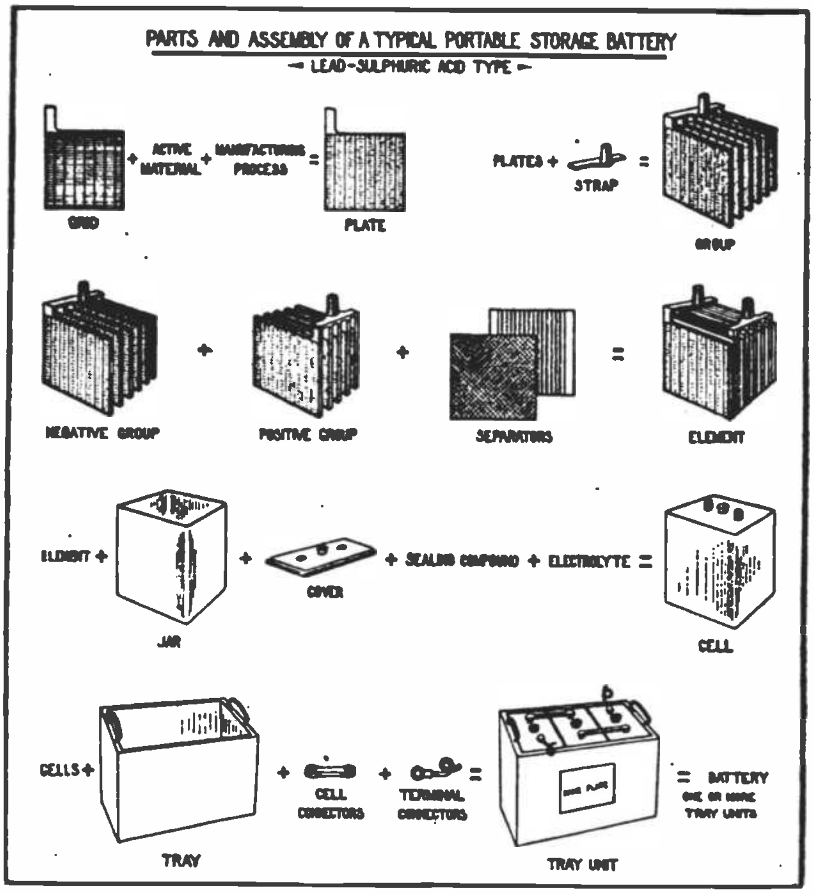


Fig. 2. Parts and assembly of typical portable storage battery

In case it is impossible to run the engine for charging and the owner does not care to incur the expense of purchasing a rectifier, he should remove the battery from the car and arrange for its storage at a garage which has charging facilities, stipulating that it must be charged every two weeks. The cost of having it so cared for will be nominal and will prove excellent insurance against deterioration.

Caring for Take-Down Types

To care for storage batteries of any type that is easily taken apart, such as used for experimental work in the laboratory or in isolated lighting systems for country homes and in yachts, the following method is recommended: First charge the battery until every cell is in a state of complete charge. If there should be be any short-circuited cells they should be put into condition before the charge is commenced, so that they will receive the full benefit of the charge. Then remove the elements from the jars, separating the positive from the negative groups, and place in water for about one hour to dissolve out any electrolyte adhering to the plates. Then withdraw the groups and allow them to drain and dry. The positives when dry are ready to be put away. If the negatives in drying become hot enough to steam they should be rinsed or sprinkled again with clean water and then allowed to dry thoroughly. When dry the negatives should be replaced in the electrolyte (of from 1.275 to 1.300 specific gravity), care being taken to immerse them completely and allow them to soak for three or four hours. Two groups may be placed in a jar and the jar filled with electrolyte. After rinsing and drying the plates are ready to be put away.

The rubber separators should be rinsed in water. Wood separators after having been in service, will not stand much handling and had better be thrown away. If it is thought worth while to keep them they must be immersed in water or weak electrolyte, and in reassembling the electrolyte must be put into the cells immediately, as wet wood separators must not stand exposed to the air for any unnecessary amount of time, especially when in contact with plates.

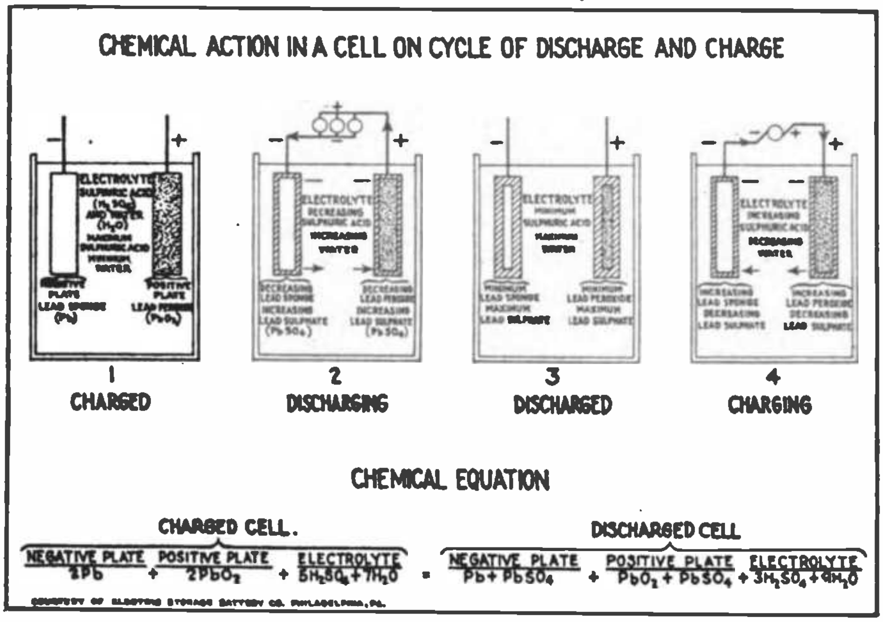


Fig. 3. Chemical action of a cell on cycle of discharge and charge

Store Batteries in a Dry Place

Storage batteries always should be stored in a dry place, preferably in one where the temperature will never fall below 40° Fahr. Storage battery solution or electrolyte varies greatly in density between the points of complete discharge and full charge. The electrolyte of the average battery has a specific gravity of 1.140 and a sulphuric acid solution of this specific gravity has a freezing point of about 10° Fahr. The hydrometer used and the methods of taking specific gravity readings with a hydrometer syringe are clearly shown at Fig. 4. Therefore if a completely discharged battery is allowed to stand where it is exposed to extremely low temperature it is quite possible for the electrolyte to freeze and the cells to be injured in consequence.

However, as already pointed out, a battery for other reasons must not be allowed to stand in the discharged condition for any length of time. With increasing charge the density of the electrolyte increases until when the charge is complete it attains 1.300 specific gravity. The freezing temperature of the solution drops very quickly as the specific gravity increases somewhat as follows:

Spec. Grav.	*Fr. Pt. Deg. F.*
1.140	+ 10
1.160	+ 5
1.175	— 4
1.200	— 16
1.225	— 36
1.250	— 60
1.280	— 85
1.300	— 100

Consequently there is no possibility of a storage battery being injured by freezing in temperatures ordinarily met in the temperate zone if it is kept in a fair state of charge. The accompanying graphic chart (Fig. 5) shows the freezing point of electrolytes of varying specific gravity.

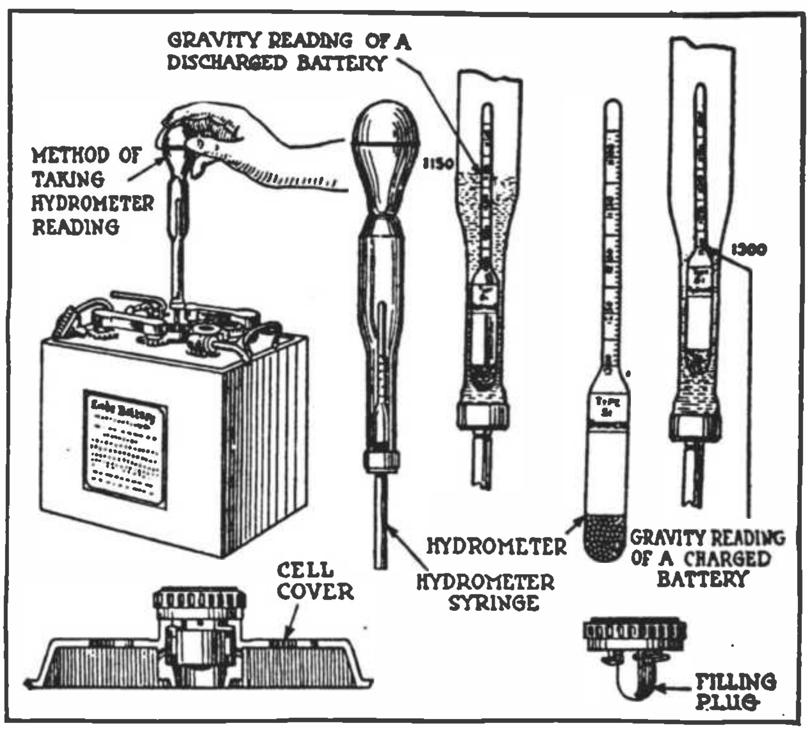


Fig. 4. How to use hydrometer in testing battery condition

(*Continued on page* 135)

TWO-CYCLE MOTOR REPAIRS

It will be evident that a worn cylinder, piston rings or piston will result in the loss of compression as in any motor and that loose connecting rods or main bearings will produce noisy operation just as in the four-cycle type. In the two-cycle motors there are other conditions to be looked for besides those involving normal depreciation of the mechanism. There are two chambers to keep tight instead of one, as in the four-cycle type. In the two-cycle form it is not hard to maintain compression in the combustion chamber because there are no valves to leak and the only chance for escape is by worn piston rings.

It is imperative, however, that a certain amount of compression be maintained in the crankcase of most two-cycle engines because the degree of compression in the crankcase determines the rapidity of transfer of explosive gas from the base where it is first received to the combustion chamber where it is exploded. Because of this the main bearings demand more attention than do those of a four-cycle engine because they must be fitted so well that there is no possibility of leakage through them. Similarly the packings between the cylinder and engine base and between the crankcase halves must be carefully maintained.

In examining the piston and cylinder care must be taken to remove any deposit of carbon from the baffle plate or deflector, which is usually cast integral with the piston top, as any sharp point or corner would remain incandescent and would cause either base firing or premature ignition. Base firing is generally prevented by making the charge from the crankcase pass through wire gauze in the by-pass passage. This prevents the flame igniting the explosive gas in the engine base because practically all of the heat is abstracted from any heated gas as it passes through the mesh of the screen. These screens sometimes become clogged with oil and reduce the speed of gas flow and consequently diminish the power output of the motor; the remedy is a simple one, as it involves only the removal of the clogged screens and cleansing them thoroughly in gasoline before replacing.

Brass Castings.—When clear, yellow brass castings are desired, a mixture of 7 lbs. of copper, 3 lbs. of spelter, 4 oz. of tin, and 3 oz. of lead makes a good casting alloy and one which will cut clean and free, and is also strong. An increase in the amount of tin augments the strength of the alloy and also increases the degree of hardness.

Replacing Broken Side-Curtain Lights.

AUTOMOBILES of the "open" or touring and roadster forms have windows in the top curtains made of a material known to the trade as transparent sheeting. This sheeting is made on a soluble cotton base and while not so brittle as glass, as the same time it is breakable and is often damaged through careless storing while not in use.

The ordinary way of replacing a broken sheeting window light is to rip the stitching that secures it to the top or curtain and insert a new pane. Top repairers charge several dollars for this work, if the light is in a side curtain and even more if in a rear curtain, which must be removed from the top to be handled conveniently.

The motorist may do the work himself at less expense if he desires. It is becoming common practice for hardware stores to carry transparent sheeting in stock for the accommodation of their customers desiring to make just such repairs. A piece large enough to replace a broken light costs but a few cents. The windows are sewed in with a double row of stitches. First cut the inside row of stitching. Leave the second row. Then cut out the broken light, leaving a strip about one-half inch all around and held in place by the stitching left intact. Cut the new pane the right size and cement it to the edges left on the old pane.

