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Vol. 10 No. 1

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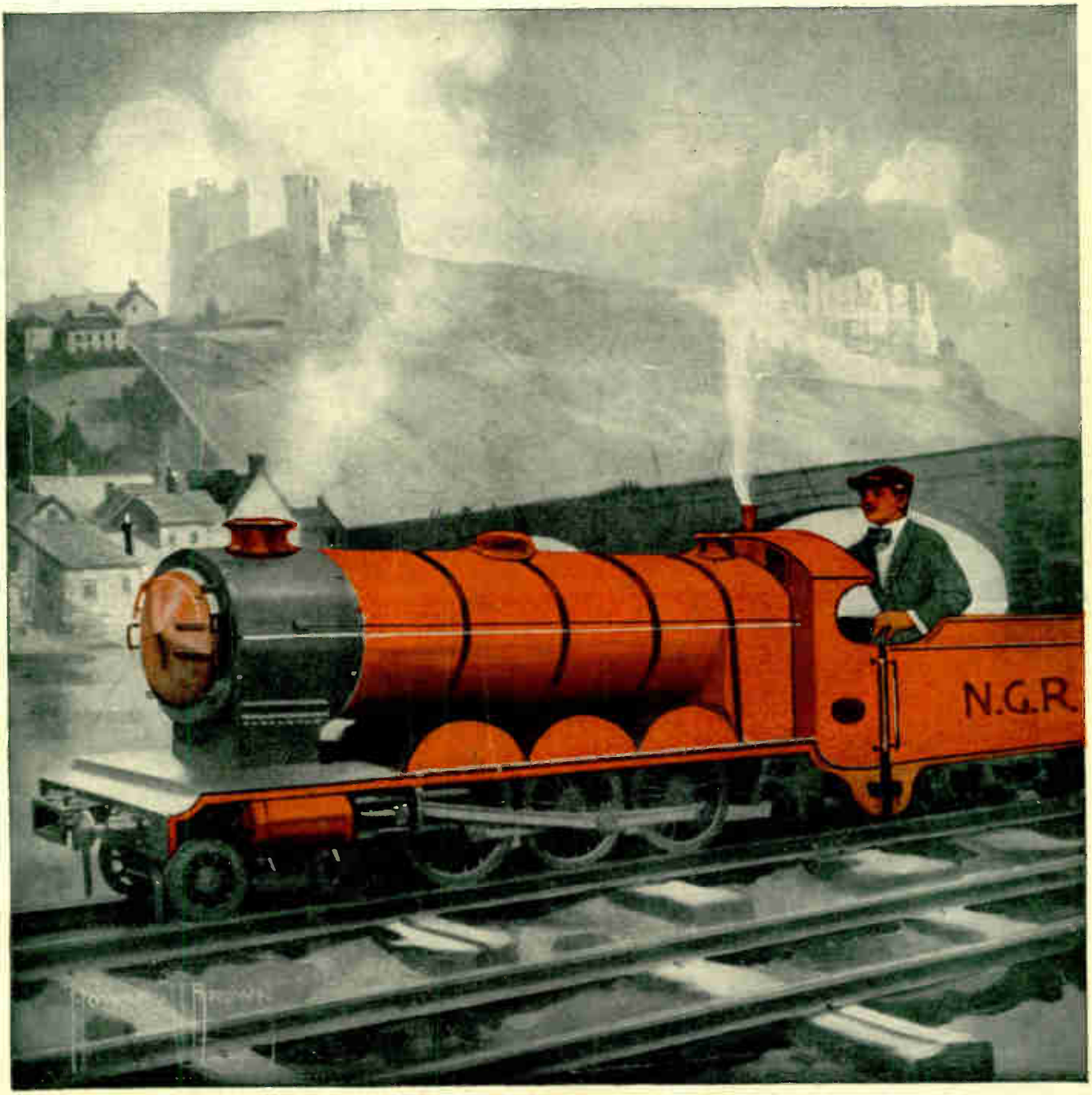

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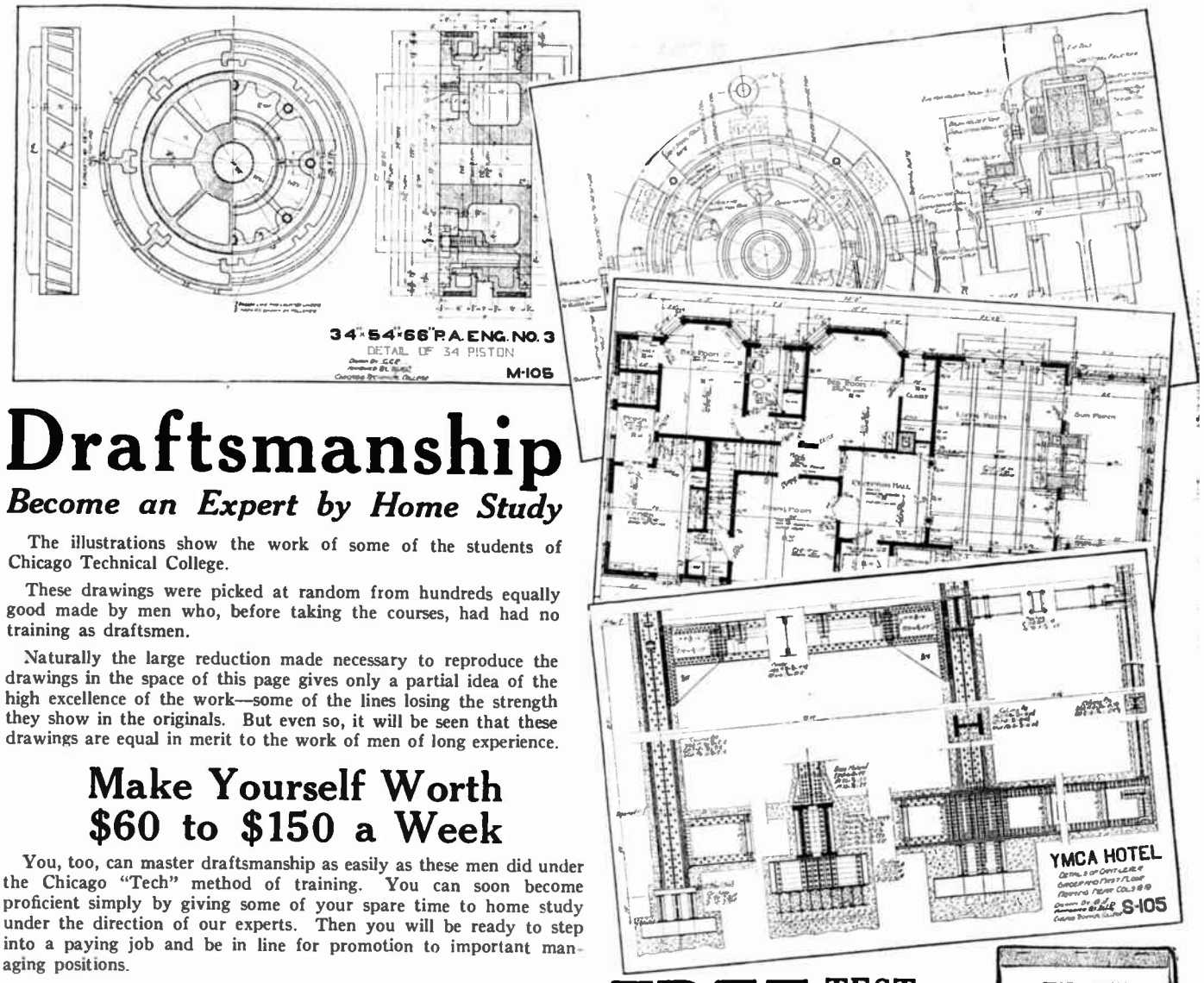
SYNTHETIC PETROLEUM

ONE of the problems now confronting the automotive, shipping and railway industries of the world that demands consideration at this time is the increase required in the production of petroleum. We are confronted with a fact and not a theory. The rising cost of petroleum products bids fair to restrict the natural development of the automotive industry and to retard the manufacture of oil burning ships and locomotives, all of which depend on crude petroleum and its distillates, not only for fuel, but also for the very necessary lubricating oils and greases to reduce friction in the mechanism, which are equally essential.

NO one knows what supplies of petroleum are still hidden away in the earth's crust, and new oil fields and wells are being constantly reported from all corners of the earth. In any event, it is doubtful if the production in the United States can keep pace with the greatly augmenting consumption, and the American people will be paying much more for oil products in the future than they are at the present time if the demand continues. This has led several scientists and chemists to give the subject of synthetic production of petroleum some consideration, and experiments are being made.

WHILE the chemical analysis of petroleum varies according to local conditions, it is approximately accurate to say that it is composed of 80 per cent. carbon and 20 per cent. hydrogen. Both of these elementary substances are plentiful, and can be cheaply procured. Chemical science has made great progress, so the natural thought is that chemists may yet find a way to combine these elements and thus produce petroleum synthetically. Man has produced many substances by combining basic elements, some of which are not found in Nature, and it does not seem that the chemical production of petroleum or other material having its principal properties is an insurmountable problem or beyond solution.

AS a starting point, it will, of course, be necessary to investigate Nature's methods very closely. It is stated that the oil-producing shales do not contain liquid petroleum, and that this product is only obtained after the shale has been heated. It is reasonable to assume that the carbon and hydrogen have been associated together in the rock in such proportions that the simple process of heating it causes them to unite and produce petroleum. Any chemist who evolves a commercial process of synthetic liquid fuel production will immensely benefit mankind, and make a fortune as well.



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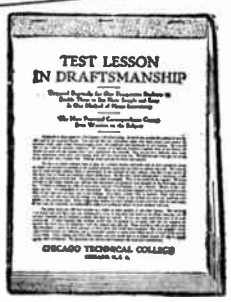

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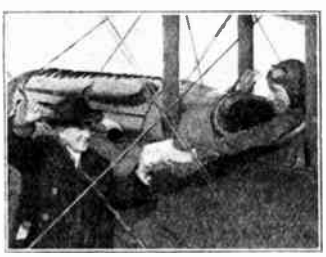

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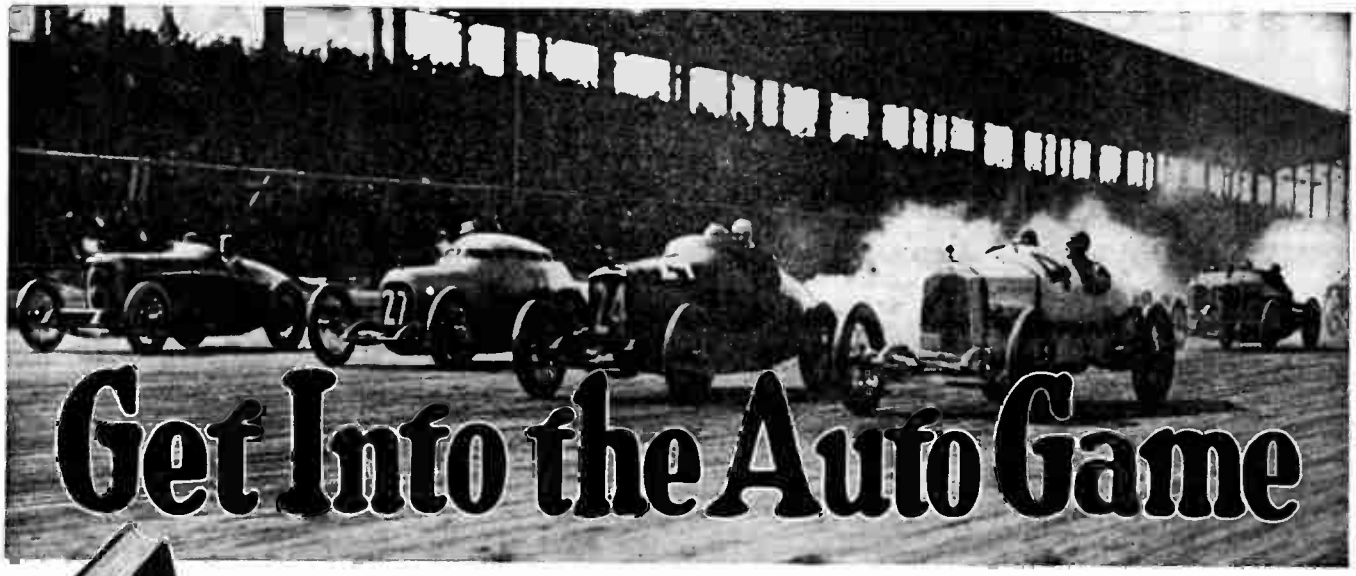

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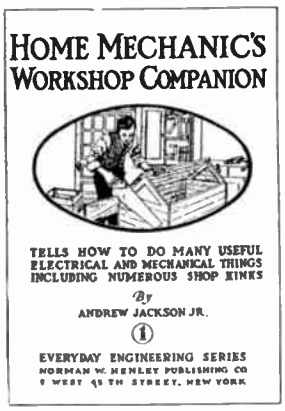

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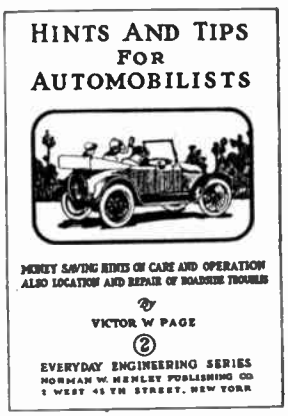

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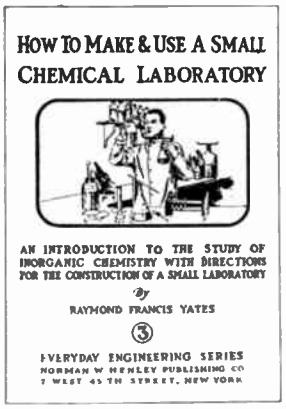