This method reduces the cost of the replacement to less than one dollar. The success of the method depends on using the right kind of cement; in short, one made on a pyroxylin base. This is because the cement and the transparent sheeting are both made of the same ingredients. Cotton is the base. A pyroxylin cement combines with the sheeting in such a way that the two pieces of sheeting become a practically homogeneous unit.

Drilling.—Use kerosene to drill, ream or turn malleable iron, or to drill or turn aluminum. Turpentine should be used instead of oil for drilling hard steel, as it will cause drilling readily when the metal cannot be touched with oil. By using a combination of turpentine and camphor, glass may be drilled with a common drill. When the point of the drill comes through the hole should be worked with the end of a three-cornered file, having edges ground sharp. Use the corners of the file to scrape rather than as a reamer. Great care must be taken not to crack the glass or flake off pieces of it while finishing. The mixture should be used freely, both while drilling and scraping. It may be used as well to drill hard cast iron and tempered steel.

Protect Your Tools From Rust

Nearly every man owns at least a few tools such as chisels, hammers, augers, saws, wrenches, files, etc.

These tools as a rule are infrequently used. They are often kept in places where they are exposed to moisture and consequently rust. Almost all tools with the possible exception of hammers are rendered less efficient by rust.

When it is so easily prevented, it seems strange that steps are not taken to do it. It is well worth while to save the tools as every one knows that has had occasion to buy any new ones lately.

Probably the best tool protector and carrying case for a small kit may be made in the shape of a roll from a piece of pyroxylin coated fabric having a napped or fleecy back. This material is thoroughly waterproof and if care is taken in wrapping the tools in it after use, it will prevent moisture from reaching them and no damage from rust can occur.

The material is durable and will last a long time. It is obtainable at many department and general stores where it is sold under the general name of leather substitutes. There are many leather substitutes on the market sold under various manufacturers' trade names. Practically any of them will answer very nicely for the use specified.

Gasoline Engine Fly Wheel Retention

Many mysterious knocks, which are often attributed to worn bearings, are due to the flywheel being loose on the shaft. In a number of the earlier forms of marine engines the flywheels are held to the shaft by a simple gib key. It often happens that these keys become worn and the wheel is slightly loose on its supporting shaft. When the engine is revolving at high speed a pronounced thump or knock will be produced because of the hammering action of the flywheel upon the loose key. The proper remedy for such a condition is to make a new key that will fit the keyways in flywheel and shaft and drive it tightly in place.

In practically all modern forms of motor the flywheel is secured to a flange forged integrally with the crankshaft by means of bolts. It may be possible for the bolts to loosen, which will permit the flywheel to rock and to pound the hole out oval. This condition is easily remedied by drilling or reaming the worn holes to the next largest standard size and to fit larger bolts to correspond. Loose or worn propeller shaft or reverse gear couplings will also cause knocking.

Statement of the ownership, management, circulation, etc., required by the Act of Congress of August 24, 1912, of EVERYDAY ENGINEERING MAGAZINE published monthly at New York, N. Y., for October 1, 1919.

State of New York, County of New York, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Stephen Roberts, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Everyday Engineering Magazine and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager, are: Publisher, Everyday Mechanics Co., Inc., 2 West 45th St., New York City; Editor, Raymond Francis Yates, 2 West 45th St., New York City; Managing Editor, Victor W. Page, 2 West 45th St., New York City; Business Manager, Stephen Roberts, 2 West 45th St., New York City.

2. That the owners are: Everyday Mechanics Co., Inc., 2 West 45th St., New York City; Norman W. Henley, 2 West 45th St., New York City; Edward J. Richmond, 2 West 45th St., New York City; Stephen Roberts, 2 West 45th St., New York City; George Rosendale, 52 Broadway, New York City.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiants' full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

S. ROBERTS,
Business Manager.

Sworn to and subscribed before me this 1st day of October, 1919.

(Seal.) ANNIE M. HOLDEN.
(My commision expires March 30, 1921.)

Reg. No. 1461, N. Y. Co. No. 501.

Signalling Apparatus

(*Continued from page* 93)

grain and when this is done the diaphragm is put in place and the holding screws soldered. The length of the holding screws should be a little under ¼ in. so that they will not meet to cause a short circuit. Two terminals are then soldered to the device, one to each side. The connections for the receiving station will be noticed in the drawing. The device must be used in connection with a battery and a telephone receiver.

A word about the operation of the device. It is, of course, understood that the batteries, key and receiver are all kept above the surface of the water. The oscillator and microphone should not be sunk over a depth of six feet. A greater depth than this will cause too severe a pressure upon the diaphragm and the device will fail to function. The oscillator will require some patience to adjust. The contact screw should be regulated until the device gives a musical hum. It may be found, however, that when it is immersed in the water it will loose its adjustment owing to the fact that the operating conditions are not the same. It may be that an adjustment that will not work out of the water will work under the water. The oscillator should be so placed that the diaphragm faces the microphone. In other words, the diaphragms of the devices are placed in the same plane. The regular Morse signals can be used to carry on communication.

By using a larger can and more powerful magnets, an oscillator can be made that will transmit up to 100 feet. The same microphone can be used.

Cup Races

(*Continued from page* 81)

Mr. N. Fischer, who operated one of the Elmara boats, made a good but unsuccessful attempt to win the prize. His craft clipped off two laps (15 and 17 seconds), but power plant trouble prevented another successful lap from being made.

This cup race is the first one that has ever been run in the United States for steam driven power boats. It was a tremendous success throughout and next year there will be many more entries. The real sportsmanship displayed by the various contestants was a gratifying feature of the event. The spirit of co-operation was manifest in no small degree. The boat owners helped one another in every possible way. It required two experienced men to operate each boat with one man continuously watching the blow torches and keep one in readiness.

The Central Park Model Yacht Club also ran off a season's cup event for a one design hydroplane class.

SMALL VULCANIZERS USEFUL TO MOTORISTS

THESE small vulcanizers are intended primarily for the use of the motorist in making minor repairs and are not practical tools for the tire repair shop, though they may be used to advantage in small garages where no attempt is made to carry on tire repair work on a large scale.

For general use of motorists and in small shops a combination vulcanizer, which is composed of a large hollow cast-iron body filled with water and heated with a spirit lamp, is marketed. In this the curved face and the flat face may be used simultaneously and an inner tube patched at the same time that the outer casing is being treated. As very complete instructions are furnished with these small vulcanizers, any motorist may become familiar with their use without much difficulty.

In some vulcanizers, the heat is furnished by electricity passing through resistance coils imbedded in the device, similar to an electric flat iron in action. In vulcanizing, the most important precaution is to maintain a proper temperature. Too great a degree of heat will burn the rubber, while a proper cure cannot be effected if the temperature is too low. The temperatures recommended for vulcanizing vary from 250 to 375 degrees F. The lower degree of heat is used in working material that has been previously cured, while the higher temperature is recommended for new rubber. Small thermometers may be obtained from auto supply houses to gauge the temperature of the vulcanizer.

Treating Polished Iron or Steel.—Wash polished iron or steel that has become gray and lusterless, with a stiff brush and ammonia soapsuds. Rinse well and dry by heat if possible. Then apply a plentiful supply of sweet oil and dust thickly with powdered quicklime. Let the lime stay on two days, after which it should be cleaned off with a stiff brush. Polish with a softer brush and rub with cloths until the luster comes out. By leaving the lime on, iron and steel may be kept from rust almost indefinitely.

When replacing anti-skid chains on your tires be sure to have the hooks toward the back as you lay them over the wheel. This gives a whipping motion to the hooks when in use, which tends to keep them closed. If the chains are put on the other way they will tend to open and be in danger of coming off.

SCHOOLS

We sell UmakeM Outfits for Manual Training to schools throughout the world. We also sell UmakeM designs and materials separately. Check below the outfits wanted and order today.

PARENTS

The tendency now everywhere is to provide materials for young people with which they may make their own playthings. It is truly educational and develops the best that is in them. Check below the outfits wanted and order today.

UMAKEM

COMMUNITY SHOPS

Note the UmakeM sets for all ages. Organize UmakeM Shops. Enroll UmakeM Community Shop Members. Combine their orders and check below the outfits wanted, giving quantity.

ORDER TODAY

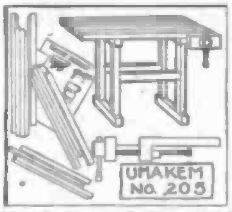
We Help UmakeM Members Make UmakeM Money

UmakeM Members

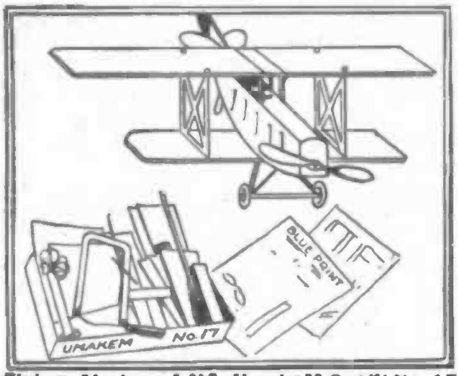
Enjoy all UmakeM benefits. Such as license to sell UmakeM toys. We will assist if you desire to start UmakeM Novelty making at home. Check below the outfits wanted and mail us your order today.

DEALERS

Dealers everywhere are selling UmakeM Outfits. Some of them are selling the UmakeM products of their customers, making double profit and creating unusual interest. Check below the outfits wanted, stating quantity and send us your order today.

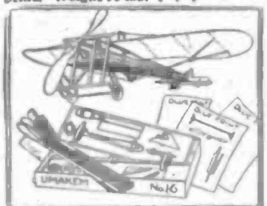


Work Bench No. 205
65 inches long. 18 inches wide. Complete material for making this sturdy bench including blue print. Weight 95 lbs. . . . $9



Flying Airplane J-N4, UmakeM Outfit No. 17
containing all wood, coverings, aluminum, steel wire, Para rubber, fittings, blue prints and full instructions, together with all necessary tools. Weight 2½ lbs. . . . $3

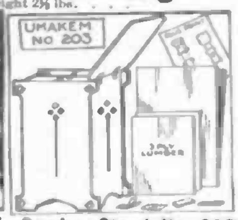
60-Piece Set No. 3
containing high quality tools, designs, 3 ply wood, hardware, colors, and everything needed to make items shown. Weight 7 lbs. $2



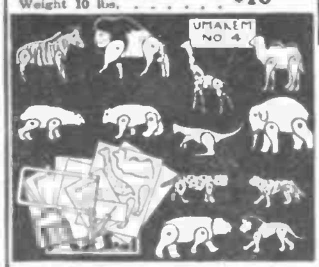
Airplane Set No. 16
A Workchest containing work table, mitre cutting board, gauge, drill, steel hammer, Model Maker's steel square, wood and all fittings for building one Bleriot Model Flying Monoplane. Full set blue prints and directions. Weight 10 lbs. $10

Circus Set No. 8
Containing 11 tools, designs, colors, special wood, complete material and instructions for making a $20.00 circus set as shown, consisting of Circus Wagon, Animal Wagon and 19 Jointed Wild and Domestic Animals. Weight 22 lbs. $10

Noah's Ark No. 7
contains tools and all materials with instructions and designs to make this 28 in. Noah's Ark and 24 animals (2 of each). Weight 20 lbs. . . $5

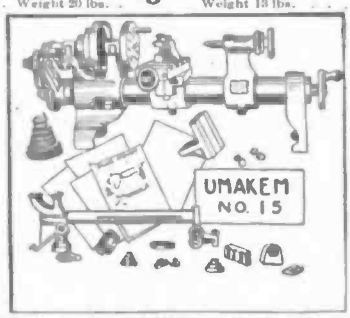


Sewing Stand No. 203
This set contains 3 ply wood, designs and hardware for making this beautiful sewing stand. Weight 13 lbs. . . . $2



Animal Set No. 4
Boxed outfit contains Steel Saw Frame, Blades, Awl, Water Colors, set of Design Sheets, 3 ply Wood, pins and washers, and complete material for making 12 jointed Wild Animals. Weight 6 lbs. $2
Set No. 5 similar but material makes 7 domestic animals. Weight 3 lbs. . $1

Toy Set No. 6
This outfit contains tools, all raw materials and fittings for making one set of above toys worth $6.00. To make more toys all you need is more raw materials. Wgt. 7 lbs. $3



Screw Cutting, Milling Lathe No. 15
Screw Cutting, Milling Lathe can be made complete from the above outfit No. 15, which includes all castings and blue prints. Size 2 ft. 11 in. x 8 in. Wt. 100 lbs. $25

Doll's House No. 9
Outfit contains tools, designs and all materials to make this $15.00 Doll's House. 24 in. high. Weight 25 lbs. $5

Design Sheets, 10c each
No. 2 to 8 shown in No. 3 Set.
No. 9 Action Toy Village Blacksmith.
No. 112A to 112D shown in No. 4 Set.
No. 111A–111B. Domestic Animals.
No. 1A Clown on Kicking Donkey.
No. 10 Doll Furniture Set.
No. 109, 103, 123 shown in No. 6 Set.

Blueprints, 25c each
No. 140 Large Model War Tank.
No. 128 Circus Wagons shown in No. 8.
No. 135 Ark shown in No. 7.
No. 205 Work bench shown No. 205.
No. 208, 8 prints each 25c Airplane No. 16.
No. 209, 2 prints each 25c for J. N. 4 Plane.

W. R. PRICE, Inc.

Dept. 2 UmakeM Building
127 Fifth Ave., NEW YORK

Check the items wanted and enclose with amount. Write name and address on bottom of page.

SCHNOTER'S SUSPENSORIES

YOU can enjoy perfect comfort and freedom. Schnoter's Suspensories and Jock Straps have gained their wide-spread popularity by quality, wear, fit, and low price.

At Drug Stores or sent direct $1.00
Send for booklet of other styles and prices

J. C. SCHNOTER CO.
523 SIXTH AVE. Dept. E N. Y. CITY

Your Prospective Customers

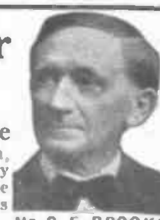
are listed in our Catalog of 99% guaranteed Mailing Lists. It also contains vital suggestions how to advertise and sell profitably by mail. Counts and prices given on 9000 different national Lists, covering all classes; for instance, Farmers, Noodle Mfrs., Hardware Dlrs., Zinc Mines, etc. *This valuable reference book free.* Write for it.

Send Them Sales Letters

You can produce sales or inquiries with personal letters. Many concerns all over U. S. are profitably using Sales Letters we write. Send for *free* instructive booklet, "*Value of Sales Letters.*"

Ross-Gould Mailing Lists St. Louis

Don't Wear a Truss



MR. C. E. BROOKS

Brooks' Appliance, the modern scientific invention, the wonderful new discovery that relieves rupture, will be sent on trial. No obnoxious springs or pads.

Brooks' Rupture Appliance]

Has automatic Air Cushions. Binds and draws the broken parts together as you would a broken limb. No salves. No lies. Durable, cheap. Sent on trial to prove it. Protected by U. S. patents. Catalog and measure blanks mailed free. Send name and address today.

Brooks Appliance Co., 264A State St., Marshall, Mich.

WINTER CARE OF STORAGE BATTERIES

(Continued from page 128)

Independent Charging

To charge a battery from 110-volt direct current with lamp bulbs for resistance, see illustration at Fig. 6. To fully charge an empty battery by this method leave it connected to the circuit for a period of thirty hours, or until each cell of the battery gases freely and each cell shows a specific gravity ranging between 1.275 and 1.300. In charging with the above method great care should be exercised to always connect the positive wire from the charging source to the positive post of the storage battery.

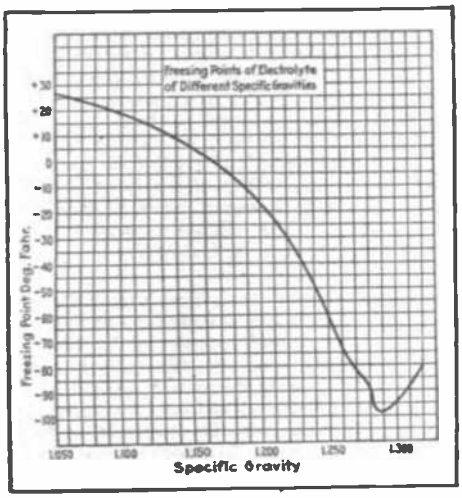


Fig. 5. Chart showing freezing point of electrolyte

To Find the Positive Wire

If a suitable voltmeter is not at hand dip the ends of the two wires into a glass of water in which a teaspoonful of salt has been dissolved, care being taken to keep the wires at least an inch apart. When the current is turned on fine bubbles of gas will be given off from the negative wire, and the positive wire will be free from bubbles.

Using Alternating Current

If an alternating current is available purchase a five-ampere alternating current rectifier. These rectifiers are moderate in price, consist of a small apparatus to be attached to the wall and plugged into an ordinary lamp socket, as shown in cut, and may be obtained through any electric supply company.

When charging with the rectifier the matter of connecting the positive of the charging source to the positive of the battery is not so important as it is when charging from direct current, as the rectifier, as soon as connected, establishes its own proper direction of current, provided the battery is connected to the rectifier before the alternating current is turned on.

It must be remembered that the efficiency of any storage battery decreases with drop in temperature and it is only about 50 per cent. efficient at zero temperature. For this reason the demand for current should be kept as low as possible in cold weather, lamps turned off when not needed, and care taken not to use starter to excess. If the engine is primed with ether or high test gasoline through the petcocks, the starter will perform its functions much more easily.

(Continued on page 137)

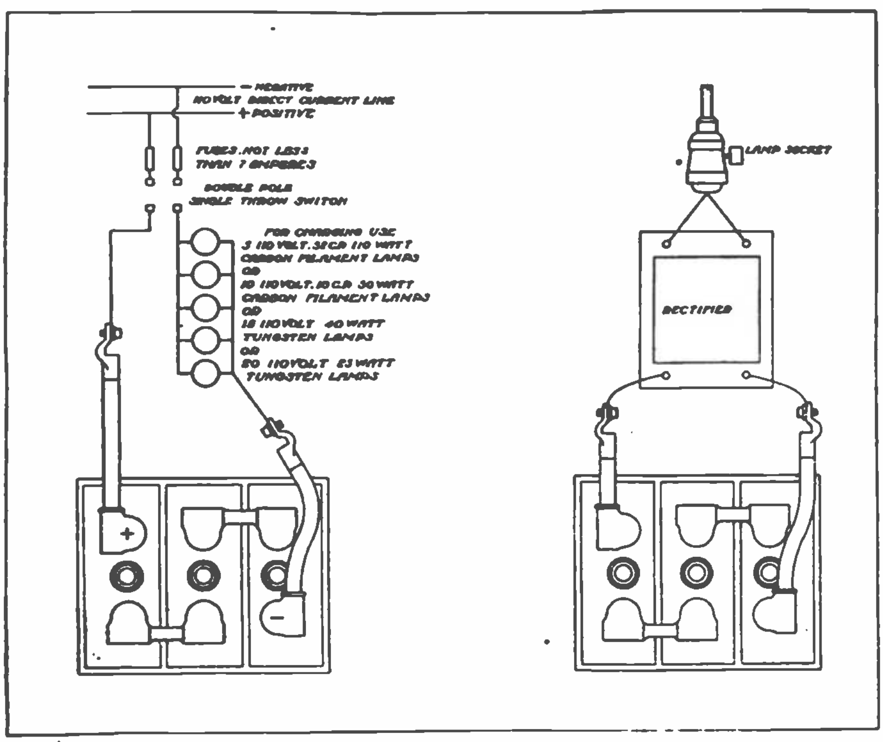


Fig. 6. Methods of charging storage battery from direct or alternating current

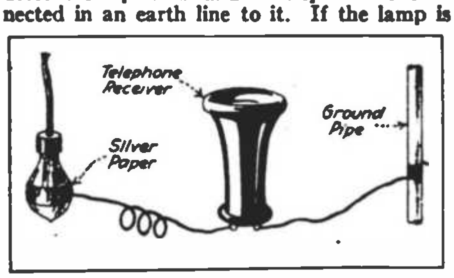
EVERYDAY SCIENCE NOTES

BY PROF. T. O'CONOR SLOANE

Glucinum has long been considered one of the rarer metals. It was discovered by Woehler and Bressy in 1828. It is a constituent of the mineral beryl, whose purer and higher colored varieties are emeralds. It is exceedingly light, with a specific gravity of 1.60 as against 2.60 for aluminum. It forms an alloy with aluminum, reducing the weight from 5% to 30%, according to the percentage in the alloy. It is silvery white in color, harder and more resisting than aluminum and does not oxidize in the air. It makes an alloy with copper similar to aluminum bronze, yellow and sonorous. The crude beryl from which it is extracted contains 11% to 14% of the oxide, or 3% to 5% of the metal. It is found in Madagascar in quantity and also in other localities. The ore is treated at a temperature of 850° C. with sodium fluosilicate; a soluble compound, glucinum fluosilicate, is formed, which is extracted with water and precipitated with sodium. Ninety per cent of the metal can be saved. The salt formed has the formula $Na_2\ Gl\ F_4$; this is the soluble compound just spoken of, dissolving in water. The silica of the mineral is not attacked, and the aluminum forms an almost insoluble compound, $Na_3\ Al\ F_6$.

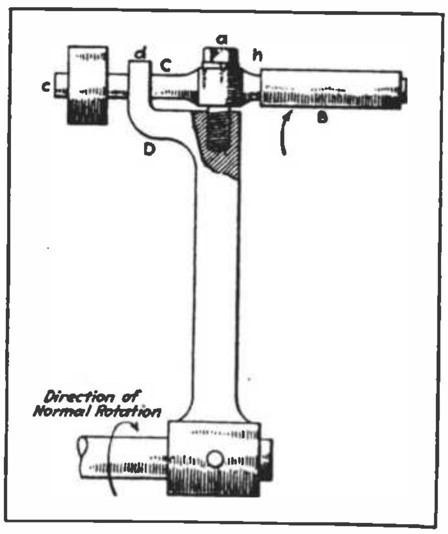
The invention of a machine for so apparently trivial a function as the saving of the filaments of cotton which are left adhering to the seeds after ginning has been noted in these columns. A recent paper by the inventor of the machine in question tells that the production of cotton in the western hemisphere has decreased in the last four years, when it was supposed that it would increase. In the rest of the world the production has fallen off, as was naturally to be expected. There is less produced in the United States than in 1907, and 60% of the product is used in home factories against 40% used in former years. It is necessary to increase the area of land devoted to its production in different parts of the world. A great development of the cotton-seed industry was noted by the speaker. Cotton-seed flour is available as a diluent of wheat flour; it contains five times the protein and fat of the cereal product. It is bright yellow in color; this will presumably operate to greatly restrict its use.

A simple experiment is illustrated in the cut, for which we are indebted to our contemporary "La Nature" of Paris. A band of silvered paper is fastened around an incandescent lamp bulb and a telephone is connected in an earth line to it. If the lamp is



supplied with an alternating current a sound will be prouuced in the telephone. If it is a direct current a sound will be produced on making and breaking the circuit. The phenomenon has been referred to the Edison effect in the original article, but a later writer has denied this.

The illustration shows a recent suggestion for a safety crank for gasoline engines. The crank arm, A, carries at its outer end a journal or pin, *a*, and the handle, B, has a hole near its center, *h* which receives the pin so that the handle can turn freely. It is held on the pin by a nut. An extension, C, of the handle carries a counter weight, c, at its end. A stud, *d*, projecting from the short arm D, only allows the handle to rotate in one direction.



If the motor back-fires, as the crank-handle starts to turn, the inertia of the counter weight, *c*, turns the handle into the plane of rotation of the crank so that there is no projecting handle to strike the wrist or hand and hurt or seriously injure the operator.

Some years ago, before self-starters were in vogue, it was claimed that automobiles injured more people when standing still, than when in motion, the broken-wrists and injuries from back-firing while cranking were so numerous.

A delicate test for the presence of ozone has been found in the use of the coal tar product, fluorescine. A mere trace of ozone will destroy the fluorescent power of this substance. If air containing a trace of ozone is shaken in a flask with some of the substance the presence of ozone will be revealed by its effect on the fluorescine. It is said to be many times more delicate than former tests, and is not interfered with by the presence in the air of chlorine or nitrogen oxides.