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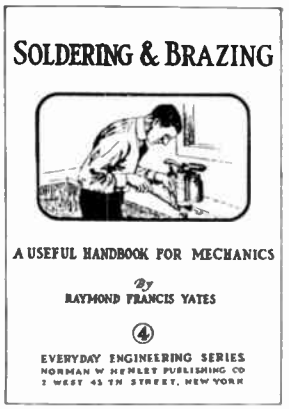

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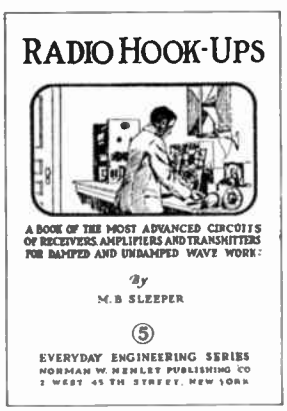

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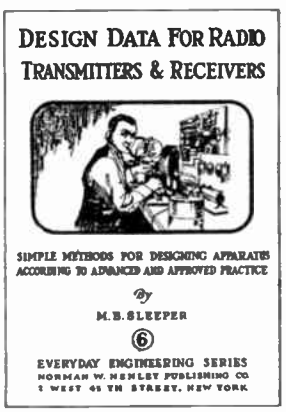

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VOLUME 10 OCTOBER, 1920 NUMBER 1

Miniature Railway Development in Great Britain

Some Interesting Details of Narrow Gauge Railways Used for Pleasure and and Profit and Descriptions of Typical Locomotives Employed on Them

By Henry Greenly

Assoc. Inst. Loco. Engineers, England

THE past year has seen a considerable development in 15" gauge Miniature Railway work in Great Britain. The only public railway, i. e., one which runs to time-table all the year round and that carries goods and G. P. O. mails, is that at Eskdale in the lake district of Cumberland, and to cope with increased traffic a new Pacific engine, made from the writer's designs has just been completed and put into service. This engine weighs in working order 5,000 lbs., of which 2,500 lbs. is carried on the coupled wheels. The cylinders are 4⅛" bore and 6¾" stroke and have the valve chests on top. The reversing gear is the standard Stephenson's link motion operating from the inside to the outside through a rocking shaft. The driving wheels are 20" diameter, with tires 1⅞" wide spaced 14" apart. The axles are 2 1/16" diameter, the driving axle having the eccentrics forged on solid with the shaft. The boiler is 20" diameter at the firebox end and has a barrel 5 ft. 11¼ inches long. The heating surface of the generator is as follows:

Tubes .....11,672.7 sq. inches

Firebox ..... 1,412.6 sq. inches

13,085.3 sq. inches

The boiler pressure is 125 lbs. per square inch which pressure is easily maintained with the heaviest loads. The Eskdale line is just over seven miles long and rises from the coast station at Ravenglass about 180 ft. This represents an average gradient of 1 in 207 (½%) but in fact, due to the undulating surface, 1 in 80 is the ruling grade with substantial sections of 1 in 34, 1 in 42 and 1 in 46.

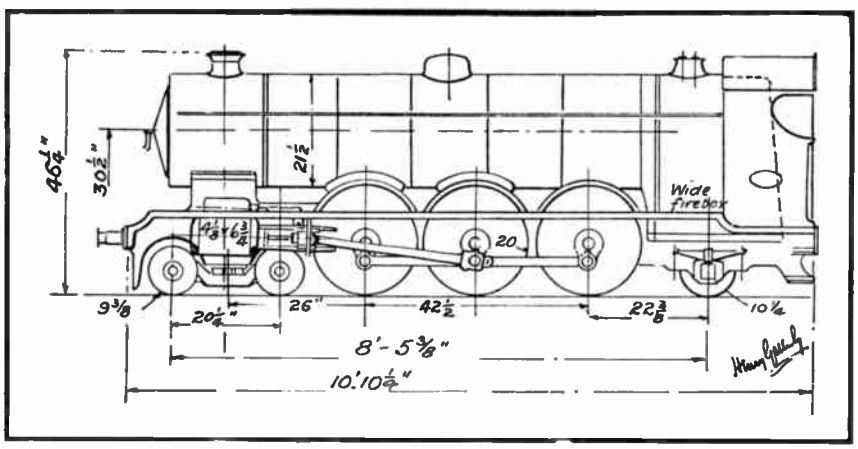
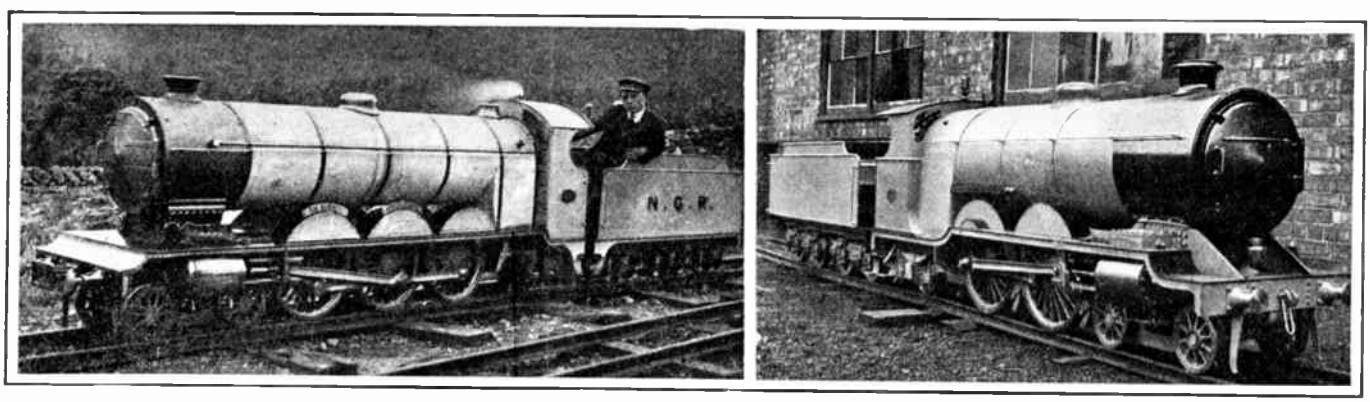


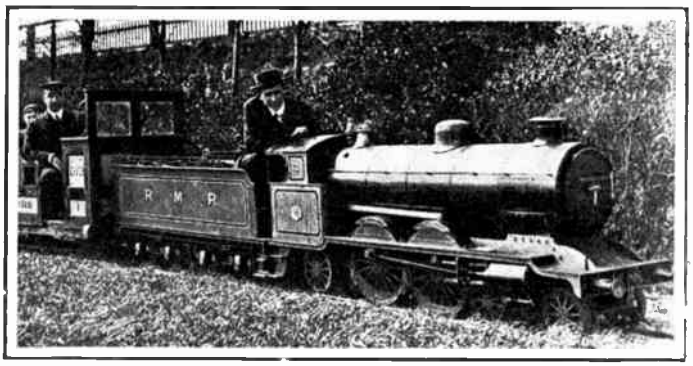
Diagram of 15-inch gauge "Pacific" locomotive for Eskdale miniature railway

The line at Eskdale is an old one and was originally laid to a gauge of 33" but in 1914, after having been closed for over a year was leased to the "Narrow Gauge Railways Ltd." and converted to 15" gauge. On one train, the 11:20, a non-stop train from Ravenglass, which does the seven miles in 40 minutes, a slip carriage is used. On the Rhyl Miniature Railway, a pleasure line at that well known seaside resort, in Northwales, the first of a new series of Atlantic Engines has



Miniature locomotives from designs by Mr. Greenly. At the left, that used on the Eskdale miniature railroad, is shown. The Atlantic type engine now running at Rhyl is shown at the right

Engine and train passing over bridge on Margate miniature line that spans a roadway

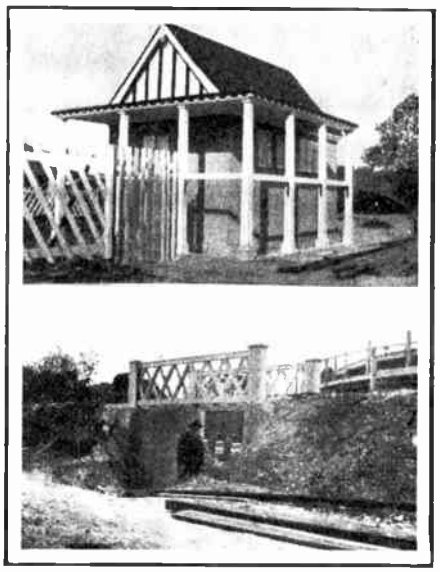


Locomotive "Prince Edward of Wales" built for Rhyl miniature railway, now used at Margate

just been completed. In the main the details are similar to that of the "Eskdale" Pacific Engine, but the cylinders have been increased to 4¼" diameter by 7" stroke and the trailing wheel is carried by inside bearings. These axle-boxes are of the radial type arranged in quite a simple and novel manner.

The latest railway to be installed is that at Margate, in Kent, one of London's popular seaside towns. Here the line is designed for the delectation of the younger visitors. It is a quarter of a mile in length and laid in the form of an irregular circle. The surface of the site was such that most of the line is either in cuttings or an embankment. This feature enabled the writer to introduce interesting effects. At the highest point, the line traverses a five-span viaduct 86 feet long. Each of the spans has a Warren type truss, the outer members of which are 17' 4" long and the inner ones 16' 4" long to provide for the 100 ft. radius curve to which this part of the line is laid. Four of the spans cross an artificial pond while the fifth is laid over a roadway leading to the center of the park. Beyond the viaduct another under-line bridge is erected. The truss for this bridge is also of wood, 12 ft. long over all and rests on concrete block abutments. The piers for the long viaduct were constructed with concrete slabs of the British standard 18"x9" size. These slabs were 3" thick, and the boxes they formed were filled with coarse concrete.

There are two over-line foot-bridges, and, as the time available for the construction of the line was very limited, these were made out of steel bars and



At top, Margate station. Single span bridge shown below

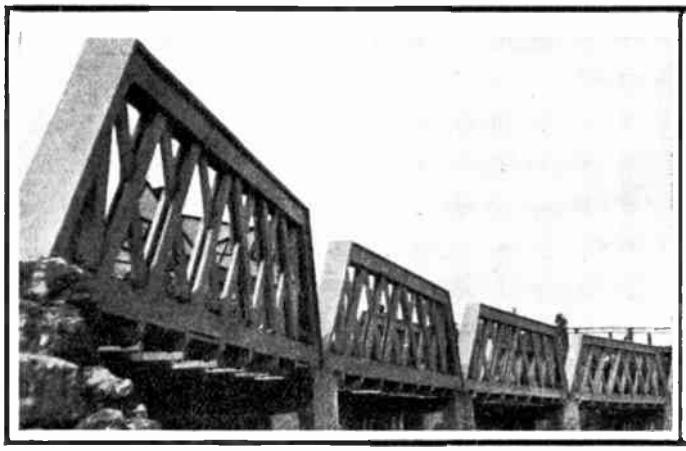
sections, with concrete floors. The thinness of these floors (4") was of considerable help in keeping down the gradients at the approaches.

The station has concrete platforms and is laid out with grass banks and flower beds. The station booking office was built with hollow concrete blocks 4½" thick, a material which is cheaper than rough wood in Europe at the present time; the roof, however, is of wood and is colored with a preservative to represent old tiles.

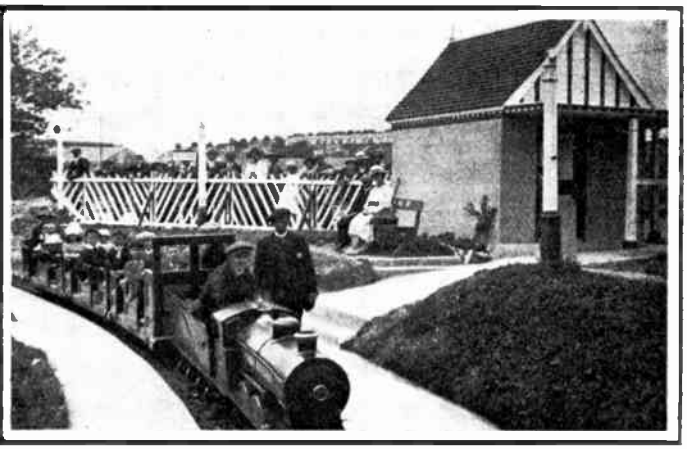
The Sunk Station proved quite a success. The turfed banks sloping down to platforms gives it a spacious appearance and the arrangement of the booking office, doors and gates makes the station very workable with a minimum staff. The over-bridge at the end of the platform lends interest to the juvenile passengers who wave "goodbye" to their Mammas as the train passes under the archway.

At the entering end of the station, a cutting was formed surmounted by a privet-hedge. At the end of this a level crossing for foot passengers was arranged to protest against children blundering across the track. Zigzag barriers 3' 6" high were erected to break any such rush. The water tank for the locomotive covers the coal store. The rails are standard flat-bottom section and are coach screwed to 7" x 4" sleepers, square washers intervening between the head of the screw and the rails.

The locomotive at present used at Margate is one of the "Atlantic" type of the writer's 1904 design, built in 1909. This engine weighs 3,400 lbs. and has cylinders 3⅜" bore x 6" stroke. Direct link motion is fitted, the valve chests being inside the frames. The coupled wheels are 18" diameter and have an adhesive weight of 1,200 lbs.