An acoustic method of sounding from a moving ship, Marti's method, depends on the velocity of the transmission of sound, as the noise of a detonation is echoed back from the bottom of the ocean. A shell is exploded over the side of the ship under the surface of the water. The interval between the original sound and the second sound due to the echo from the bottom is taken by a chronograph to about 1/1600 second. This gives a degree of accuracy of about one meter, a little over half a fathom. This is at a speed of 10 knots for the ship.

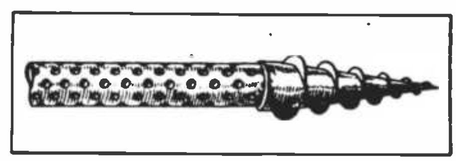
In France experiments with lacquers for aeroplane propellers have been so successful that an expert was brought from China to superintend operations in a works near Paris.

The shrinking on by the use of heat of spiders and armature parts on the electric motor armature shafts is noted in the "*London Electrician*," as being done with much success. In some cases water or steam heat is enough—in other cases electric heating is employed. One case is cited where a very large shaft was increased in heat to only 80° C., less than the heat of boiling water, and it was possible to put a piece in position by the use of a five-ton chain hoist, where to drive it on cold would have required a 600 ton press. The slight expansion was sufficient to give it a shrinking fit.

In meteorological work absolute temperature, i. e., temperature referred to the absolute zero is often used, while with this attempt at scientific accuracy, the entirely artificial barometer scale corrected to 45° latitude has never been abandoned in favor of some definite standard. To improve on this practice it is proposed to adopt the millibar as the unit of barometric pressure. This is a pressure of 1,000 dynes per square centimeter. This would be independent of the variations in the force of gravity at different localities on the earth's surface. As the absolute zero is now determined to be at a point between 273.05° and 273.27° below zero, and as 275° below zero is accepted in practice as the absolute figure it appears that there is room here for improvement in exact scientific work.

During the war it was a subject of wonderment that the English authorities were able to predict the arrival of bombing Zeppelins, so as to be prepared for their reception. Now it is revealed that the Zeppelins were guided by directional wireless from the shore, and these signals picked up by the English on their side of the channel gave them warning long before the arrival of the attacking party.

The engraving shows a drive-well tip. It is provided with a screw, exactly such as used for corkscrews. Above the screw is the



usual perforated pipe. The idea is to screw it down into the earth instead of driving it down with a ram or sledge hammer in the old way, the way which gave the name of drive-well to the wells thus made.

A bath made up of 7 grams copper acetate and 2 grams of gelatine to 750 cubic centimeters of water can be used to give beautiful color effects to copper. With a low intensity current a blue effect results, the anode receiving it. No gas is disengaged. After bluing the piece is washed and immersed in a 5% solution of copper acetate, which treatment gradually changes the shade, so that by arresting the process at one or the other point a variety of effects can be produced. By heating the original solution while the operation is in progress other effects can be produced, such as yellow and irridescent gold. The coating is composed of gelatine and copper.

WINTER CARE OF STORAGE BATTERY

(Continued from page 135)

Miscellaneous Suggestions

If your battery is arranged with terminal posts for wiring connections, these must be examined occasionally to see that they are clean and free from sulphate. The thorough application of a small amount of vaseline at the metal connections to the battery posts will prevent sulphating and consequent corrosion and poor electrical contact at these points. If the electrolyte leaks from the bottom joints or wood sides of the battery case, one or more of the hard rubber cells are cracked or broken. The battery must be returned to the factory for repairs or replacement. The battery box, if of metal, must be thoroughly wiped out with a cloth saturated with ammonia to neutralize the acid and prevent corrosion. The top of the battery must be kept clean and dry to prevent a leakage of current between the terminals.

See that the battery is held securely in its metal box or other container. If necessary, pack tightly with waste to prevent the battery shaking about from jolting of the car. Tools, other metal articles, or anything of value should not be placed near the battery, as the acid fumes will corrode and destroy metal, cloth and like material. Make certain that the battery terminals cannot touch the cover of a metal battery box if such is employed. A thin sheet of wood fiber fitted inside the cover of the battery box will prevent short circuits or grounds from this cause.

Substitute for Clay in Babbitting

As a substitute for clay, which is not always obtainable, in rebabbitting bearing, boxes, another material has been found very practical and economical. It sticks well, will not blow out or soften with hot metal contact, and can be used many times over by the addition of a very small quantity of oil when softening it again. It is far better than clay or putty when either is used alone. Reduce putty with cylinder oil until it is almost as thin as the oil itself; next take some powdered asbestos (old asbestos pipe covering ground up will do) and add to the putty mixture until you get a stiff compound as dense as the putty was in its first state. Use this in any way you would clay and it will give entire satisfaction.

It is an admirable idea to wrap good tools, such as polished pliers, wrenches, etc., in oiled cloths before stowing them away in the tool compartment, as the oiled cloths prevent them from becoming rusty, which is quite likely to happen if the brightly finished surfaces are exposed for any length of time.

Anti-Freezing Solutions for Automobile Radiators

By Kenneth Alton

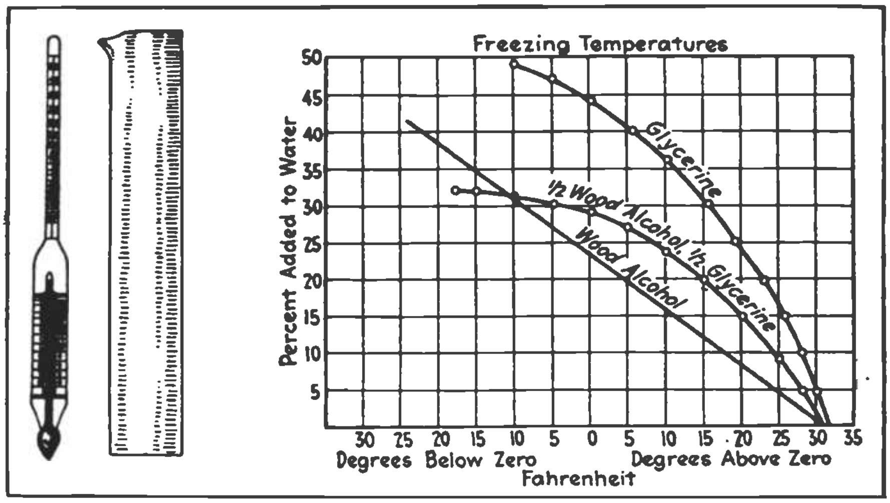
PLAIN water and alcohol solutions would be the best were it not for the ease with which such compounds boil and the rapidity with which the alcohol evaporates. We have seen that the objections advanced against calcium chloride solution because of deposition of salt crystals in the cooling system have ample foundation and that such compounds are not the best to use, the chief advantage, that of cheapness, having been eliminated by the reduction in the price of denatured alcohol. The addition of a little glycerine to an alcohol and water solution reduces liability of evaporation and when used in such quantities it has no injurious effect to speak of on rubber hose.

The tables appended show the various combinations and their freezing points and the proper proportions of the mixtures used must, of course, be governed by conditions of locality, but it is better to be safe than sorry and make the solutions strong enough for the extremes than may be expected. The writer has used both alcohol and water, and glycerine, alcohol and water solutions with good results, though considerable trouble was experienced with alkaline solutions.

The following tabulations give the relative values of solutions commonly employed:

Calcium Chloride Solutions

	Freez. Pt.
2 lb. salt, 1 gal. water	+18° F.
3 lb. salt, 1 gal. water	+1.5° F.
4 lb. salt, 1 gal. water	—17° F.
5 lb. salt, 1 gal. water	—39° F.



Alcoholmeter at left for testing specific gravity of alcohol-water solutions. Chart at right shows freezing points of various solutions

Water and Alcohol Solutions

	Freez. Pt.
Water 95%, alcohol 5%...	+25° F.
Water 85%, alcohol 15%...	+11° F.
Water 80%, alcohol 20%...	+ 5° F.
Water 70%, alcohol 30%...	— 5° F.
Water 65%, alcohol 35%...	—16° F.

Water, Alcohol and Glycerine Solutions

	Freez. Pt.
Water 85%, alc.-glyc. 15%..	+20° F.
Water 75%, alc.-glyc. 25%..	+ 8° F.
Water 70%, alc. glyc. 30%..	— 5° F.
Water 60%, alc.-glyc. 40%..	—23° F.

Alcohol and glycerine, equal proportions.

Annealing Copper and Brass

In annealing copper and its alloys, the quickest method is a reversal of that adopted in dealing with steel. The metal, whether wire, sheet, or castings, is gradually brought to a full red heat, and then either air or water-cooled, in some cases more than one heating being desirable. This produces the greatest softness, but after being compressed by hammering, drawing or rolling, the metal again becomes hard, and the annealing process has to be repeated. Cooling in water gives the best results in most instances, but this is a point which can only be determined by experience. In any case, if not well annealed, the metal is likely to split and it is not difficult to cause damage to work through lack of proper annealing when rolling or drawing.

A little oil on the clutch thrust bearing may facilitate gear shifting by preventing clutch drags. It surely will prolong the life of that important member.

A SIMPLE PRINT TRIMMER

PHOTOGRAPHS, to show to the best advantage should be trimmed, and one cannot trim them to the best advantage unless all four sides are done at once. This result can be attained by using a plate of glass of the size of the largest print you are likely to make, and a pair of shears. If you use a plate camera, a spoiled negative from which the emulsion has been washed will serve the purpose.

When you have cleaned the plate, lay it on the table and beginning at the side nearest you, rule a series of parallel lines, half an inch apart, to within two inches of the opposite edge; then beginning on the left, rule in the same way another series at right angles with the first. Ruling a piece of paper first and placing it under the glass as a guide will make the work easier.

If you make the lines with a drawing pen and water-proof India ink you will not need to renew them for a long time. If you desire greater permanence, do the ruling with a glass cutter.

To trim your prints, hold the plate in the left hand with the ruled side down and with the fingers underneath; then slip the print between the fingers and the glass to such a position that the outer edges of the plate and two selected lines shall coincide with the desired outlines. Trim the two outer sides close to the edges of the plate; turn the print half way round, and trim the other two edges in the same way. The lines will serve as a guide not only to size, but to right angles. You can trim wet or dry plates with equal facility.

J. W. WOLFE.

NEW ISOLATED LIGHTING SYSTEM

This new system is complete in its every detail. It is operated by a Willys-Knight air-cooled sleeve valve motor, and is self-cranking, self-running and self-stopping. The complete plant consists of the engine, a directly connected generator, a simple control box and a storage battery, and last but not least, the engine burns kerosene successfully. The generator is shunt-wound for 32 volts and is designed to deliver 750 watts. Generator, armature, engine fly-wheel and crankshaft are so constructed as to comprise practically a single unit, thus eliminating separate generator bearings and resulting in greatly reduced friction. The battery which has a capacity of 160 ampere hours consists of 16 cells with nine plates to the cell, enclosed in sealed glass jars.