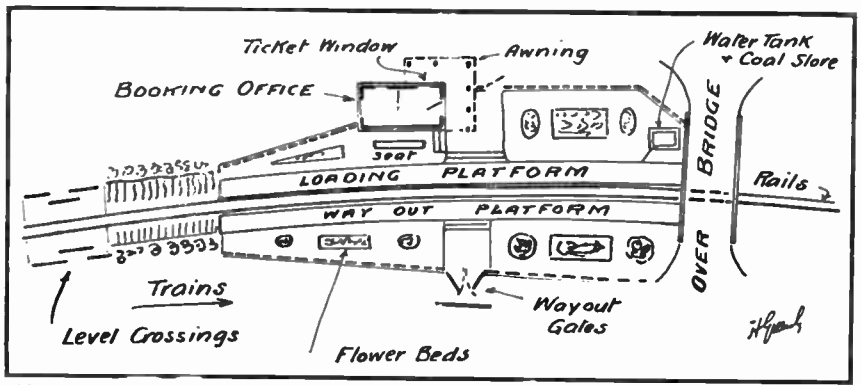


The five span viaduct 86 feet long, wooden trusses on concrete piers and abutments, designed and built by Henry Greenly



The station and train of the Margate miniature railroad viewed from the interior of the enclosure

resting on them. This engine has something like 50,000 miles to its credit, but is still in good working order. The new engine with double the tractive effort, *i.e.*, 700 lbs. instead of 300 lbs., promised from the Rhyl batch will, however, take over the bulk of the work, the old engine, "Prince Edward of Wales" being classed as a spare.



Plan of station, Margate miniature railway. This plan makes a very convenient layout which works admirably in practice and a 50-foot station can deal with 1,200 passengers per hour

The capacity of the Margate line is at present 750 passengers per hour, 24½ trains per hour, (including loading and unloading) which is a measure of the traffic of an average busy day. With the new engine this could be increased to over 1,200 per hour.

HAWAIIAN MOTORS RUN ON MOLASSES

FROM the lowly and sticky molasses is being produced "motor alcohol" —a substitute for gasoline. Discovered by J. P. Foster, chemist of one of the big sugar plantations on the island of Maui, Hawaii, production within the next three months will be sufficient to furnish fuel for all cars on the islands should a gasoline shortage occur. According to the first reports of the new fuel brought to San Francisco "motor alcohol" gives more power, greater mileage, easier starting and more freedom from carbon than gasoline. It can be used without an adjustment of the carburetor, says the *Scientific American.*

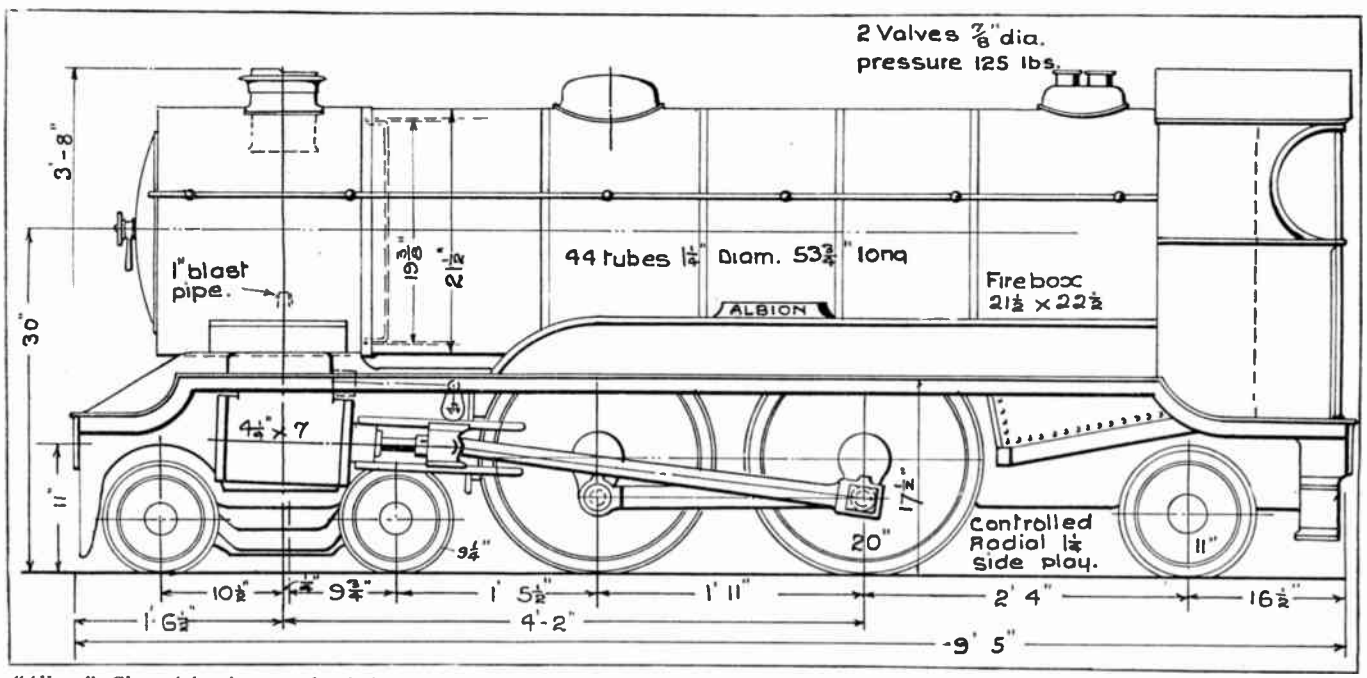
The new fuel is performing in automobile, marine, stationary, truck and tractor engines. In a 36-hour test made with a 75-horsepower tractor the consumption of "motor alcohol" was four gallons an hour compared to four and a half gallons of gasoline in the same engine on the same work. Examinations of the cylinders showed most of the old carbon deposit removed and the remainder so soft it could be removed with the fingers.

Sugar plantations have been letting their molasses run to waste or burning it for the potash recovery. Nitrogen and phosphoric acid are also valuable by-products of molasses. Now, however, production of the new fuel is found to be more profitable than obtaining other by-products. At present there is enough molasses available to produce 9,000,000 gallons of "motor alcohol"—enough to supply all automobiles in Hawaii. Development of this industry will release shipping space formerly used for transporting gasoline from the United States.

A NEW GASOLINE STREET CAR

THE preliminary test of a new type street car devised by a well-known auto and tractor builder at the shops in Dearborn, Michigan, was declared to be a complete success. The new type of car will leave ahead of the Wolverine Flyer, between Detroit and Chicago, and will race it for a time record over the tracks of the Michigan Central Railroad, and in order to be successful will have to make 70 miles per hour. The power unit which will move the car represents a new combination of functions. It is a motor, an air compressor, an electrical generator, and a heating and lighting plant all in one. All operations necessary for the control of the car are centered in the motor. All this is accomplished, it is said, with a 75 per cent reduction in weight, as compared with the power and control equipment of the ordinary electric car.

Some iron ore deposits in the northwestern peninsula of Iceland, which a Danish company proposes to develop, are said to contain from twenty to thirty million tons of ore. The material is a brown oxide containing from 40 to 55 per cent of Fe, and lies at a height of some 1,000 feet above the base of the basalt rocks.



"Albion" Class Atlantic recently designed by Henry Greenly for Rhyl, Margate and other 15-inch miniature railroads. First engine just built and hauling 80 passengers quite easily at Rhyl. Cylinders (two) 4¼-inch x 7-inch; drivers, 20-inch. Tractive effort, 780 lbs. Maximum load on level, 17 tons. Speed on level with 9 tons—20 miles per hour

The Earth's Requirements of Energy

An Interesting Study of the Power Requirements of the World Explaining How the Demands of Modern Industry is Gradually, But No Less Surely Depleting Nature's Stores

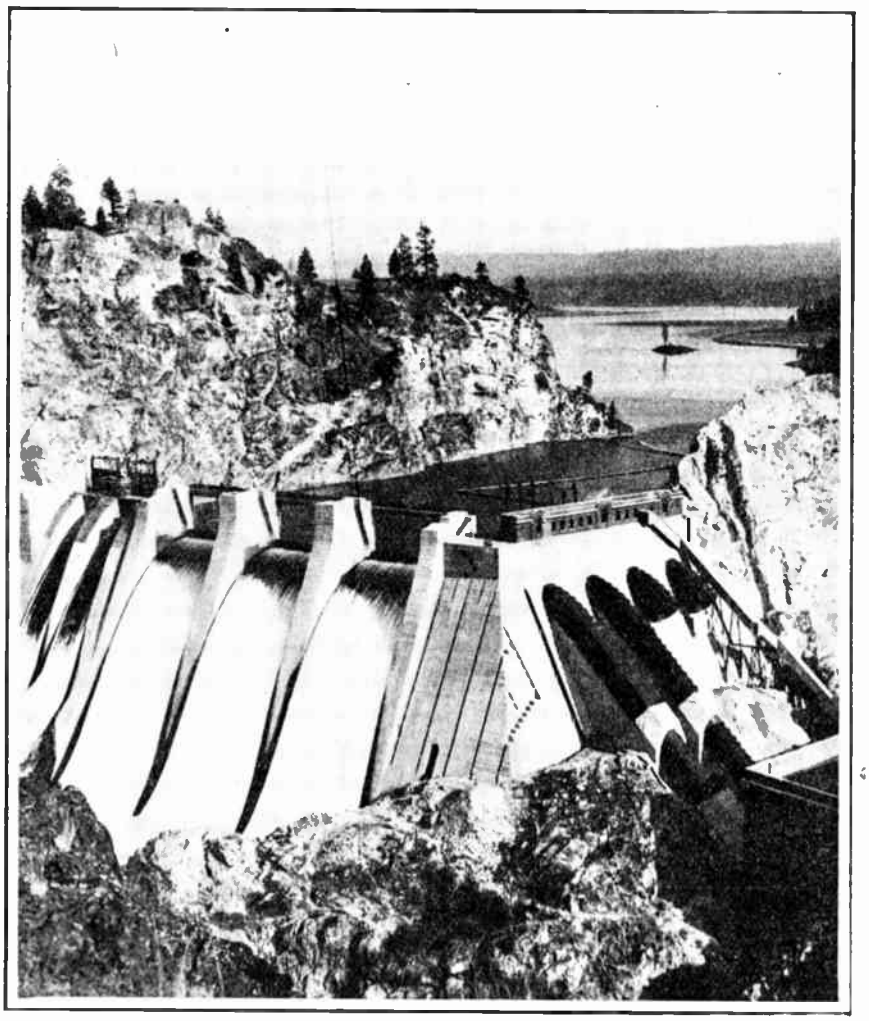
By T. O'Conor Sloane, Ph. D.

IT is now many years since the late Dr. Leslie, State geologist of Pennsylvania, warned the world that the wonderful evolution of natural gas and petroleum would not last forever. As we look at it now it would seem as if his prophecy had been falsified, because by exploiting new regions and boring more wells in the old regions, the total amount of oil and natural gas has been increased. But, it should not be forgotten that according to the very best geological authorities we are drawing upon one of Nature's stores which is not being replenished. The origin of petroleum and natural gas is one of Nature's secrets, but there is little probability that it is being constantly produced. We are definitely sure that coal is not being produced, so that the world is now delivering its treasures, for the use of mankind, the population of the world is increasing and the demand upon Nature for heat and energy is greater year by year, so that, if our charity reaches that far, there is room for apprehension of what will be done to the future generations.

The period for which the coal in different countries and continents will suffice has been investigated. Thus in Canada it has been calculated that, by going down to a depth slightly exceeding a mile, coal enough would be found for 6,000 years of the present demand in that country. But much of this coal would have to be left behind as pillars to support the roof of the mines and there is the culm waste and, of course, more coal will be used from year to year, so it is supposed that this period might be reduced to 1,500 years. The United States is supposed to have 2,000 years of coal, Germany a little over 1,000 years, and England only 200 years' supply.

If we now look into the question of oil we find that the production per well in the Pennsylvania district along the Appalachian Ridge decreased from 207 barrels per day in 1816 to 1.73 barrels in 1907. In West Virginia there was a decline amounting in 1910 to 56% of its maximum output, it is noted. In New York and Pennsylvania oil fields reduction to 50% of their production was noted from 1891-1898. It is claimed that the end of oil in this country is in sight, that it may be about 1935, and another estimate places the duration of the fluid at 90 years. There are enormously rich oil fields in other countries not yet developed.

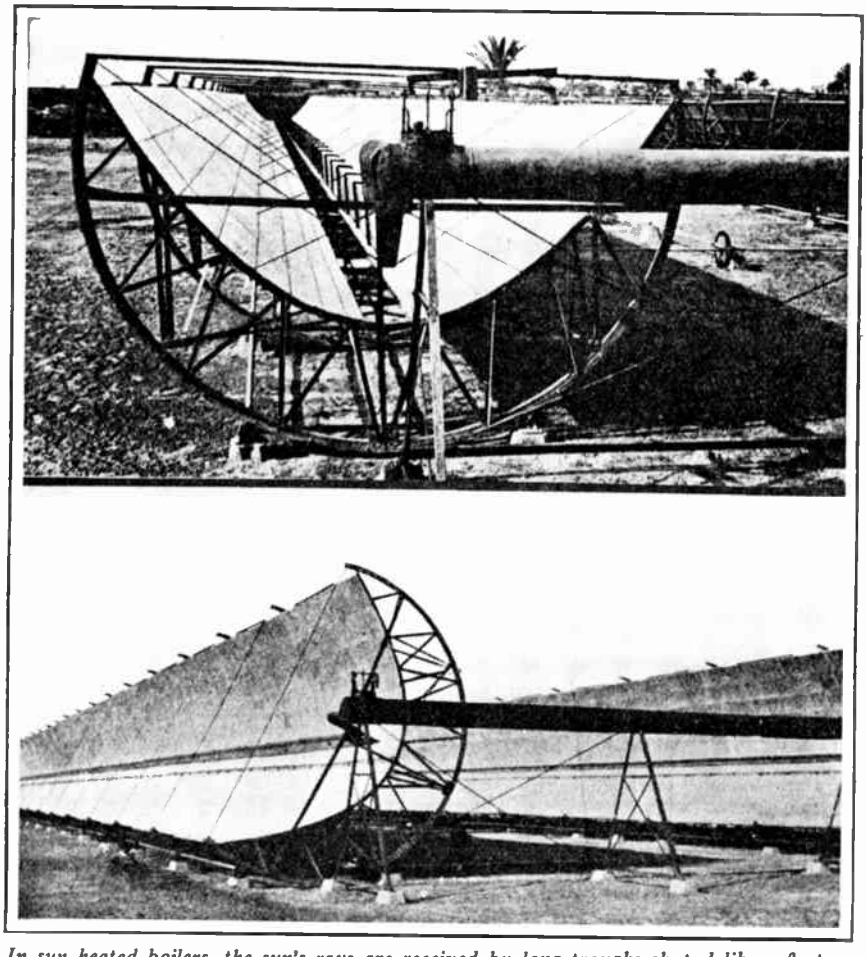
Some 1,200,000,000 of tons of coal are used in the world per annum, and perhaps 3% of this amount of petroleum. But the latter is getting to be a favorite fuel and more and more of it will be consumed as the years go by, provided, of course, that it can be supplied. Meanwhile water power is being used more and more. Switzerland is very prolific in waterfalls and it is said that in that country all the waterfalls with economic value have been utilized. In Switzerland the peak of power required is reached in winter. In summer Switzerland has power to spare and has been selling it across the frontiers, to foreigners. This water power is derived from Switzerland's snow fields and glaciers and is properly called white coal. Norway is a land of waterfalls and bids fair as water power is concerned. Iceland has large water power and so few inhabitants that it is calculated that there are 22 horsepower for every individual of the population. Italy has enough of mountainous country to develop a very respectable horsepower from waterfalls and is contemplating the possibility of electrifying all her railroads. She has practically no coal and only a little lignite.



The power of falling water can be utilized advantageously by diverting a portion through penstocks to turbines below

The following tables from figures by the investigators Koehn and Keplan,

revised by Dr. Arrheniaus, give the horsepower for different continents and for different countries expressed in millions for the first columns and the second columns the horsepower per inhabitant. It must be remembered that these are not accurate figures but are approximate estimates:



In sun heated boilers, the sun's rays are received by long troughs shaped like reflectors of parabolic cross-section. A long boiler is located at the focus. The reflectors are 201 feet long and 13 feet 1 inch across at the top. They are placed on frames and the troughs are turned to face the sun. The reflecting surface is glass backed with bright metal. The steam generated is supplied to engines of the conventional construction

Continents	*Horsepower in millions*	*Horsepower per inhabitant*
Asia	236	0.27
Africa	160	1.14
North America	160	1.17
South America	94	5.25
Europe	65	0.13
Australia	30	3.75
Total	745	(av.) 0.45

Countries	*Horsepower in millions*	*Horsepower per inhabitant*
Canada	26	4
United States	100	1
Iceland	2	22
Norway	13	5.2
Sweden	6.7	1.2
Finland	2.6	0.8
Balkan Countries	10	0.6
Switzerland	1.5	0.4
Spain	5.2	0.26
Italy	5.5	0.15
France	6.0	0.15
Austria-Hungary	6.2	0.12
Germany	1.43	0.02
Great Britain	1.0	0.02
Russia	3.0	0.02

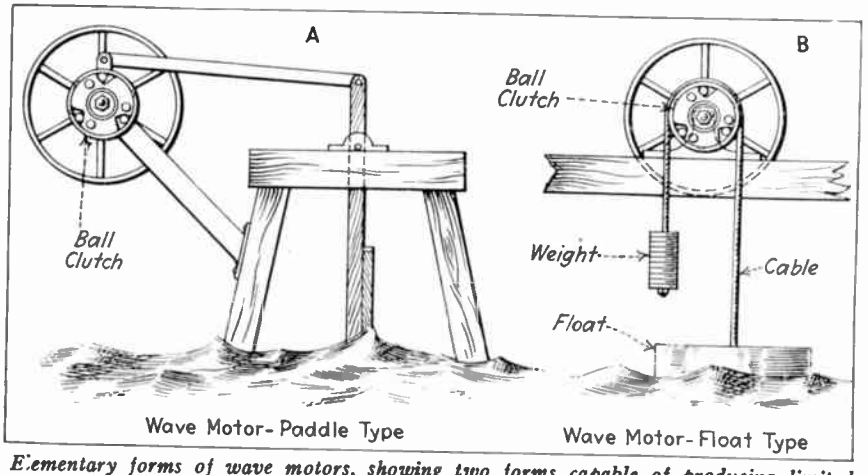
The celebrated Ericson got power from the sunlight reflecting its rays by mirrors from an area of over 100 square yards. This gave him much horsepower. Of course, this system applies particularly to regions of perpetual sunshine and some authorities believe that something may yet be done in its developing, especially in desert regions.

River power, called green coal by the French, represents an immense volume of water with very small fall, but can be made to deliver considerable power. Tidal power from the ocean, called blue coal by the French, has never been utilized on a really large scale, although the tide wave sweeping around the earth represents an enormous aggregate of power. Wave motors are still awaiting invention.

If we consider the prospects of vegetable fuel, such as fire wood, we find there is an enormous amount of energy accumulated annually by vegetation. It is calculated that vegetation, which, of course, includes all plant life, accumulates in a year 22 times as much energy as is represented by the coal consumed in the same time. The forests of the world take up 67% of this energy. Cultivated plants take up 24% and the other 9% is taken up by minor growths. The forests alone accumulate fourteen times the equivalent of coal used per annum. Yet our forests are disappearing, largely because there is no systematic system of reforestation carried on in this country. The great forests in the tropics, of course, are too far off to be really available.

The wind represents five thousand times the energy of coal at the present rate of consumption, yet it is less used than ever. It depresses the economical student to see the sailing ship disappearing from the seas and that more and more oil is being used to drive ships across the ocean each year. Even in Holland, celebrated for its windmills, steam power is being introduced to replace them. Years ago the inventor, Brush, combined a windmill with an electric generator and storage battery to store up the power of the windy days and especially in Dakota there are a number of windmills doing this work for the farmer, giving him power at low cost. Of course, if the contours of the country facilitate the construction of a large reservoir wind power may be utilized to raise water to a reservoir to drive turbines.

It would certainly seem that in the tropical regions where rain is unknown or a very infrequent occurrence, the solar engine might be very successfully employed.

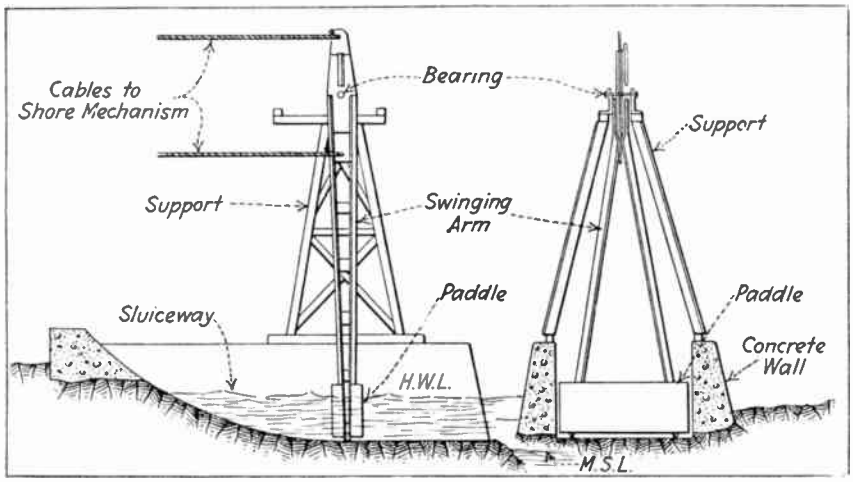


Elementary forms of wave motors, showing two forms capable of producing limited power by the rise and fall of water

In the development of prime motors such as steam engines and gas engines, a controlling motive has always been a subjective one, the concentration of the mechanism in small volume, and it is in this regard that many attempts to utilize the powers of Nature have failed. The solar engine, if of any great power, would require enormous reflecting or refracting elements and one which would cover an acre of ground would be exceeded in power by a little aeroplane engine that could be put into an insignificant space.

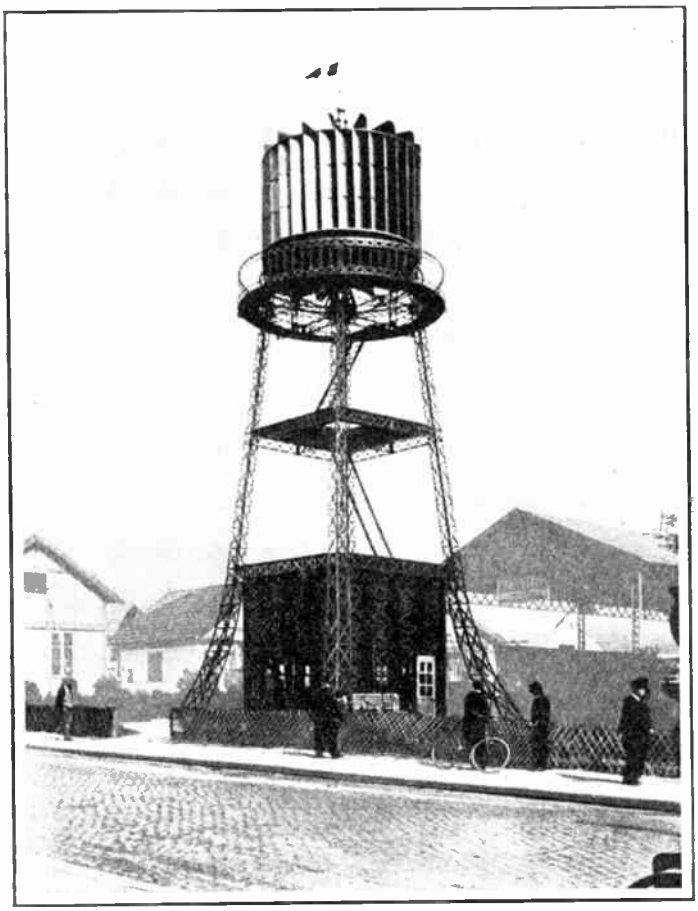
We have spoken of the wave motor. One attempt after another has been made to utilize the power of waves. It is there, ready for use, costing nothing and inexhaustible, but we are up against the same trouble of getting the motor into sufficiently compact form.

Then there is terrestial heat. The interior of the earth is very hot and is prevented from losing its heat by what is popularly termed its crust, which is a virtual non-conductor. The deepest shaft sunk by man into our earth has not reached a place where the temperature of boiling water was attained. It is probable that half a mile more of depth would give a region where a boiler could be established which would perpetually convert water into steam by the heat of the earth. The difficulty of sinking such a well is almost insuperable, but in the neighborhood of volcanoes there is no telling what might be done. Mount Vesuvius, if its heat could be utilized, could supply power for a great part of Southern Italy. Sicily might draw endless power from Aetna and little Iceland, of which so much is expected in the way of water power, has incalculable volcanic heat.

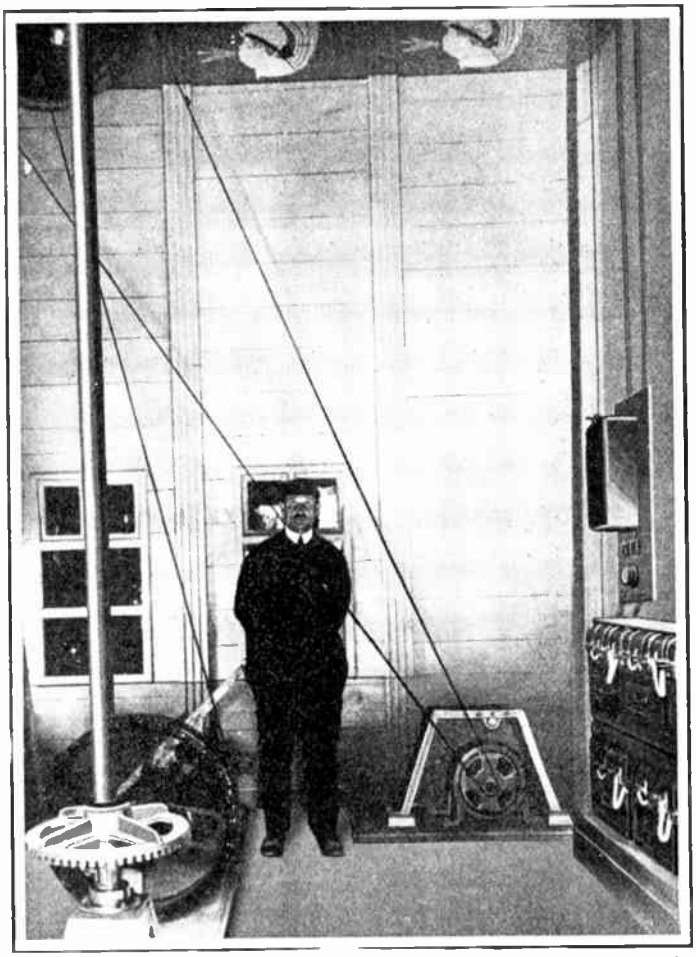


English wave motor of paddle type utilizes water movement in sluiceway to produce power

Much of this sounds fanciful and imaginary, for a volcano as a neighbor is not a tempting object for the engineer to experiment with. But it is very interesting to realize that the volcano brings us face to face with the enormous stores of heat which have accumulated in our globe and which may be still accumulating by the action of radium. And all the while the sun is pouring out incalculable quantities of energy into space and our little earth intercepts many times its requirements, were there any way of utilizing even a small fraction of the solar heat which it receives as mechanical power.