BORING A SQUARE HOLE

THE possibility of boring a square hole has been long thought of and many attempts have been made to accomplish this seeming impossibility. At last the boring of a square hole has

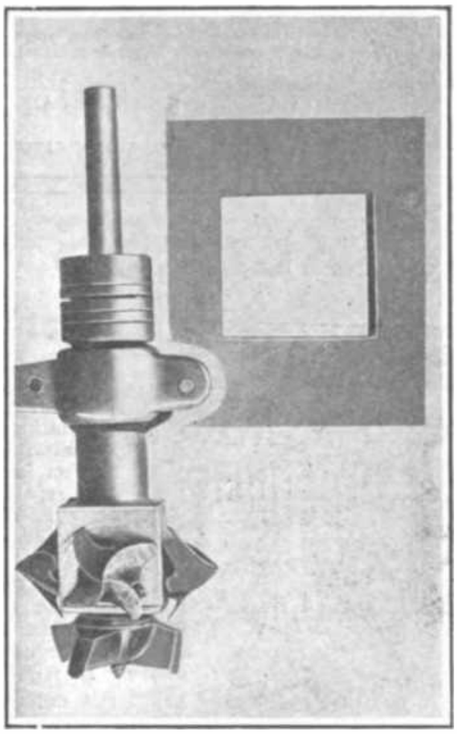


Fig. 1—Special boring head for making square holes

been made possible with a simple, but ingenuous device invented by an Illinois man. The device will not only

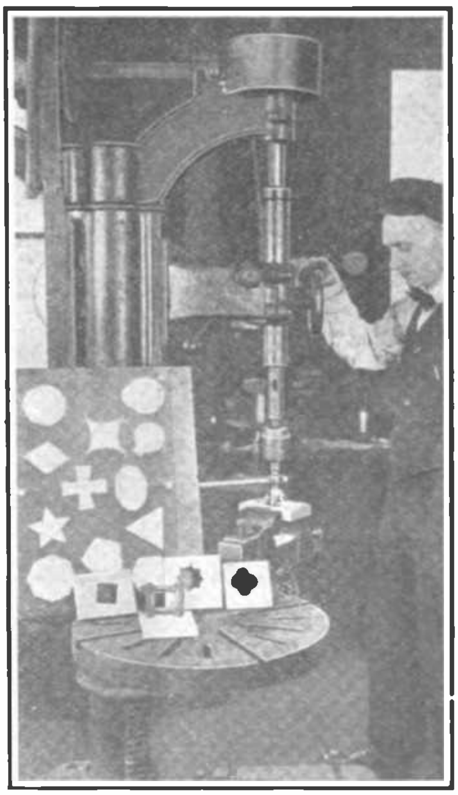


Fig. 2—How tool for boring square holes is used. A variety of work that can be done with it

bore square holes, but it will produce holes with various shapes, by a simple rearrangement of its various working parts.

The operation of the device will be seen by referring to the illustrations. Three triangular shaped cutters are arranged about a square block in such a way that their cutting edges form a square. A larger cutter is placed on the bottom of the tool and it is the duty of this cutter to lead the way for the other four cutters. Thus the bottom cutter bores the center out of the piece being cut while the four side cutters cut away the sides. By changing the shape of the side and bottom cutters it is possible to bore holes with various outlines; stars, crosses, triangles, etc.

As yet, this principle has only been applied to wood and with the present arrangement and type of cutters it would not be possible to cut metals. The need of a metal drilling device that will produce square holes is still as great as it ever was. Wood is so different in physical structure than metal that anything that will work with wood will not function on metal.

A LATHE KINK

The mechanic often has trouble in mounting a circular piece of work concentrically upon the surface plate. If the piece to be turned is not mounted in the center of the face plate the turning marks left by the lathe tool will look very bad.

To mount a piece of circular work for turning, first set the lathe in motion. Then take a piece of chalk and by holding the end on the revolving face plate, draw a circle that will have a diameter just a little larger than the work to be turned. It will then be a simple matter to mount the circular piece within the circle drawn by the chalk.

FINISHING AN ALUMINUM SURFACE

Few experimenters realize that aluminum can be planed with an ordinary wood plane. However, the plane used should be an old one which is no longer needed for other work. Before planing, the surface of the aluminum to be finished should be well covered with kerosene which is used as the cutting compound. The surface should be kept lubricated while the planing is being done. A very light cut should be taken. If the plane is set for too heavy a cut, it will be found impossible to carry on the work. The rough surface of cast aluminum should be smoothed down with a file before the planing is started.

AN EXTRAORDINARY OFFERING

A Standard Wavemeter Condenser, 0.00006 to 0.0015 mfd., $10.

The cancellation of a GOVERNMENT WAR CONTRACT has made it possible for the G. A. Company to give Experimenters this unusual opportunity—a double variable condenser built for the Signal Corps wavemeters, worth $50 at a price of $10. As a WAVEMETER condenser, a finer instrument cannot be purchased at any price. This is your chance to own a real meter. This condenser is of such a high grade type that it is specially adapted for use as a LABORATORY STANDARD for making all kinds of measurements. VACUUM TUBE TRANSMITTERS require air condensers of this type which will not break down between the plates LONG WAVE RECEIVERS must have condensers of large capacity and very low losses to operate with minimum inductance and to give loudest signals. For all these purposes, the DOUBLE CONDENSER is the best you can buy, regardless of the price you pay.

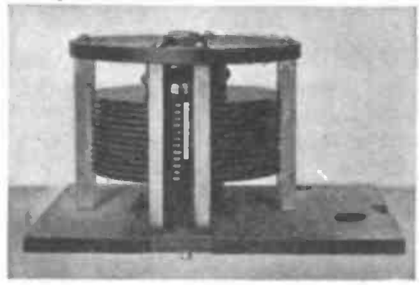
A limited number of these instruments are available. If your order comes too late, your money will be returned, immediately. The G. A. Company gives no credit slips, makes no substitutions.

0.00006 to 0.0015 mfd. condenser, $10.00, sent by express. Capacity calibration curve $1.00.

DON'T LET THIS OPPORTUNITY SLIP BY — YOU WILL NOT HAVE THIS CHANCE AGAIN

Orders accepted by mail only.

15 WEST 45th ST. **The General Apparatus Company** NEW YORK CITY



CONDENSER AS SHOWN, NEVER USED. **$10** ACTUAL VALUE OF THIS INSTRUMENT, $60

"THE 100% WIRELESS MAGAZINE"

What "Radio Amateur News" Is:

With its fifth issue RADIO AMATEUR NEWS holds the field undisputedly as the greatest radio magazine in print today. In point of circulation, number of articles, illustrations, RADIO AMATEUR NEWS now leads all other wireless magazines. Take for instance the November issue with its fifty-six pages; there were fifty-four separate purely radio articles and 114 illustrations. *Over twenty-seven thousand copies were printed and circulated.*

Each issue of the RADIO AMATEUR NEWS now contains 56 pages (or more) and an artistic cover in two colors. The illustrations average 125 every month and there are from 40 to 50 up-to-date articles, some by our biggest radio scientists, in every issue.

RADIO AMATEUR NEWS is the greatest and biggest radio magazine in print today.

RADIO AMATEUR NEWS is the only INDEPENDENT monthly wireless magazine in existence. It caters to no commercial interests—it has no boss save its readers. It is "different"—it has the latest radio news. It is a scientific magazine but it caters largely to the RADIO AMATEUR—it is by and for the Amateur. It is publisht by the publishers of the ELECTRICAL EXPERIMENTER, but there are no duplications of articles in the two magazines. Both are entirely different—but both together will give you ALL the radio news of all the world. Whether you are a professor or an Amateur, get a sample copy or order it from your Newsdealer today.

Partial Contents of November Issue:

- Audio Frequency Wireless Telephone By E. T. Jones
- The Eaton Oscillator and Eaton Circuit Driver By William H. Priess
- Why I Am Opposed to Government Radio Control By Dr. Lee de Forest
- Underwater Submarine Telegraphy
- Developing an Audion for the Amateur By E. T. Jones
- A 170-25000 Meter Receptor By Francis R. Pray
- Second Prize Award, $25.—Radio Contest
- Amateur Radio Broadcast de Navy Department
- Notes on R-34 Return Trip By R. F. Durrant, Lieut. R. A. F.
- San Diego, Cal., from London By Alexis J. Hall
- How Manufacturers Work "Formica" and "Bakelite" By J. Stanley Brown
- Ideas—2nd Spasm By Thos. W. Benson
- Increasing the Secondary Voltage of Your Transformer By F. E. Terman
- Notes on Crystal Detectors By C. H. Byron

EV. EN. 12

Gentlemen: Please enter my subscription for RADIO AMATEUR NEWS for the term of one year for which I enclose herewith $1.50. You will also send to me free, immediately, your great Wireless Course, containing 160 pages, 350 illustrations, size 6¾ x 10", with fine flexible cloth cover. I have added 5c extra for postage.

Name ....

Address ....

City ....

CUT ALONG THIS LINE

SPECIAL OFFER

15c The Copy

$1.50 a Year

Canada and Foreign $2.00 A Year

SEND 15c FOR SAMPLE COPY TODAY

56 PAGES 125 ILLUSTRATIONS

REGULAR DEPARTMENTS MONTHLY

"Radio Telephony," "Radio Constructor," "Radio Digest," "With the Amateurs," "Radio Stories," "Club Gossip," "Junior Section," "New Radio Patents," "I-Want-to-Know."

EXPERIMENTER PUB. CO., 241 Fulton St., N. Y. C.

SCIENCE NOTES

The sensibility of the human eye for light has been investigated by Drs. Coblenz and Emedson of the U. S. Bureau of Standards. A normal eye can see a star of the sixth magnitude, and they determined the energy received from such stars as being only $1.3 \times 10 - 16$ watts of energy, which is $3 \times 10 - 11$ gram-calorie. This infinitesimal amount of heat energy would require 60 millions of years to raise the temperature of a gram of water 1° centigrade.

The radium pastes used on watches and other objects to make them luminous contain about 0.4% of the radium salt. The light may be feebler but is more durable if a smaller proportion of the radium compound is employed. Radium bromide may lose as much as 5% of its luminosity per month, so as to be of but half its original power at the end of six months.

In the United States in 1919, 55 grams of radium were produced, which is half the metal in the world; in 1918 the production was 13.5 grams.

Nichrome is an alloy of nickel and chromium which has been used for some time in electric heating apparatus. It has been tried for chemical vessels with success, as it resists both sulphuric and nitric acids; 85% sulphuric acid acting on it for two months only attacked it to the extent of 0.065% and 45% sulphuric acted on it with about five times this intensity in a single month. Nitric acid acted with five times this intensity, and hydrochloric acid attacked it vigorously.

A curious proposal has been made to shoot projectiles vertically into the air with registering instruments attached to get the data of high altitudes. It is calculated that a small calibre projectile, 1.3 inch diameter, with an initial velocity of 2,500 feet would reach an altitude of about 45,000 feet in 48 seconds. This applies to the regular shaped shell. A specially shaped shell would rise over 75,000 feet in 69 seconds. A shell from a "Big Bertha" would ascend to three times the last named altitude in 125 seconds. The idea seems a curious one but the interest is in the figures. Few realize the altitudes which may be attained by projectiles. The long range gun which was used against Paris is supposed to have owed its long range in part to the rarified air, in which so much of its trajectory lay, offering but little resistance to its motion. The proposal to use captured German artillery for this purpose was made before the French Astronomical Society by M. Pluvinel.

SCIENCE NOTES

An enormous deposit of bauxite, containing from 64% to 67% of aluminum has been found in British Guiana, and has been taken up by the government. It is thought that the water power of the tropical rivers may be available for power to operate the works for producing the metal. Deposits have also been found in Dutch Guiana. Another use for bauxite has been found in the preparation of an abrasive, an artificial emery. To make it bauxite is heated with anthracite to a temperature of 2,000° C.

A compound of alumina, iron oxide and titanium oxide has been prepared by heating red bauxite with anthracite coal to a temperature of 2,000° C. It is red in color, melts at 1,700° C. and is nearly as good an abrasive as Naxos emery. It has been named corindite. Its analysis shows 69.3% alumina, 23.35% ferric oxide, 3.7% titanic oxide, 3% silica, and 0.5% carbon, the latter derived from the coal.

An unaccounted for glow has been observed on the aluminum terminal in an electrolytic rectifier. One of the electrodes was made of lead, and this one showed no glow. The solution was sodium phosphate. The same glow was obtained with other electrodes and solutions, with a very wide range of potential difference. It is still unaccounted for.

A very practical observation on electric lighting is to the effect that the lighting of rooms can often be greatly improved by cleaning the ceiling and reflectors, if the lamps are provided with such. It is stated that the cleaning of the reflectors in one case improved the illumination 25% and treatment of the ceiling some 40%. The tendency to put in new lamps it is suggested should be resisted, as only 15% improvement in the case cited was secured by so doing; the obvious method was the better.

Silicium has now been prepared in two ways, one giving a negative and the other a positive thermo-electric element, as referred to each other. The potential difference is very large; a couple can be made out of the two varieties, which will have a potential difference of 1,000 microvolts for 1° C. difference of temperature. It is essential that it is free from iron. The electro-negative variety is made by crystallization from tin or silver—the other kind by crystallization from aluminum. The metal germanium comes next to silicium in thermo-electric power.