Exterior view of windmill of French design having a rotor that will run regardless of the wind direction, the power being used to generate electricity which is accumulated in a battery



Interior view of French windmill showing bevel gear drive from rotor shaft and belt drive of electrical generator. The current is drawn from a storage battery as it is needed

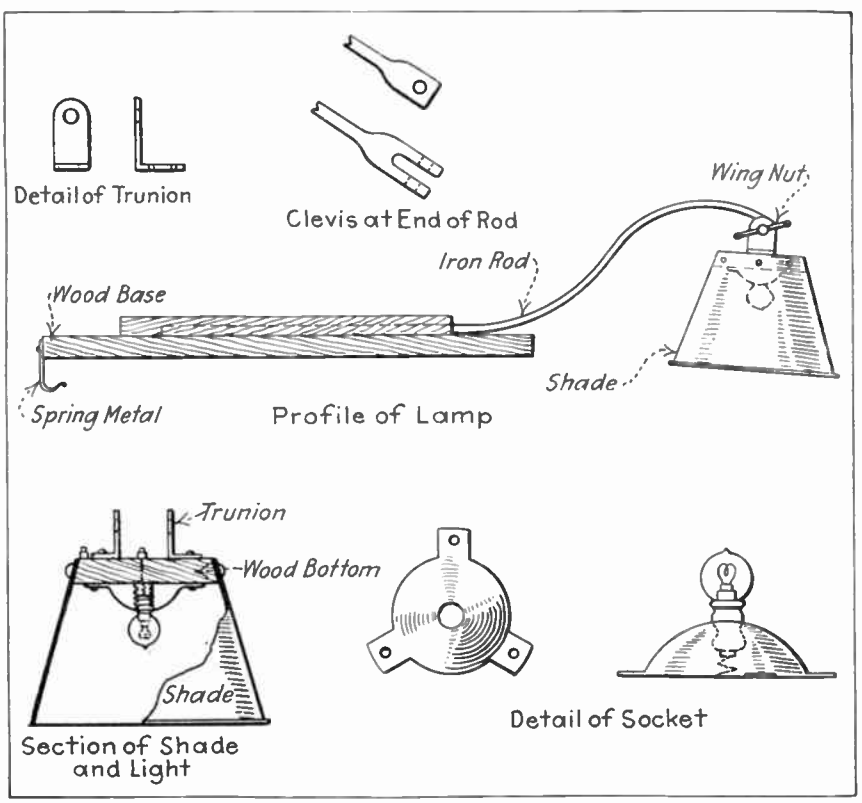
Electric Lamp for Piano Made of Odds and Ends

By L. B. Robbins

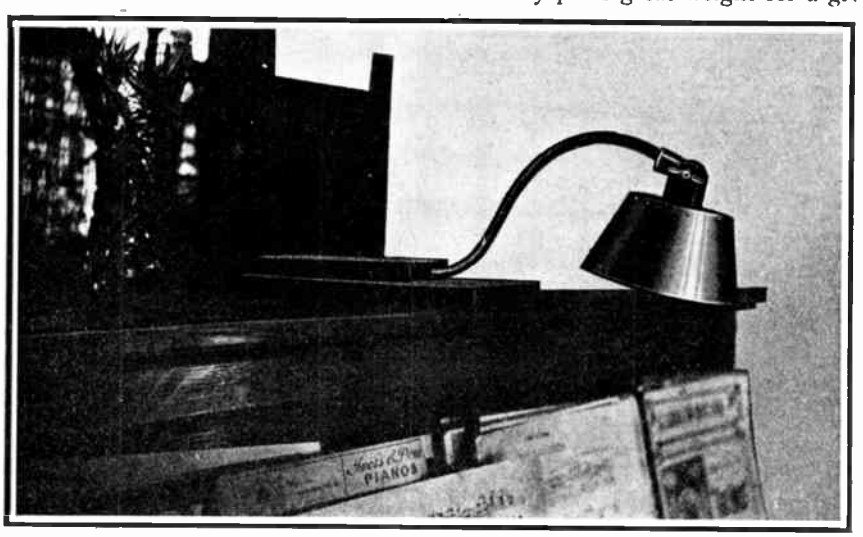
AS it was impossible to shed a good light on the music at the piano by any kerosene lamp in the house the electric light shown in the accompanying photo and sketch was made of odds and ends about the place and does all the work of a manufactured one at a great deal less cost. The base is of two pieces of clear cypress. The smaller one is fastened with screws to the bottom one and is so constructed as to clamp around iron rod between them. This rod is the bracket and is part of an old automobile brake rod with the clevis left on as shown at the outer end. Bend the rod in a pleasing arc so the clevis rests somewhat above the level of the base.

The bottom section of the base is as long as the width of the piano top and a spring holds it in place at the rear. The spring slips under the moulding along the edge. The shade as made from a section of a conical chicken waterer. A tin funnel would do. A wooden disc was then fitted into the top opening and the metal tacked to it with upholstery tacks. Two trunnions of copper were sawed out and fitted to the clevis so as to swing back and forth and the shade held in a fixed position by turning down upon a wing nut.

The lamp socket consisted of a flashlight reflector turned upside down, three little lugs being cut in its edge, bent out and tacked to the wood bottom. It was wired up and the wires run thru the bottom to the batteries on the floor below. The wiring was hidden behind the base and the switch was located somewhere near at hand to the player.



Details of electric lamp for piano



How the finished piano lamp appears installed

A four C. P. bulb connected to six dry batteries, connected in series multiple, gave sufficient light to illuminate the music and the batteries lasted a year with a few hours use of the light a week. The base was stained the same color as the piano, the rod and outside of the shade were black enameled and the inside of the shade and bottom were given three coats of pure white enamel.

OBTAINING BALLOON GAS DIFFICULT

THE international balloon races which were planned for last month in Indianapolis have been somewhat delayed by the inability to secure the necessary balloon gas at this location. The Air Service is now seeking a new location at which adequate facilities will be available. The gas required is, of course, one of low specific gravity in order to give high lifting power. Stripped run-of-oven by-product gas, special coal gas made at high temperature to give low specific gravity, or uncarbureted water gas are the usual supplies employed for these purposes. Gas of a gravity of approximately 0.40 or slightly less is desired for the type of free balloon which is to be used by the contestants. If other means fail, it may be necessary to produce this supply by adding hydrogen to city gas supplies. The hydrogen thus used would have to be manufactured in the portable type ferrosilicon plants used as field equipment by the Air Service.

Steel castings are preferable for use in cases where a forging is unsuitable or too expensive and where combined strength and toughness are required. Cast iron is suitable for service in which the stresses are mainly compressive or where the stresses can be overcome by increasing the size of the casting regardless of the resulting weight. In many parts great weight for a given strength is desirable. Where extra strength and toughness combined with fairly good resistance to wear and fatigue are essential, a malleable-iron casting will suffice.

Repairing Blow-Outs In Tire Casings

By Kenneth Alton

WHILE almost any motorist without much mechanical experience can make satisfactory repairs on pneumatic tire inner tubes, providing that the punctures are not of too large a size, it is somewhat more difficult to make satisfactory repairs on tire casings which have blown out. There are a number of repairs which the motorist can make for himself provided that he uses special care and the proper equipment, though it would be much more economical, if the damage is of any consequence, to have the work done by an expert tire re-builder.

The accompanying illustration shows the various steps to be followed in repairing a small blow-out and indicates how a person of even slight mechanical ability can handle such work.

The illustration at Figure 1 depicts that class of tire injury which is known as a blow-out, and, as will be evident, the fabric carcass has been punctured clear through. Regardless of the size of such an injury, the principle underlying the repair is to reinforce the casing so that it has ordinary strength by using layers of fabric and then to fill the hole in the tread by vulcanizing in new rubber.

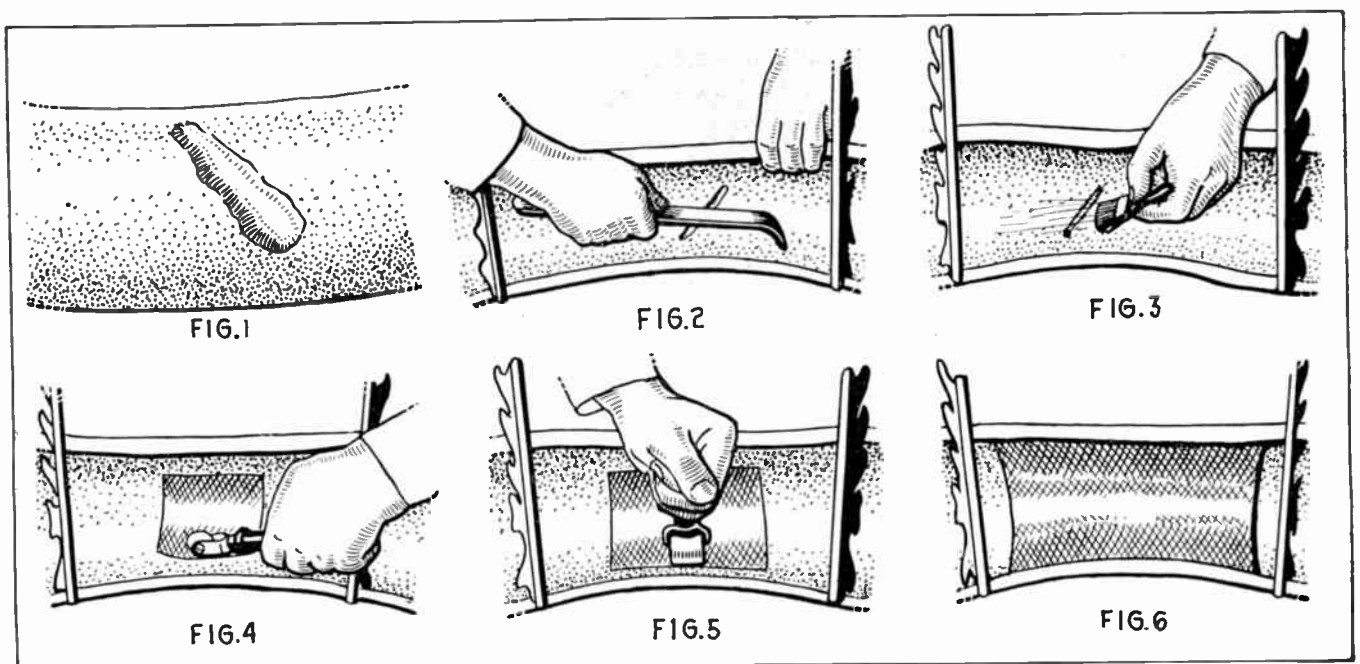
The first step in the process is to clean the blow-out in the casing thoroughly from both sides and scrape the area at least six inches in radius around the defect on the inside as indicated at Figure 2. This may be easily done by using any form of hoe shaped scraping tool and keeping the inside of the casing wet with gasoline while the scraping is going on. Attention is directed to the casing spreaders, which are simple castings that may be obtained at low cost from any dealer in automobile supplies and which keep the beads of the casing spread apart sufficiently so that it is possible to work in the casing interior without difficulty.

After all the old rubber has been scraped away with the hoe shaped scraper illustrated, the inside is given a final washing with gasoline and the tire is allowed to dry until the liquid has evaporated. The next operation, shown at Figure 3, is to cover the injured area with vulcanizing cement, which should be forced in between any loose plies of fabric and also around the ragged edges of the damaged portion. The entire area on the inside of the casing, which has been thoroughly cleaned, is also cemented. The cement is applied with a brush, at least three layers being applied, each layer being allowed to dry thoroughly before applying the next one.

The next step, which is depicted at Figure 4, is to take a piece of special repair canvas which is covered on both sides with raw rubber and to cut a piece of this material about three inches larger in each direction than would be required to actually cover the ruptured tire. This is placed on the inside of the tire and is carefully rolled so it will be in contact with the entire cemented area with a stitcher.

The next operation, which is shown at Figure 5, is to apply another layer of canvas, which is an inch larger in all dimensions than the first piece applied. For small tires, such as 3½ inches in diameter, four layers of prepared fabric are enough, each one of these being about an inch larger all around than the one over which it is placed. For tires four inches in width and over, five layers of canvas should be applied. The intermediate layers are always of the material that is covered on both sides with raw rubber, but the last layer must always be of fabric that is covered on only one side with rubber, which is placed coated side down. Owing to the rubber coating, it is not necessary to use cement between the reinforcing layers.

The view at Figure 6 shows the appearance of the tire after the final layer of new canvas is in place. Care must be taken to smooth the fabric down well and roll each layer as it is applied with both the stitcher and roller shown at Figure 5. The stitcher is better adapted for rolling the edges down and insuring an intimate adhesion between the patches or reinforcing strips, while the roller is most suitable for smoothing down the larger part of the area of the patch. No material is removed from the fabric ordinarily provided in the tire except such frayed or decayed parts of the casing that cannot be worked back into the repair. What we have really done is to build up a blow-out patch or casing reinforcement on the inside of the tire so that the strength of the carcass is just as great, despite the break, as it was originally. The next thing to be done is to fill the gash on the opposite side of the tire casing with scraps of pure rubber stock as indicated at Figure 7.



Steps in repairing blowouts in outer casings of the fabric type showing how inside reinforcement is applied

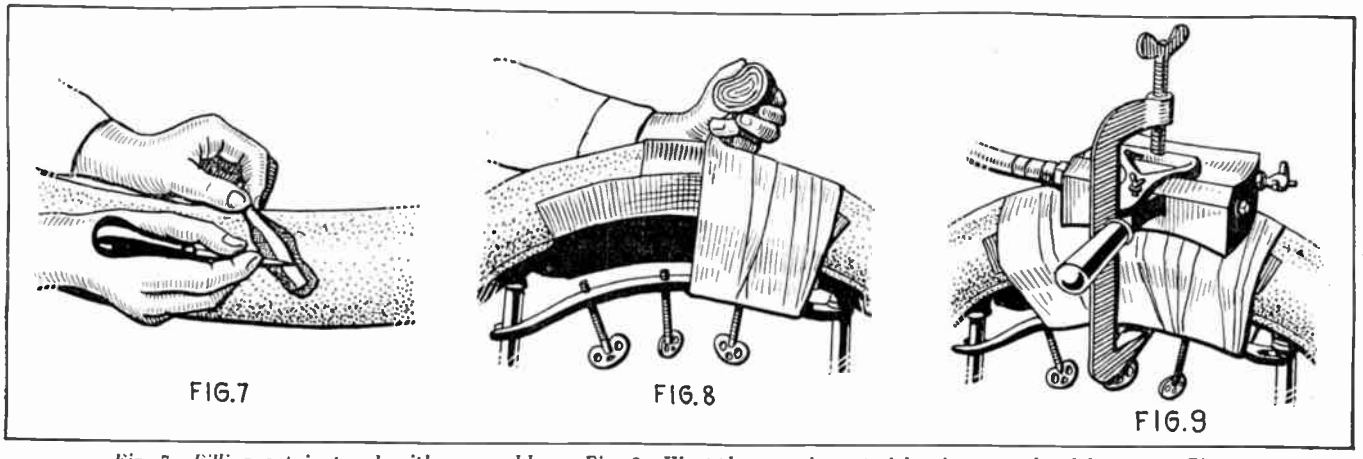


Fig. 7—Filling cut in tread with raw rubber. Fig. 8—Wrapping repair material prior to vulcanizing as at Fig. 9

The rubber tread stock does not have to be cut to fit, as strips or straps of any kind may be brazed in to fill the cut. Of course, it is understood that only uncured stock can be used in making this repair. The reason strips and odd shaped pieces can be used is that the rubber will unite ultimately with the edge of the tread with the fabric during the vulcanizing process.

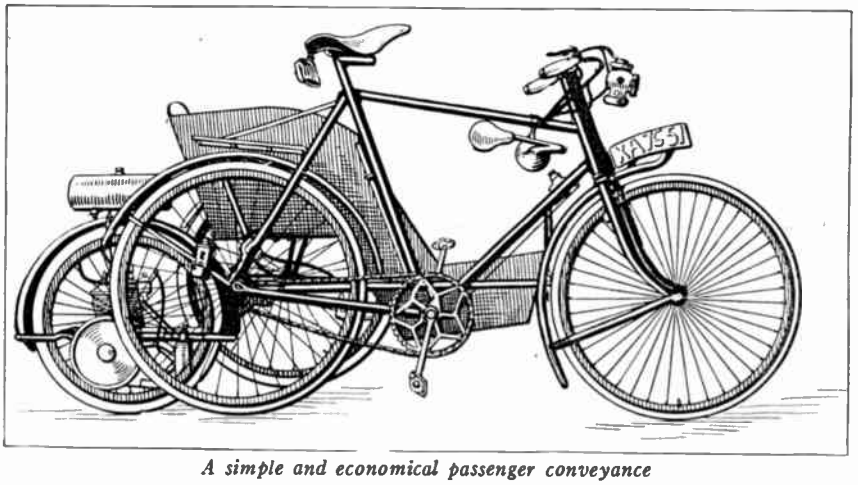
The method of repairing a blow-out is just the same as that used in dealing with a tread cut. The rubber filling acts as a block to keep the water out of the interior. The final step, which is illustrated at Figure 8, is to place the casing on a heated form which is known as an inside heater and then wrapping the tread with special tape. On some form of inside heaters, a tension strip provided with clamp screws is used which will bind the repaired parts of the tire firmly together.

A vulcanizing plate is then applied as indicated at Figure 9 and clamped in place. The steam is allowed to circulate through the inside and outside vulcanizing plate and is allowed to flow at the desired pressure and temperature through the heating elements for from forty minutes to an hour, depending upon the size and thickness of the tire. As will be apparent a shorter period is required to "cook" a small tire with only three or four plies of reinforcing fabric and a smaller amount of tread rubber filling than will be needed to cure the parts of a larger tire. The degree of temperature used, however, is independent of the size of the tire because vulcanization can only take place at certain temperatures.

A SIMPLE CONVEYANCE

A VERY simple and economical vehicle for carrying two people that was constructed by an English mechanic is shown in the accompanying illustration. This is a side-car outfit, consisting of an ordinary type of safety bicycle and light side-car to which an auto wheel is attached. The side-car should be very light and attached to the bicycle in three places. One of these clamps to the rear, near the back hub, the other clamp at the front end was attached to a suitable fitting on the steering head. A stay was used from the axle of the side-car to the saddle post of the bicycle.

As the auto wheel is a separate unit of itself, it was easily attached between the back wheel of the bicycle and the wheel of the side-car. The front end of the auto wheel supporting bracket is attached to the side-car axle and is placed nearer the bicycle wheel than it is to the side-car wheel. As an example of the economy of this device, the builder states that he has made a 70-mile trip, carrying two people, in four and one-half hours, using only three quarts of gasoline.



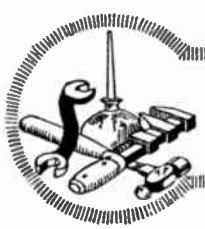
A simple and economical passenger conveyance

While a device of this nature can only be used for good roads, there are many parts of the country where a simple arrangement of this kind could be used to advantage, as it can be made without the expenditure of much money and would be much more economical than the lightest possible form of motorcycle and side-car outfit. Instead of the passenger-carrying side car, a light box could be used and the outfit would be a very economical method of delivering light parcels on short routes.

RESETTING SPRING LEAVES

AUTHORITIES on spring manufacture state that it is not advisable to reset spring leaves of any kind by hammering them, hot or cold, or by running the leaf through a tire-bender. The method suggested is to heat the steel to about 1,900 degrees F., reshaping the leaf to a predetermined form and immediately dipping the leaf in a bath of oil. It is usual to sprinkle a little water on the hot plate before dipping it into the oil bath. The plate is then very brittle and must be drawn carefully, depending a great deal on the degree of heat before quenching, but at 1,900 degrees, quenched in a moderately cool bath, it is usual to draw until there is just the slightest suspicion of a dull red glow, or about 700 degrees.

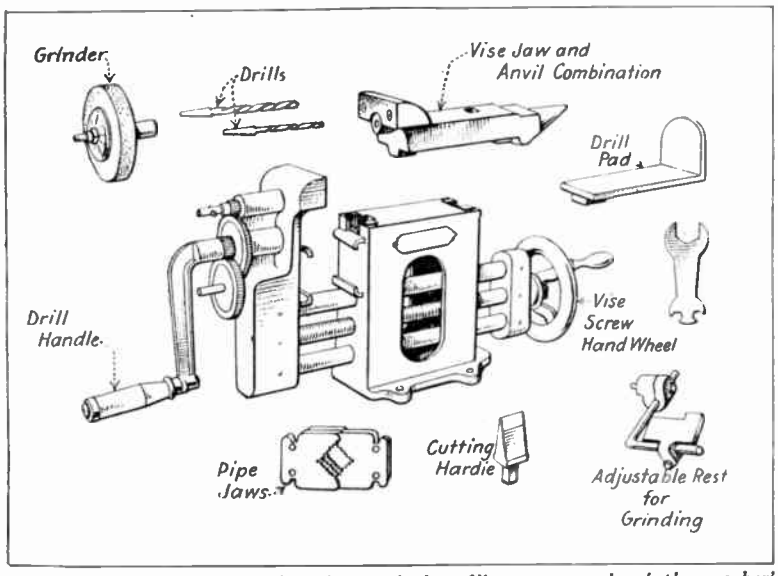
In most cases there is a little fitting necessary, after the plate is drawn and allowed to cool slowly. This is done by hammering on a regular spring-fitter's block or anvil, but the amount of such hammering, compared with what is necessary to completely change the set of the spring, is negligible and not particularly harmful to the spring, just enough being done to insure a snug fit between the plates.



SHOP PRACTICE

HANDY WORKER TOOL OUTFIT

BY combining various adjustments with a specially constructed vise, a manufacturing firm has contrived a tool that is remarkably useful to the autoist, home mechanic, farmer and to the various trades' men, such as plumbers and electricians who have to handle many pieces of metal or pipe in the course of their daily work. As a vise, the jaws open 4½ inches and as they are faced with hardened steel, they are practically indestructible. The jaw opening mechanism is operated by a hand wheel and screw, the sliding jaw being supported by two substantial and well-



The handy worker, a combination tool that fills many needs of the worker's workshop

finished, cold-rolled, steel rods. The sliding jaw is fitted with a three gear reduction spindle, a special provision being made for carrying the handle on each gear shaft, thereby enabling the operator to drive the top shaft or spindle directly or with an increase of speed of four turns of the spindle to one of the handle when placed on the center shaft and sixteen turns of the upper spindle to one turn of the handle when it is placed on the lowest of the three shafts. The upper spindle extends through a jaw and has a socket for holding square shank twist drills. Two drills are included with the outfit, but as these are the standard form so widely used in blacksmith's post drills, any size can be procured at small cost as needed.

The anvil top may be readily removed and a special "L" shaped bracket fitting put on in its place to form a rest. A five-inch grinding wheel is furnished and is mounted on a detachable arbor from which it can be removed and its place taken by a buffing wheel or scratch brush. A detachable rest is provided so that tools may be ground on the grinding wheel. A pair of detachable vise jaws provide a sure grip on pipe when placed between the vise members. The anvil is very substantial in construction and is fitted with a pritchel hole to receive a cutting hardie and also has the usual horn for bending eyes and doing similar work on light rods.

It will not require very careful study of the illustration to show how the machine can be used as a grinder, by moving the handle to the lower of the three spindles and placing the grinding wheel arbor in the special bearings provided between the vise jaws.

If a suitable drill is placed in the upper end spindle and the vise top removed and its place taken by the drilling bracket, it is possible to do a wide variety of drilling work. The drill is fed into the work that is machined by the same hand wheel that normally operates the vise jaws. The methods of using this tool as a pipe vise are obvious. The anvil portion makes it possible to do quite a variety of light simple work and the cutting hardie provides a ready means of cutting flat or round bar stock quickly. Many uses will suggest themselves to the practical mechanic for this ingenious and useful combination tool.

GUARDING THE EYES WHEN WELDING

AN important hazard in the use of the welding torch is that of injury to the eyes by the heat and glare from the work and by particles of hot metal that fly up from the weld. Properly colored lenses fitted in goggles will furnish complete protection to the eyes. Blacksmiths sometimes think they do better work without them or are too indifferent to wear them, so the injury is done before it is realized.

Amber, yellow and greenish-yellow glasses are the most efficient for protection. The selection of lenses, however, should not be left to chance; goggles with the proper lenses may be procured from several reliable manufacturers. The expensive colored lenses may be protected from injury from flying sparks by a clear glass lens outside of each colored lens in the frame.

Goggle frames preferably should be of a material which is a non-conductor of heat. If metal frames are used, they should be padded. The frames should permit free circulation of air, therefore have wire mesh or vent holes in the cups.

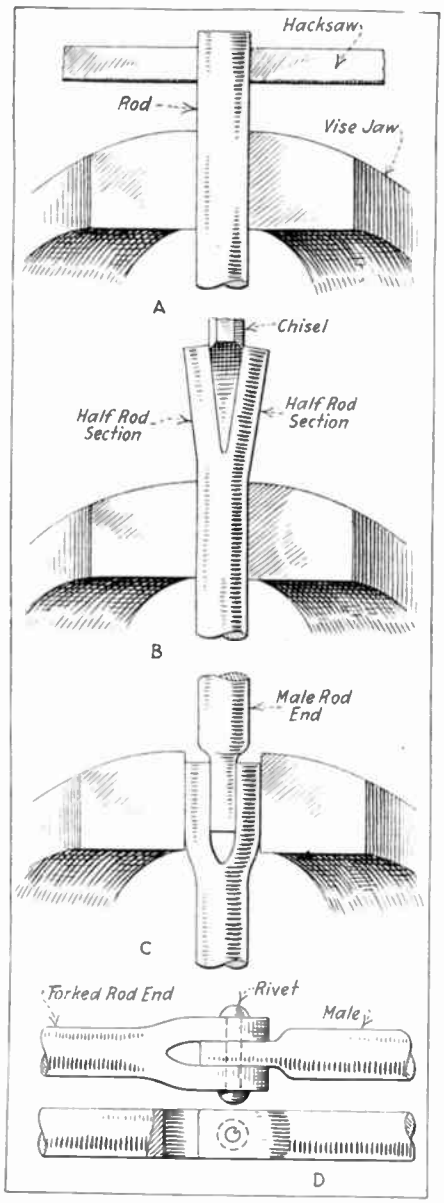
PAINTING IRON SMOKESTACKS

EXPERIENCE has shown that, although there are a fair number of heat-resisting paints on sale, it is doubtful whether for general use the old oil and lampblack paint is not as good as any, where the heat does not exceed about 600 degrees F. Possibly, however, if graphite is used in place of lampblack, the result will be better if the paint is well rubbed in with a somewhat stiff brush, as in itself graphite is a protective for iron when well attached to the surface. There are specially made graphite paints for hot surfaces, but it often happens that these are not available when wanted; while in most places graphite and lampblack are available.