RUSTLESS IRON ALLOYS

Many attempts have been made to obtain a rust proof iron or steel. Of these some were based on the production of a coating of magnetic oxide of the metal itself in a thin coating or covering. The trouble with these attempts was that the coating would crack if the metal was bent or subjected to strains. Yet the Bowers-Barff and similar processes attained a considerable vogue.

At the present time efforts are directed more in the direction of the production of an alloyed iron or steel which will resist rusting. It has been definitely found that wrought iron rusts with comparatively slowness. One of the distinguishing features of wrought iron is the presence in it of a small percentage of slag. One theory is that this is what stops it from succumbing so quickly to corrosion. To the writer a better theory seems to be that it is the absence of carbon that accounts for its resistance. Carbon and iron make a galvanic couple or little battery of particle to particle, and this would favor corrosion.

The following table gives the reactive corrosion of iron, steel and two alloys. It will be observed that the mild steel resisted about as well as the wrought iron, perhaps due to the absence of carbon in any quantity. The samples were exposed to sea-water, fresh water and to the atmosphere:

Wrought Iron............	100
Mild Steel...............	103
3 per cent Nickel Steel.....	77
26 per cent Nickel Steel....	31

The expensive 26% nickel alloy has been used in cases where the quantity was so small that the cost was of little import. It has even been proposed to use a still richer nickel alloy for boiler tubes; a 30% allow will outlast three sets of boiler tubes of everyday steel. In scientific instruments and apparatus an alloy containing 36% of nickel has been used a great deal. It expands but little with rise of temperature, resists corrosion and is of high strength coefficients. Such alloys have a field for use in torpedo and submarine practice. The last named alloy is called Invar metal.

Copper in small quantities retards corrosion. Less than 1% is all that can be present without injuring the metal, unless a third element is present, and nickel has proved to be the desired addition. With nickel present more copper can be added, the copper can even be taken as replacing some of the nickel, and the triple alloy is said to be twenty times more resistant to sea water than steel. This alloy can be produced from the slag from nickel smelters; the slag contains the three metals, and from it the alloy is produced by reduction and refining.

An alloy of iron and chromium, the latter being between 10 and 15%, is also non-corroding and has received a considerable degree of utilization. It also resists corrosion by gases, and this makes it available for the valves in gasoline engines. It has been used for cutlery with great success. Care is said to be requisite in working these steels; the finishing cuts should be of little depth and the final surface should be as smooth as possible. Annealing and hardening are said to help in retaining the rustless qualities.

INDUSTRIAL USES OF TUNGSTEN

The metal tungsten has acquired an immense importance in industry. The name is Swedish and means "heavy stone." From 20,000 to 25,000 lamp filaments can be made from a pound of the metal. Its specific heat is very low, 0.03. It is very difficult to fuse, requiring a temperature of 3,200° C.—and is so hard that it could replace corundum as an abrasive. Its specific gravity—18.5—is so great that it is being thought of as a substance for projectiles, including shrapnel. It would have a long range and a very low trajectory. It is believed that the Germans intended using it for such purposes, and that the submarine the Deutschland took a consignment of it to Krupps. The ore is very scarce in Germany. There are three principal ways of making it. One is to precipitate the hydroxide from solution and reduce with hydrogen at a high heat. Another is to reduce it in the electric furnace and a third process uses the well known thermit reaction. It has three times the electric resistance of copper and is 50% stronger than iron. A trace of carbon makes it brittle. It has risen enormously in price and there is said to be a regular "tungsten fever" in South America, presumably in the same order as the Texan "oil fever."

BRITISH OUTPUT OF SHELLS

In Great Britain during the war 200 million shells and 26,430 big guns were made. In one week in August, 1918, 2,900,000 rounds were fired, and in a single day in breaking the Hindenburg line 943,300 shells were expended, the weight was 40,000 tons. The factories which turned out these great quantities of war materials are making all sorts of products, from tool work to mechanical toys and are repairing trams and doing weaving, dyeing and finishing.

EVERYDAY ENGINEERING MAGAZINE

2 WEST 45th STREET NEW YORK CITY

You may enter my subscription to EVERYDAY ENGINEERING MAGAZINE for........years at $1.50 per year (Canada, $1.75; foreign, $2.00). Please let this start with the........................ (Date of issue) issue. I enclose $................, and according to your special offer send me copy of book checked off.

Name ....

Street ....

City ....

State ....

TEAR OFF AND MAIL THIS NOW

EVERYDAY ENGINEERING SERIES OF HANDBOOKS Check off title desired here		
1	HOME MECHANIC'S WORKSHOP COMPANION	
2	HINTS AND TIPS FOR AUTOMOBILISTS	
3	HOW TO MAKE AND USE A SMALL CHEMICAL LABORATORY	
4	SOLDERING AND BRAZING	
5	RADIO HOOK-UPS	
6	DESIGN DATA FOR RADIO TRANSMITTERS AND RECEIVERS	

SCIENCE NOTES

The Pratt and Whitney Co. has been producing gauge blocks which are tested for accuracy to one millionth of an inch. There are two things to be tried, one is the flatness of the face and the other is the thickness of the block and parallelism of the faces. A plate of glass placed on the surface will show interference bands of color. If the band is curved it indicates an error in the block of one half a wave length of the light employed if its curvature is equal to its own width. If the green ray of the mercury vapor lamp is used the wave length would be .0000215 inch; as it is a simple matter to read to one-tenth the width of the band, the reading will disclose the error of one-millionth of an inch. To test the parallelism of the faces two blocks are placed close together and the plate rests on both. Regularity of the lines indicates identity of the blocks. The method is due to W. E. Hoke of St. Louis.

Attention is being given to the use of pulverized coal, and in the United States 12 million tons are pulverized per annum. In reheating steel in a furnace having an output of 168 tons per day there was a saving of 2% owing to the fact that with pulverized fuel the steel scaled very little. The reason is that the air is kept down to a much lower percentage than is possible with full size coal. One ton of steel can be melted with one-fifth of a ton of fuel. In the electric furnace the efficiency is 35%, in the producer gas furnace 48%, with pulverized fuel 55%. Fine grinding is essential and the coal after it is pulverized must be dried.

Where wood beams are to be bolted together in Sweden a corrugated washer is being used. It is 1/16th inch thick and the corrugations are 9/32nd inch deep. It is placed between the surfaces and the pieces are drawn together by a bolt with flat outside washers. The grip is given by the corrugated washer which imbeds itself in the wood under the pressure. No knots must come in the way; if present they must be removed. The joint is made twice as strong by this simple arrangement.

In France steel belts working on magnetic pulleys have been tried. The wheels are magnetized by helicoidal coils of wire. One-inch width of belt will transmit as high as 800 horsepower. They can be speeded up to 18,000 feet per minute. They are the subject of a French patent.

SCIENCE NOTES

It is estimated that in Germany during 1918 95 million pounds of paper yarns were made, yet it is not believed that a substitute for cotton is even in sight. Home grown fibres for cloth are believed to have been largely a bluff. To make paper yarn narrow bands of paper were twi·:cd in a machine at the rate of 5,ιυ00 to 6,000 turns were minute, and w.·:t treated with a special glue made water proof with formaldehyde. Such yarns stood twenty-four hours immersion in water. The yarn was available as a jute substitute for bags and the like. The writer remembers a time when paper twine was in somewhat limited use in this country.

The purification of the water of the Thames is being accomplished with considerable success by chlorination. A quantity of 0.44 parts of available chlorine in one million parts of the water to be purified is sufficient. This requires 13.33 lbs. of 33% bleaching powder per million gallons. Sometimes super-chlorination is employed, liquid chlorine being used to make a solution which is added in greater quantity than in the first process, and after it has reacted and done its work sulphurous acid is added to destroy the excess of chlorine.

In England some attention is being given to the possibility of using a mixture of benzol and alcohol for motors. A mixture of 75% alcohol and 25% benzol is reported as working perfectly. The production per annum in that country of benzol is 44 million gallons per annum, but it is claimed that the output could be brought up to the volume of all the gasoline now imported. A tree, the mahwa tree, is reported from the Deccan in India, whose dried flowers yield 70 gallons of 95% alcohol per ton, which is five times the yield of potatoes.

Experiments with acetylene in explosion motors have given the following results: If the gas was taken directly from a generator it was found that 2¼ lbs. of carbide went about as far as 1½ pints of gasoline. In France eight different concerns carried out experiments. The 2¼ lbs. of carbide were taken as giving one horse-power hour.

A new tap is described in a contemporary, which is provided with spiral grooves, which operate to keep the tap clear of chips. It presents the exact appearance of a threaded twist drill, and should operate extremely well in freeing itself when cutting a thread.

SCIENCE NOTES

Mr. W. R. Gregg of the Weather Bureau Service from the records of past years has investigated the weather conditions on the trans-Atlantic air routes. The best western-bound routes he finds to be these three: 1. Scotland, Iceland, Greenland, Labrador. 2. Portugal, West Indies. 3. Africa near Cape Verde, Brazil. For east-bound flights the two already successfully taken he considers the best. Consulting records he found that May might average 11 favorable days for the Newfoundland-Portugal route, and 12 such days for the Newfoundland-Ireland route. For the return over the same routes only 2 good days could be looked for. In June, the good days were about half as many. In July, 1906, there were 28 good days—in July, 1907, there were only 4. He considers that in the present state of the art favorable weather is essential, and that the western journey conditions are seldom favorable. He finds little difference between summer and winter conditions.

A reinforced concrete ferry boat recently met with an accident in launching at a shipyard in India, when it fell six feet, and had a number of holes made in it as it struck the surface beneath. The sides were three inches thick. The holes were patched up and the boat was found to be as good as ever. Recently an ocean-going concrete ship went ashore but was got off and proceeded on her journey apparently uninjured.

In France sources of helium have been found in some of the thermal springs. The gas from Maizieres contains 5% to 6%—that from Sautenay as much as 10% and Bourbon Lancy 2%. The latter is about the maximum found in natural gas in this country. It is believed that the Norton process will greatly reduce the cost of manufacture compared with the Linde and Claude processes.

Metallic glucinum alloyed with 1% to 5% of aluminum is said to be superior in many respects to pure aluminum, being of better mechanical properties and also lighter. Glucinum is found as a constitutent of the mineral beryl, which in its precious variety is the emerald.

Selenium is stated to be a better vulcanizer for india rubber than sulphur. The operation takes more time, about twice as long; 0.3% to 0.5% of nitrophenol is used as an accelerator. Selenium is found in some quantity in the Argentine Republic.

Be sure and Read the Announcement of Everyday Engineering Series of Informative Hand Books on Pages 156-157.

To Fasten Linoleum on Iron Stairs

Use a mixture of glue, isinglass and dextrin, which dissolved in water and heated, is given an admixture of turpentine. The strips pasted down must be weighted with boards and brick on top until the adhesive agent has hardened. Soak three parts of glue in 8 parts water, and ½ part hydrochloric acid and ¾ part zinc vitrol and let this mixture boil several hours. Coat the floor and the back of the linoleum with this, press the linoleum down uniformly and firmly and weight it for some time.

Cutlers' Cement for Fixing Knife and Fork Blade Tangs In Handles

Formula 1

	Pounds
Rosin	4
Beeswax	1
Plaster of Paris or Brickdust	1

Formula 2

Pitch	5
Wood Ashes	1
Tallow	1

Formula 3

Resin, 12; sulphur flowers, 3; iron filings, 5. Melt together, fill the handle with hot, and insert the instrument.

Formula 4

Rosin	600
Sulphur	150
Iron Filings	250

Pour the mixture, hot, into the opening of the heated handle and shove in the knife likewise heated.

In the siege of Paris in 1871, 64 balloons left the city to effect communication with the outer world. Of these 57 were successful; they carried 155 people, 9 tons of dispatches and 3 million letters. To get answers back homing pigeons were carried on the balloons, and these brought back letters photographed down to miniature size. A solitary battle of German and French balloons is chronicled; the Frenchman won.

A curious and interesting feature of the electric iron ore reducing furnace has been recently noted. The electric heat operates to reduce the iron at the expense of the carbon of the fuel; as the electricity supplies the heat no air is blown in as is the case with the blast furnace, so that only one-eighth the volume of gases is generated as in the blast furnace, but owing to the small amount of nitrogen and carbonic acid gas, one or both, the calorific value of the escaping gas is three times as great as that from the blast furnace.