HANDY LINK JOINT

A LINK joint for joining two rods which are to have some degree of motion, and which is very easy to make is outlined in the accompanying illustration. The first step is to clamp the end of a rod of suitable size in a vise as shown at A and saw down to any desired depth along the center line with a hack saw. The depth of the cut depends upon the size of the rod

and is from 2 to 2½ times as long as the diameter of the rod. For example, a split one inch long is enough for a ⅜ inch rod. The next step is to spread the sides of the rod apart with a cold chisel or wedge of the proper shape, as shown at B, the pieces having been moved up in the vise jaws so that these clamp the rod just at the bottom of the cleft portion The male member of the

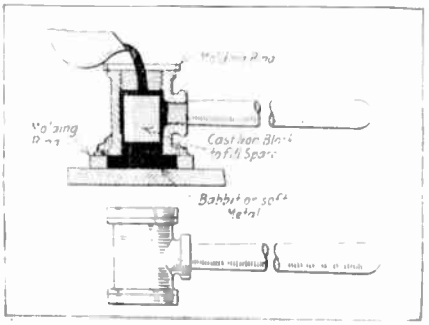


How to make a link joint in rod ends with simple tools

joint is made by cutting away the sides of a round section rod end with a file so that its thickness is only half that of the rod. For instance, on a ⅜ inch rod, the male end or flat portion would only be 3/16 of an inch thick. It is then driven into the forked end of the other rod and the fork sides are closed against the male end by closing the vise jaws as shown at C. The final step is to bore the hole and insert either a small rivet or a stove bolt of suitable size, to form a hinge as outlined at D.

SOFT-FACED HAMMER

WE have given several examples in previous issues on methods of making soft-faced hammers so that finished work could be worked on without marking the surface. For certain classes of work, such as driving out bolts by hitting the threaded end, an all metal hammer is required that will have a soft face. A standard pipe "T"



A practical soft-faced hammer

fitting may be used as indicated and a metal handle can be made from a piece of rod and threaded with a pipe die, or a piece of the proper sized pipe may be used as a handle instead, which is assembled into one member of the "T."

Simple collar moulds are used to form the face of the hammer and any babbitt or soft bearing metal scrap may be melted in a ladle and made to form the hammer head as shown. When the faces are worn or pounded out of shape, it is not difficult to repair the hammer by melting out the soft metal and pouring in a new babbitt.

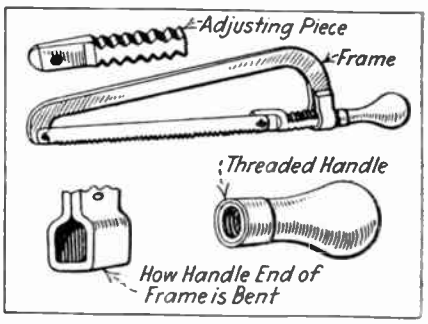
HARDENING AND TEMPERING KINKS

ARTICLES made of tool steel and polished may be hardened without raising a scale, thereby destroying the polish, by the following method: Prepare equal parts in bulk of common salt and (fine) cornmeal, well mixed. Dip the article to be hardened first into water, then into the mixture and place it carefully into the fire. When hot enough to melt the mixture take from the fire and dip or roll in the salt and meal, replace in the fire and bring to the required heat for hardening. Watch the piece closely and if any part of it shows signs of getting "dry" sprinkle some of the mixture on it. The mixture, when exposed to heat, forms a flux over the surface of the steel which excludes the air and prevents oxidation, and when cooled in water or oil comes off easily, leaving the surface as smooth as before heating. Borax would possibly give the same result, but is sometimes difficult to remove when cold.

To temper small coil springs, in a furnace burning wood the springs are exposed to the heat of the flame and are quenched in a composition of the following preparation: To a barrel of fish-oil 10 quarts of rosin and 12 quarts of tallow are added. If the springs tempered in this mixture break more tallow is added, but if the break indicates brittleness of the steel rather than excessive hardness, a ball of yellow beeswax about 6 inches in diameter is added. The springs are drawn to a reddish purple by being placed on a frame having horizontally radiating arms like a star which is mounted on the end of a vertical rod. The springs are laid on the star and are lowered into a pot of melted lead, being held there for such time as is required to draw to the desired color.—*American Blacksmith.*

HACK SAW FOR CLOSE QUARTERS

THE ordinary form of hack saw frame is not always suitable for working in close quarters about an automobile or other piece of machinery and most mechanics have met with difficulty in cutting a key, pin or stud where the regular hack saw frame cannot be used on account of its large size. Any mechanic may make a hack saw frame for himself that can be used in places where the ordinary saw frame could not be employed by following the



Hacksaw frame for close quarters

design outlined in the accompanying illustration. The simple frame is bent up by heating a ⅛ inch by ½ inch piece of bar stock of the proper length. A pin is provided at the front end to fit into one of the holes in the hack saw blade ends while the rear of the frame is bent either square or oval to prevent the saw blade tension fastening fitting from twisting. A special nut which may be soldered to or form part of the ferrule is attached to the usual form of hack saw handle. The saw blade tension adjuster may be made from an ordinary bolt filed flat at the sides so it will fit the back end of the hack saw frame. It will be apparent that as the handle is screwed up, that the saw blade tension member will screw into it and hold the saw blade securely. Parts of an old hack saw may be used if desired in making this saw. The reader should be cautioned against attempting to bend the frame of some of the cheaper hack saws which are merely iron castings and which cannot be changed in shape.

Diving Machine for Ship Salvage

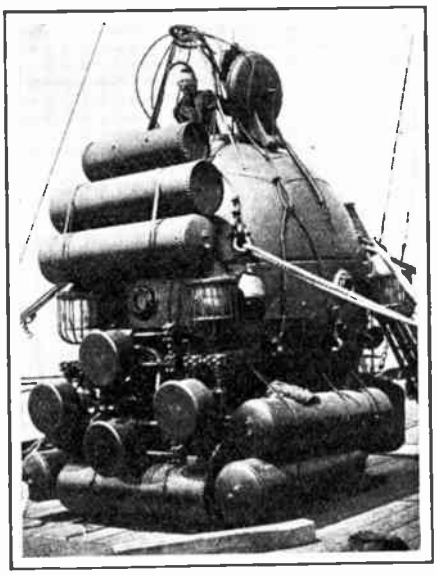
By H. A. Mount

MOST of the hundreds of vessels sunk by submarines during the war lie at ocean depths to which a diver, with ordinary equipment, dare not venture. They can never be salvaged until some method of working effectively at great depths has been devised. Many inventors have turned their thoughts in this direction, for the treasure that lies within the grasp of a deep sea diving machine is enormous. Many of the vessels are known to have carried down with them millions in gold and silver money, as well as untold wealth in imperishable cargo. Even in normal times less than ten per cent of the vessels lost at sea are ever recovered because they cannot be reached.

An inventor, W. D. Sisson, of New York, believes he has solved the problem. He has constructed a monster egg-shell of steel, designed to carry two men and a mass of machinery to depths as great as 1,000 feet in safety. It is equipped with four great electro-magnets for attaching itself to the steel sides of a sunken vessel. It is then able to drill a row of holes in the hull, insert bolts to which are attached the lifting cables of steel pontoons. Air is then pumped from the pontoons and the vessel is lifted in the ordinary manner.

The device is really a miniature submarine, but instead of carrying its own storage batteries or other source of power, electric energy is carried through a cable from a tender ship. The machine is lifted from the ship's deck and lowered to the water by a cable. Once in the water, however, it is navigated entirely by the crew of two men.

The machine is so balanced that it always remains upright in the water. For traveling up or down it has two propeller screws mounted on the bottom. Two other propeller screws and a rudder on the side provide a means of lateral navigation. Four powerful electric lights, in globes designed to resist great pressure, are mounted on the outside of the shell and a number of small portholes are provided for the crew. The machine has just sufficient buoyancy to bring itself to the surface unaided, should something go wrong with the machinery.



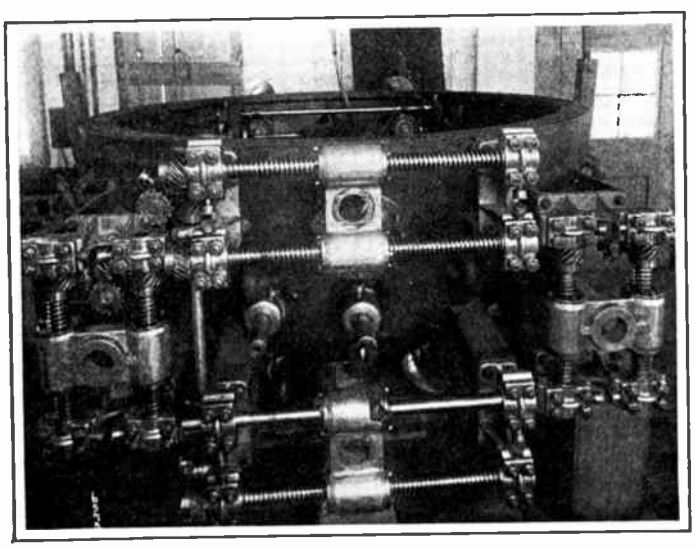
Exterior of diving machine for ship salvage

All of these features do not greatly differ from ordinary submarine practice. The real novelty of the machine is the gear on which the four electro-magnets are mounted. These not only permit the machine to attach itself to the side of a steel vessel, but make it possible for the huge shell to creep along the side of the vessel, or up and down. It will be noted from the illustrations that the magnets are four in number, two mounted on horizontal, and two on vertical screws. If it is desired to move the machine in a horizontal direction, the two vertically mounted magnets only are energized and the horizontal magnets are moved as far as possible to one side. Then the horizontal magnets are energized and the vertically mounted ones are demagnatized. When the horizontal magnets are moved back to the opposite end of the screws, the effect is to shift the whole machine about a foot. By repeating this operation as often as desired, the machine creeps along by very much the same method as a centipede uses in locomotion.

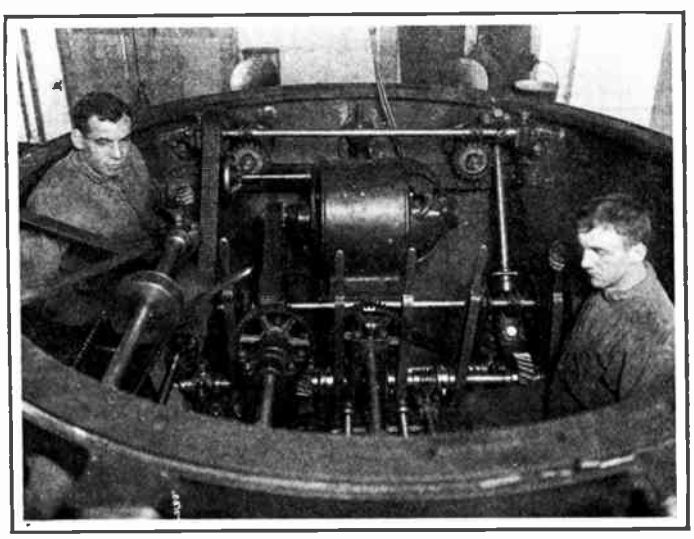
Mounted between the magnets is a large drill, manipulated from the inside of the shell. Its function is simply to drill a hole in the side of the ship. An arm mounted beside the drill is arranged to pick up an expansion bolt and insert it in the hole, after the drill has been removed. The bolt is already attached to the pontoon cable and it is held in an upright position, to prevent tangling, while the machine proceeds to attach other cables of the pontoon. When a sufficient number of pontoons are thus attached, the air is pumped from all of them and the ship is lifted to the surface.

In order to economize in space in the interior of the machine, all of the various working parts are operated from a single electric motor. The various parts are started and stopped by shifting gears. The air supply for the crew is carried compressed in a tank and is released at a predetermined rate. A small exhaust pump expels the bad air at the same rate of speed and thus normal atmospheric pressure is maintained at any depth.

The first of these machines has been completed and it has entirely proved its seaworthiness in a number of trips to



This view shows the mechanism for moving the magnet frames to allow machine to go up or down on the ship's hull



Interior view of ship salvaging machine showing electric motor, internal drive gearing and control levers

the bottom of Long Island Sound, operating at depths of more than 100 feet. It was found that, because of the great weight of magnets and gears on the side, the machine listed in the water and eight steel ballast tanks were attached to the sides of the machine to correct this. It is planned to correct this defect in design in future machines. Pontoons are now being made and when these are completed it is planned to begin actual salvage operations.

AUSTRALIAN "BLACKBOY" TREE

A PECULIAR product of the vegetable world is what is known as the "blackboy" tree which flourishes in the state of Western Australia. It is, in fact, a species of the grass tree, and grows to a normal height of 7 to 10 feet, and is found to be useful for a variety of purposes.

Until recently no attempt has been made to utilize the tree commercially, according to an article in the *Scientific American*, but a company has now been formed to work and market its by-products. The plant consists of nineteen sets of retorts and furnaces, condensers, receiving tanks, etc., and can deal with 100 tons of gum and other material derived from the tree. The company at present employs about twenty men, besides cutters, and among other things being produced are tars (free from harmful acids), turpentine dressings, rope tar and sanitary tar, lacquers (such as Japan black), steam and refrigerating pipe lagging, paint for ironwork that requires stoving at high temperatures, stains and paints, pitches for marine insulating, phenol, benzol and alcohols, coke, potash and pryogeneous acid. The production of dyes perfumes and formalin and various kinds of varnishes is also planned.