MAIL PLANES TO USE NEW FUEL

A NEW fuel consisting of alcohol, benzol and ether is announced to take the place of the high-grade gasoline, which has been used widely in the Air Mail Service. The new fuel has been tested under adverse weather conditions. As soon as the new carburetors required for the proper use of this fuel are attached, all airplanes operating on mail service routes will use the new fuel.

The advantage of this fuel lies in the resulting cleanliness of the engine, reduction in the cost of upkeep and its burning cooler than gasoline, which to some extent overcomes the objection to a high-compression engine when operating at low altitudes. It requires about four-fifths as much of the new fuel for any given distance and altitude. This gives greater flying radius to the planes and will enable the De Haviland Fours to cover the New York to Cleveland route, a distance of 430 miles, in a non-stop flight. It will minimize the probability of forced landings by keeping the spark plugs and the engine cylinders clear of carbon deposits and accumulations of oil. The super-compression Liberty and Hispano-Suiza engines used in aerial mail planes are particularly well suited to this alcoholic fuel.

PRACTICAL MUFFLER FOR AIRCRAFT ENGINES

After a series of tests, a new muffler has been adopted by the French Air Service which is claimed to not only result in complete silencing but which also prevents any fire or exhaust flame reaching the air which gives it marked advantages for dirigible balloons as well as airplanes.

This consists of a long tube with a closed end forming a continuation of the exhaust manifold. The tube has a series of hollow longitudinal fins of triangular section about its exterior. Communication is made from the interior to these fins by a series of holes about 1/8 in. in diameter. Along each face of the fins a large number of louvres are cut through which the exhaust gases reach the air. By reason of the fins and the shape of the louvres a partial vacuum is formed, and a continuous suction is created along the length of each fin.

The tests made by the French gave an increase in power when using this apparatus compared with a straight manifold outlet. The action of the wind and the escape of the gases cause a continuous whistling sound, but on the demonstrating plane with two engines, each of nearly 300 h.p., it was possible to carry on a conversation as easily as in a room.

VARIOUS WAYS OF STARTING GAS ENGINES

NOT every motorist, as he presses his starter pedal, stops to think how fortunate he is that the process of cranking the engine has been so simplified for him. Electric starters were developed because the old method of cranking by hand proved intolerable to the exacting American motorist. Yet hand starting of an automobile engine is child's play compared with the methods necessary to start some other types of engines.

When a tractioner starts the engine of his big "caterpillar" he fits a bar into one of a series of sockets in the big engine's flywheel and rocks the engine up to compression. No one can spin these monsters. Rarely can they be rocked past compression, but are usually rocked backward up to compression, where, thanks to generous priming and a hot spark, they usually fire and the wielder of the pinch-bar pulls it from the starting socket hastily. The petty officer on a submarine chaser relies upon compressed air to start his unwieldy engines. He, too, must prime copiously and has the additional responsibility of an auxiliary engine, hand-started to pump the air.

A most picturesque but risky method is ordinarily used to start airplane engines. The mechanic shouts: "Switch off; throttle open!" as he approaches the propeller, and is answered in kind by the pilot at the switch. He then spins the great wooden blades by hand to charge the cylinders with gas. Having worked up a warm perspiration, even on the frostiest mornings, he springs clear and shouts: "Contact; throttle closed!" The pilot indicates that he has closed the switch and throttle by repeating the signal and the mechanic once more approaches the propeller. Gingerly this time, however. With a single swift motion he twirls the blade through an arc of more than 90 degrees and steps quickly away from and to the side of the murderous whirling stick.

A 150-horsepower engine is about all any but a Samson can swing. When heavier engines, culminating in the 400-horsepower Liberty, made their appearance, new methods had to be devised. At first the blade was pulled over compression by running past it, giving it a smart pull in passing. Sometimes two men with hands joined were required. As many as three were required to do the preliminary "winding up" or charging. More than one unwary mechanic was sucked into the whirling circle of the propeller and injured before a safer method was devised.

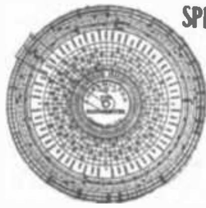
Owing to their added weight and complication, electric starters were not considered seriously except on seaplanes during the war, but an ingenious auxiliary magneto was contrived. This magneto was operated by a small hand crank in the pilot's cockpit. The engine was charged in the usual way, whereupon the mechanic stepped back, shouting "Clear!" The pilot then closed the switch and turned the crank on the starting magneto a few times. The charged cylinders received a shower of white-hot sparks and failure to start promptly was exceptional. With the Dixie starting magneto a lone pilot might start a 400-horsepower engine unaided, a thing previously impossible, unless the engine is equipped with an electric starter or an air starting mechanism.

The same company has greatly simplified the starting of big truck and tractor engines by applying the impulse starter to the regular Dixie magneto. This contrivance comprises a driving coupling, which, with the engine idle, is not solid as the conventional coupling is. When the engine is cranked, the first motion merely compresses a spring, with the magneto stationary. At a predetermined point a trigger is tripped and the magneto twirls around at high speed for part of a revolution. This naturally generates a hot starting spark, even though the engine may be turned over very slowly. Two or three snaps of this sort generally suffice to start the engine and no auxiliary battery or coil is required. When it starts running, centrifugal force acting on weights locks the coupling solid, so that it drives as the ordinary rigid coupling and there can be no change in time of sparking.

Blueing Iron or Steel.—Dissolve $4\frac{1}{2}$ ozs. of hyposulphite of soda in a quart of water and $1\frac{1}{8}$ ozs. of acetate of lead in another quart of water. Mix the two solutions and heat until boiling. Immerse the clean and bright pieces of iron or steel to be colored. The metal becomes a rich blue color which is more lasting than the color produced by tempering.

Bronzing Cast Iron.—Clean the metal and polish it smooth. Apply a coat of sweet or olive oil evenly over the surface and heat the iron, taking care that the temperature does not rise sufficiently to burn the oil. Just as the oil is about to decompose, the cast iron will absorb oxygen and this forms a brown oxide skin that is so hard it will admit of a high polish, giving the iron surface the appearance of bronze.

When testing the air pressure in your tires do not overlook the spares. It will be very aggravating if you have a puncture and find your spare is not inflated. Besides, it is much easier to inflate it with an air hose connected to a power compressor in the garage than with a hand pump on the road.



The Everyday Engineering Series of Handbooks

The Experience and Knowledge of Experts Condensed and Simplified for the Handy Man—the Mechanic and the Radio Experimenter

ILLUSTRATED BY SPECIAL DRAWINGS AND PHOTOGRAPHS

HOME MECHANIC'S WORKSHOP COMPANION

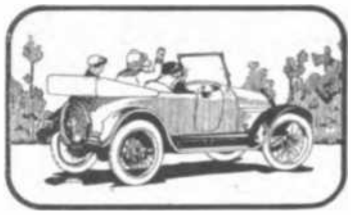
TELLS HOW TO DO MANY USEFUL ELECTRICAL AND MECHANICAL THINGS INCLUDING NUMEROUS SHOP KINKS

By
ANDREW JACKSON JR.

①

EVERYDAY ENGINEERING SERIES
NORMAN W. HENLEY PUBLISHING CO.
2 WEST 45 TH. STREET, NEW YORK

HINTS AND TIPS FOR AUTOMOBILISTS



MONEY SAVING HINTS ON CARE AND OPERATION ALSO LOCATION AND REPAIR OF ROADSIDE TROUBLES

By
VICTOR W PAGE

②

EVERYDAY ENGINEERING SERIES
NORMAN W. HENLEY PUBLISHING CO.
2 WEST 45 TH STREET, NEW YORK

HOW TO MAKE & USE A SMALL CHEMICAL LABORATORY

AN INTRODUCTION TO THE STUDY OF INORGANIC CHEMISTRY WITH DIRECTIONS FOR THE CONSTRUCTION OF A SMALL LABORATORY

By
RAYMOND FRANCIS YATES

③

EVERYDAY ENGINEERING SERIES
NORMAN W. HENLEY PUBLISHING CO.
2 WEST 45 TH. STREET, NEW YORK

For the Handy Man in the Home or Shop

There has always been a demand for a hand book of mechanical instruction that would help the average everyday man to do the many small jobs of repair work that are found around the home and shop.

This treatise includes a compilation of useful suggestions that cannot fail to interest the handy man and while it is not intended for mechanical experts or scientists, it will prove to be a veritable store of information for any one who desires to rig up a small shop where odd jobs can be carried on.

The subject matter is divided in five parts as follows:

Chapter 1—The Home Workshop and Its Equipment. Chapter 2—Special Tools and Shop Expedients. Chapter 3—Useful Home Appliances. Chapter 4—How to Do Things Electrical. Chapter 5—Helpful Recipes and Formulae. The illustrations are especially clear and all suggestions are further amplified or made more easy of comprehension by hundreds of thumb nail sketches made by the author.

For the Automobile Owner or Driver

This volume is replete with interesting facts compiled by an expert from a mass of information furnished by the Service Departments of leading automobile makers on operation, upkeep, lubrication, location of troubles and simple repairs of automobile parts. The instructions given are concise and to the point and no information that will help in the everyday operation of automobiles is omitted.

The book is ideal for the busy man or woman who wants to know about car operation and upkeep because of the economies possible when an automobile is intelligently operated. It contains many money saving hints and a brief simple exposition of location and remedy of roadside troubles apt to occur under ordinary operating conditions.

To permit of logical presentation, the subject matter is divided into four chapters. Chapter 1 deals with the Control and Operation; Chapter 2, Systematic Inspection and Lubrication; Chapter 3, Power Plant and Auxiliary Groups; Chapter 4, Automobile Care and Maintenance Suggestions.

For the Student Chemist and Experimenter

The treatise covers all of the essentials of elementary chemistry. The law of definite proportions, solutions, crystalloids, colloids, electrolysis, etc., are explained. The second part of the book is devoted to chemical and electro-chemical experiments. Only those experiments that will tend to broaden the readers' knowledge of chemistry in general have been chosen.

The third part of the book describes the construction and fitting out of the home chemical laboratory. Directions for the construction of the many simple pieces of chemical apparatus are given. A chemical balance, ring stand, electric furnace, etc., are described in detail, with working drawings. The manipulation of chemical glassware is also treated.

This book gives all the necessary information for a well-grounded understanding of chemistry. It will not only be a help, but an inspiration to study further into this fascinating realm of science.

A SPECIAL OFFER TO READERS OF

ANY ONE OF THE ABOVE VALUABLE WORKS WILL BE

FILL OUT THE SPECIAL BLANK ON PAGE 148 OF THIS ISSUE. CHECK OFF THE TITLE DESIRED AND MAIL TO

Should be in Every Experimenter's Library

All of these Books are written in Simple Non-technical Language and contain Information of Real Value on Subjects of Timely Interest

RADIO BOOKS CONTAIN MANY WIRING DIAGRAMS

SOLDERING & BRAZING

A USEFUL HANDBOOK FOR MECHANICS

By

RAYMOND FRANCIS YATES

④

EVERYDAY ENGINEERING SERIES
NORMAN W. HENLEY PUBLISHING CO.
2 WEST 45 TH. STREET. NEW YORK

RADIO HOOK-UPS

A BOOK OF THE MOST ADVANCED CIRCUITS OF RECEIVERS, AMPLIFIERS AND TRANSMITTERS FOR DAMPED AND UNDAMPED WAVE WORK:

By

M. B. SLEEPER

⑤

EVERYDAY ENGINEERING SERIES
NORMAN W. HENLEY PUBLISHING CO.
2 WEST 45 TH. STREET. NEW YORK

DESIGN DATA FOR RADIO TRANSMITTERS & RECEIVERS

SIMPLE METHODS FOR DESIGNING APPARATUS ACCORDING TO ADVANCED AND APPROVED PRACTICE

By

M B SLEEPER

⑥

EVERYDAY ENGINEERING SERIES
NORMAN W. HENLEY PUBLISHING CO.
2 WEST 45 TH STREET. NEW YORK

For the Mechanic and Model Maker

This treatise gives all the necessary "kinks" that will enable one to accomplish successful soldering. If a mechanic has not succeeded in his soldering, this book may tell him just what he needs to produce good work—something that he may heretofore have forgotten.

Hard soldering, for some reason, is not generally known. Hard soldering, however, is very important and must be used in all cases where soft solder does not possess sufficient strength. Hard soldering and solders are thoroughly covered in the book. Nothing has been omitted that will enable the mechanic to apply hard solder successfully.

Brazing and all of its important ramifications are treated in detail. Brazing, like hard soldering, is a process little understood by many mechanics. The book "Soldering and Brazing" is divided in five parts as follows: Part I—Soft Soldering; Part II—Hard Soldering; Part III—Brazing; Part IV—Heating Devices; Part V—Soldering Notes.

For the Radio Experimenter and Amateur

In this book, the best circuits for different instruments and various purposes have been carefully selected and grouped together. The result is a comprehensive summary of radio circuits for tuning coils, loose couplers, capacity coupling, variometers and other equipment for receiving long and short damped and undamped waves; damped, undamped and modulated wave transmitters using buzzers, spark coils, transformers, arcs and vacuum tubes, telephone transmitters, laboratory oscillators, vacuum tube characteristic measuring circuits, wave-meters, and audibility meters—in short, diagrams for every purpose.

A special feature of this book is the explanations which accompany each circuit, giving construction or operating details. Spaces are also provided for notes on the results obtained with each diagram. This arrangement, coupled with the skillful selection of the circuits, makes Radio Hook-ups an essential to every radio experimenter or operator.

For the Radio Engineer and Student

Far from being a collection of formulas, Design Data takes up in proper sequence the problems encountered in planning all types of receiving sets for short, medium, and long wave work, and spark coil, transformer, and vacuum tube transmitters operating on 200 meters.

Where formulas are difficult, tables have been worked out so that values can be found without the use of mathematics. The few formulas given are so simple that any school boy can solve them. The subjects are so arranged that, having decided upon the type of receiver or transmitter to be built, the reader can locate immediately the problems and solutions required.

In Design Data, radio experimenters are given such information, readily accessible, as to make it possible for them to have modern and highly efficient equipment and to get the best possible results from the instruments they make or buy.

EVERYDAY ENGINEERING MAGAZINE

SENT FREE FOR EACH NEW OR RENEWAL SUBSCRIPTION

EVERYDAY ENGINEERING MAGAZINE, 2 W. 45th ST., NEW YORK CITY

OPPORTUNITIES FOR INVENTORS

THE equipment section of the engineering division of the Army Air Service is anxious that inventors and designers in general and members of the society in particular lend their efforts in the development of certain airplane equipment. Among these is a gasoline tank which will withstand a salvo of 30 calibre ammunition, equally mixed, service, tracer, incendiary and armor-piercing bullets, fired at a range of 30 yards and at the most vulnerable angle. There are to be ten consecutive tests on as many tanks without fire occurring. The weight should be kept as low as possible, the maximum limit being 75 per cent more than standard tank weights.

Air bag floats, landing skids, etc., to prevent the machine from capsizing when landing in water and to keep it afloat after landing constitute other problems requiring solution. Such devices should present as small an amount of wind resistance surface as possible, should be light and readily detachable.

A mobile independent cranking device, mounted on a small motor truck, is also desired. The device should be electrically driven and arranged so that it can be backed up to the front end of an airplane and attached to the propeller by a flexible arm. The electric motor is then used to crank the engine, causing it to begin firing. When the engine picks up, the device should be automatically thrown out of connection with the propeller.

A gasoline supply gauge is needed which will be responsive, serviceable and accurate to the last half gallon. It may be mounted on the tank, although it should preferably be mounted on the dashboard. This gauge must, of course, register under conditions existing in airplane service where the center line of the tank changes rapidly from one to another of practically every plane that it is possible to assume, and is frequently 180 deg. out of its normal position for comparatively short intervals of time.

At present portable canvas hangars for field service do not weather winds or rainstorms well enough to be practical, and they are generally too small. The improved hangar should be capable of housing four De Haviland planes with working space. They should provide for the necessary electric lighting and small machine work.

PATENTS

To the Man with an Idea

I offer a comprehensive, experienced, efficient service for his prompt, legal protection and the development of his proposition.

Send sketch, or model, and description, for advice as to cost, search through prior United States patents, etc. Preliminary advice gladly furnished without charge.

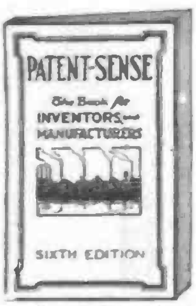
My experience, and familiarity with various arts, frequently enable me to accurately advise clients as to probable patentability before they go to any expense.

Booklet of valuable information and form for properly disclosing your idea, free on request. Write today.

RICHARD B. OWEN
PATENT LAWYER
Owen Building, Washington, D. C.

Free Book on PATENTS

Write today for a Free Copy of "How to Obtain a Patent." Contains valuable information and advice to investors. Tells how to secure Patents. Send model or sketch of your invention for opinion of its patentable nature—Free. (20 years experience.) Talbert & Talbert, 4368 Talbert Bldg., Washington, D. C.



The Book for Inventors and Manufacturers

SIXTH EDITION

By return mail FREE.
Write LACEY & LACEY
Dept S. Washington, D.C.

Competent Patent Service

By a Former Examining Official of the U. S. Patent Office

NORMAN T. WHITAKER
Lawyer and Engineer
580 Whitaker Bldg. Washington, D. C.
Branch Office, 87 Nassau St., New York City
INQUIRIES INVITED

PATENTS

Record your invention. Upon request, I will forward to you my form "Fixing the Essential Dates of Invention", together with full information concerning its use and the best way to secure patent protection. Prompt, personal efficient service, by an attorney-at-law, having over twelve years experience in patent matters. Reasonable pre-war charges. B. P. FISHBURNE.
321 McGill Bldg., Washington, D. C.

Making Your Invention a Financial Success

How best to dispose of your invention
What kind of agreements to make for your protection
What kind of offers and mistakes to avoid
Valuable tables and other data

By M. G. Delaney, an experienced Inventor, in

The Inventor's Manual of Valuable Information

$1.00 per copy, postpaid

Additional information and Table of Contents will be mailed on request.

G. E. Perry Co., Publishers, 1328 Broadway, New York

96-Page Book Catalogue Sent Free

WE have just issued a 96-page Book Catalogue listing about 2,500 of the most recent Scientific and Technical books. This is all the more welcome by reason of the fact that both the publishing and importing of books have been very much upset by the war, and many books can only be supplied with great difficulty. This catalogue will be sent to any address in the world, free on request.

Manuscripts Considered for Publication

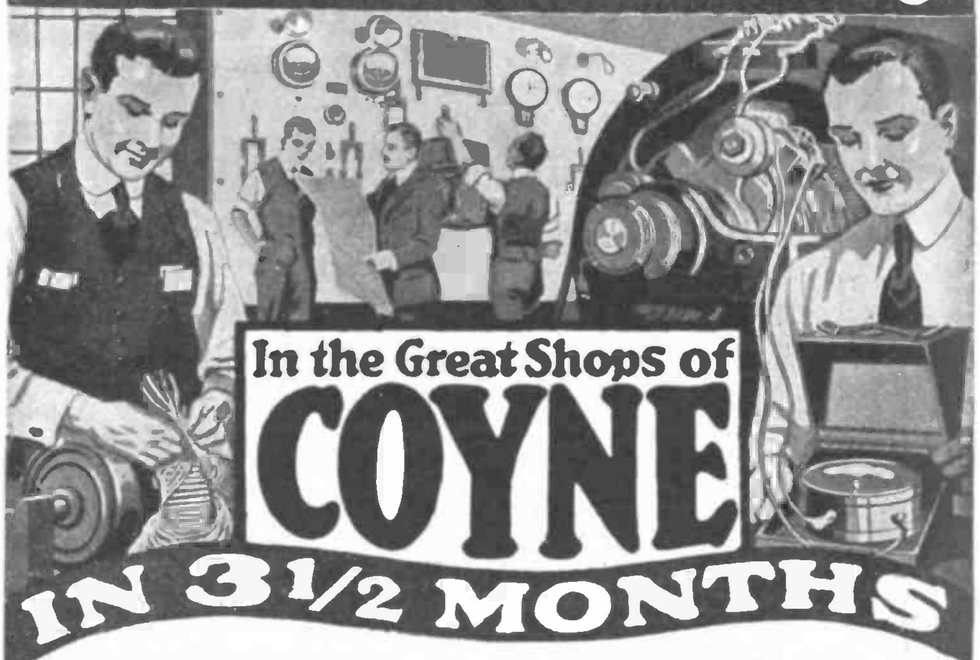
The Book Publishing Department of the SCIENTIFIC AMERICAN will be glad to give an examination of any manuscript of Scientific or Technical nature. Submit as much of matter as possible, including illustrative material. There was never a better field for books of this nature than at the present time.

Scientific-American Publishing Company
Woolworth Building 233 Broadway, New York

EVERYDAY ENGINEERING MAGAZINE SERVICE DEP'T

Readers of this magazine are invited to write for any information relative to procurement of supplies, technical or practical books, tools, etc., they need to carry on their experimental work most efficiently. Our Service Dept. manager can render you valuable aid if you avail yourself of this privilege. All inquiries will receive prompt attention, and to insure proper service, the writer should enclose a stamped self-addressed envelope or postal card.

Learn Electricity



Thousands of Electrical experts are needed now. Come to the great shops of Coyne and let us train you quickly by our sure practical way backed by 20 years of success.

Earn $125 to $300 a Month

Come to Coyne where experts train you on the actual apparatus. You work on everything from the simple bell to the mighty Generators, Electrical Locomotives and Power Plants. Everything to make you a Master Electrician. Look at the picture taken from life in our shops.

Become an Expert in 3½ Months

No need of taking 1 to 4 years to become an expert. We have proved this in thousands of cases. We are the only school teaching by the original Coyne methods, which means no books, no classes—all practical training.

Earn Your Way. Our employment department will help every ambitious man to earn a part of his expenses—without charge.

Bennett W. Cooke, Director
COYNE TRADE AND ENGINEERING SCHOOLS
Dept. 16X 39-51 E. Illinois Street
CHICAGO, ILL.

LEARN DRAFTING

The country needs hundreds of skilled Draftsmen in all lines at big salaries.

Coyne is the only school in the country that gives you the advantages of big shops full of construction and machinery. This makes our drafting courses practical, just like the job you'll have when you graduate. You can't get this in any other school.

WE TEACH ELECTRICITY, DRAFTING, MOTION PICTURE OPERATING AND PLUMBING

We teach all these professions in such a thorough, practical way that when you finish you can step right into a position of responsibility and big pay.

Fill out the coupon *now* and send it for our big free book of information. It tells what others are doing and have done, what you can do.

Be sure and check the trade that interests you. Do it now.

COYNE SCHOOLS
Dept. 16X 39-51 E. Illinois St.
CHICAGO, ILL.

Please send me that big free book. I'm interested in:

☐Electricity ☐Drafting ☐Plumbing
Motion Picture Operating

Name ....

Address ....

CAMELS supply in a lavish way everything you ever hoped to find in cigarettes! Camels are so unique in quality, in flavor, in full-bodied-mildness, in refreshing satisfaction that you should not delay your pleasure an instant! *Try Camels out to the limit*—then compare them with any cigarette in the world at any price!

Quality alone would make Camels distinctive. But, behind quality is Camels expert blend of choice Turkish and choice Domestic tobaccos. *This blend is a revelation to cigarette smokers!* You'll prefer it to either kind of tobacco smoked straight, it is so mellow, so delightful.

Prove conclusively that Camels are made to meet your most exacting demands; that you can smoke them liberally without tiring your taste! And, know yourself that Camels leave no unpleasant cigaretty aftertaste or unpleasant cigaretty odor!

Quality will make you keen for Camels!

R. J. REYNOLDS TOBACCO COMPANY
Winston Salem, N. C.

Camels are sold everywhere in scientifically sealed packages of 20 cigarettes; or ten packages (200 cigarettes) in a glassine-paper-covered carton. We strongly recommend this carton for the home or office supply or when you travel.