RECOVERY OF BELGIAN IRON AND STEEL INDUSTRIES

BELGIUM is gradually rehabilitating her industries, although the progress naturally is slow. In the early part of this year, the pig iron production of Belgium amounted to about 20 per cent of the pre-war production, and the steel production to about 27 per cent of the production in 1913. The wrought-iron production in January, 1920, was over 26,000 tons, which was slightly greater than the average monthly production in 1913, indicating that in this field Belgian mills have entirely recovered their pre-war production capacity. The coal production has also regained the average total previous to the war and in certain districts is now exceeding the output in 1913. In some districts, where the damage to mines was the greatest, the production is still the pre-war figures, but not more than an average of about 15 per cent.

Comparative Efficiencies of Various Prime Movers

THERE are two methods of producing power by the combustion of fuel, either under boilers or within the main cylinders of combustion engines. The greater part of the world's power is still derived from steam which, owing to its proved reliability and greater adaptability to the services demanded of it, holds the field in competition with its rival, the internal-combustion engine. The steam engine exerts powerful starting efforts; puts trains or other masses into motion; operates at any speed from the start to its designed maximum; can develop more than its rated power at reduced speed; can carry severe overloads for long periods, and generally gives ample warning before ceasing to operate; but this is accomplished with a loss of 80 per cent, at least, of the heat energy contained in the fuel supplied to it, a loss which is irrecoverable.

The internal-combustion engine shows a far higher heat efficiency, but cannot start itself without some external source of power; cannot develop its full power except at certain definite speeds, is a poor performer at low speeds, can only operate on moderate overloads for short periods; and may cease to operate owing to a small defect, without warning, so combustion engines have as yet made little progress in competition with steam in locomotive work, and have supplanted steam only to a limited extent in marine and stationary engines.

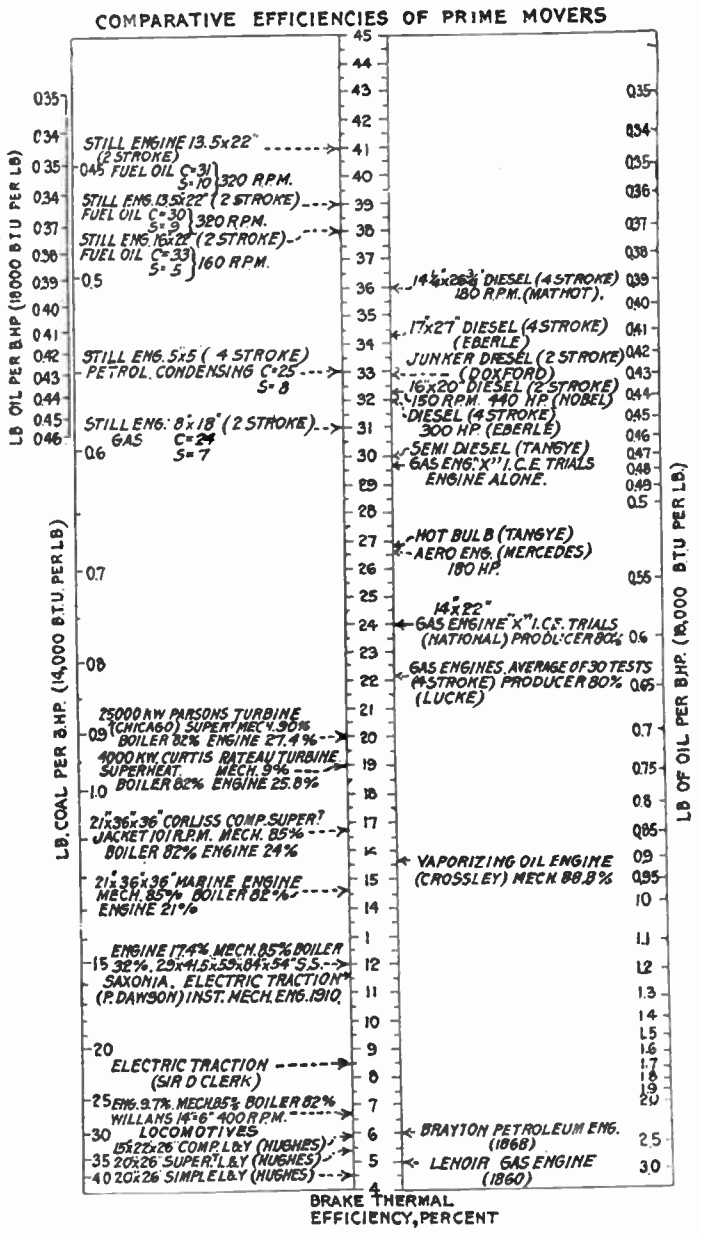
The subject of comparative efficiences of various prime movers are well summarized by Capt. Frank E. D. Acland in a paper read before the Royal Society of Arts, London, in which the Still engine and its advantages was described. Inasmuch as we have previously explained the Still cycle engine in detail and demonstrated how its principles of operation made it very efficient (November-December issue of EVERYDAY ENGINEERING) we will publish this extract which we feel sure will interest those of our readers following power plant development.

The conversion of heat into useful work, with the minimum of waste, depends upon the efficiency of the means employed; that is, it depends upon the losses in the heat cycle, and on the losses in the mechanism employed for producing the heat and converting it into power. The efficiency of a heat engine is the ratio of the heat converted into mechanical work to the total amount of heat which enters the engine. We are taught that, and we owe to our teachers a mass of accurate information about the laws of thermodynamics, thermal and ideal cycles, which serve as standards of comparison for every kind of heat engine; but they do little more than point out the way to getting the most out of the heat in an ideal engine, and ignore the losses in the creation and supply of the heat, or in the machine which converts it into mechanical work. It by no means follows that an engine which thermodynamically attains the highest indicated efficiency is best for its purpose, or is the most economical in fuel. Efficiency from the user's point of view is the ratio of the useful work to the total heat in the fuel used.

The accompanying chart shows the brake thermal efficiencies of various types of prime movers, steam, gas, and liquid fuel, with the fuel consumption in pounds per shaft horsepower-hour, based upon a calorific value of 14,000 B.t.u. per lb. for coal and 18,000 B.t.u. for liquid fuel. The mechanical efficiencies of the various engines and heat efficiencies of the boiler and producer, when not expressly stated in the reports of the trials, are assumed to be as shown. Comparing the cycle of steam with that of combustion engines, the latter has two great advantages over the former. The fuel which imparts the heat to the working fluid is introduced directly into its working cylinder, and the temperatures and pressures are far above the limits of those possible in the steam engine and boiler. The steam engine suffers from heavy heat losses in the creation of its heat; it is forced to work at comparatively low temperatures and pressures, and with superheating, compounding and condensing added to it, has arrived at a point where further efficiency is well nigh impossible.

Sir Dugald Clerk, in his paper submitted to the Royal Society of Arts, in March, 1919, compared the thermal efficiency of the gas engine, which is 28 per cent, with an efficient producer, with that of the largest and best of existing steam turbines, which is 18.5 per cent referred to the coal consumption under the boiler, and alluded to the probability of great improvements in gas engine efficiencies. The further recovery of thermal loss in the steam engine, or in the mechanism, is a difficult if not an almost impossible task. In the internal-combustion engine all the losses at present existing are capable of some recovery, and certainly of considerable reduction.

The maximum ideal efficiency of a heat engine is obtained where the difference existing between the highest and lowest temperatures of the working fluid is greatest in proportion to the



maximum temperature, and here the internal-combustion engine, with an initial temperature higher than the furnace temperature of the boiler and even higher than the melting point of cast iron, is capable of realizing better thermal conditions than any other form of heat engine; but in its turn it suffers from two disadvantages, it ejects its working fluid at a temperature too high for ideal conditions, and it loses heat energy to a regrettable extent in the cooling of its cylinder. The result obtained in practice from the two cycles separately, based on their best performances after half a century of intensive development, is that in the steam engine there is a loss of over 80 per cent of the heat contained in the fuel, and in the combustion engine of 60 per cent.

The recovery and the efficient use of the waste has been the work of many years of patient research by William Joseph Still and others associated with him, and has resulted in the design and construction of a variety of engines which bear out the correctness of his principles, and point to a vast field of further practical application. The possibility of combining in one engine the superior thermal cycle at the high temperatures and pressures of the combustion engine with the low thermal cycle of steam to deal with its rejected heat, and, in the same engine, to add the superior working advantages of the steam engine, was the basis of his work.

The development of the internal-combustion engine has included many proposals and attempts to utilize the heat going to waste in the exhaust and cooling water; but while in existing engines some proportion of the heat can be usefully recovered as steam from the exhaust gases, the cooling water from the jacket is of little value, owing to its low temperature, and the efficiency of the engine itself is not augmented. If, however, the temperature of the cooling water could be maintained at that of steam at useful pressure, the efficiency of the engine would be improved and the weight of steam usefully increased.

POWER ECONOMY

IN any wood-working shop, business economy should be exercised in the use of power, and this applies both to the use of an engine or the employment of electric power for motors. Cut down the running of idle lines of shafting and belts, and long reaches that may be shortened. Where motors are used the shafting and belt loads can be cut very low. In some shops the setting of the shafting and machinery could be altered so as to lighten the friction load of shafting and belts materially.

Not only in this way can power be saved, but roller and ball bearings can be used in hanger bearings to save power. Too much speed and dull knives and saws in the woodshop are great power wasters. Proper speed of wood-working machines and keeping cutters sharp will work a great economy in many a shop. A hand saw running too fast may consume nearly twice as much power as it would for the same work if reduced in speed. Speed reduction in a case of this kind not only saves power, but it saves wear and tear on the machine, too. It is the same thing with planers. In the past we have too often sought to make speed serve in the place of more careful adjustment of the knives. It has taken the modern machine with knives jointed while running and the electric motor direct connected to show us how power was wasted in excessive speed with planers.

OIL, SUGAR AND ALCOHOL FROM AN AFRICAN TREE

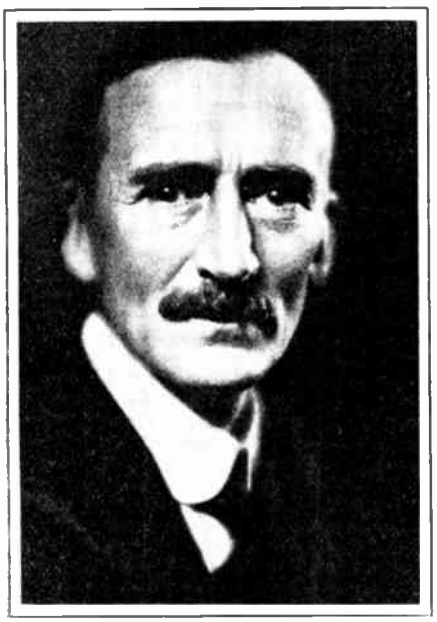
THE sump tree or Balanites aegyptiae Del., five or six million tons of whose fruit are gathered annually in Senegal, is a variable source of oil, sugar and alcohol. The fruit consists of an oleaginous spindle-shaped kernel enclosed in a hard fibrous shell and surrounded by sweet pulp containing a very high percentage of sugar and enclosed in a tough skin. The kernel contains 41.80 per cent of fats and 25.32 per cent of nitrogenous substance. However, the shell is so difficult to crack that only the pulp can be at present considered useful for industrial exploitation. This pulp contains sufficient fermentable material to hold from 9.7 to 10.8 cm. of sugar per 100 gr. of fruit. The composition of the fruit is as follows: Sweet pulp, 42.9 per cent; shell, 48.3 per cent; oil-bearing kernel, 8.8 per cent. The sweet pulp contains 40.3 per cent sugar.

Features of the Spirograph

A New Type of Moving Picture Projector for Home and School Use That Employs a Novel Form of Film That Can Be Handled By Anyone

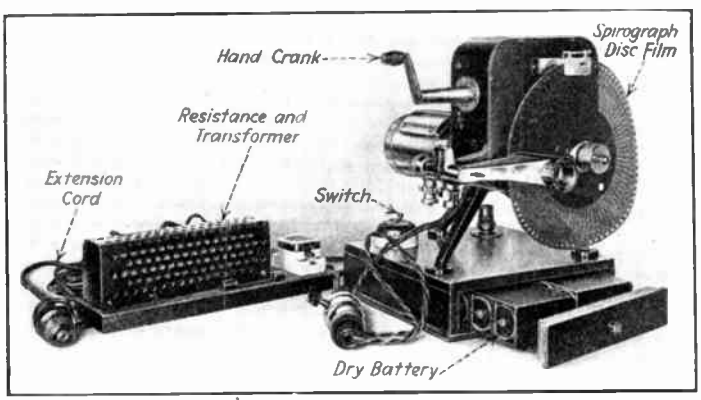
By Fred. E. Baer

THE word "Spirograph" is a name given to a system of moving picture photography intended primarily to be used in the home; it indicates a "Spiral writing or record." No claim is made for the novelty of reproducing photographs in spiral order; in fact, the idea had birth prior to the introduction of the present day moving picture film. The first attempt was to make the negative direct in a specially designed camera provided with a glass photographic plate mounted to rotate intermittently upon a common center and at the same time to gradually feed across the optical axis of the picture, so that each succeeding picture would be slightly nearer the common center than its predecessor; from this negative it was sought to print an indefinite number of positives, also on glass. The foregoing method failed right from the start: 1st, it is impossible to take a photograph direct by any means sufficiently small in area to meet the requirements of Spiral Photography; 2nd, the weight of the glass negative or positive produces a much greater inertia than is possible to be overcome by the slightly built retarding mechanism, even the tensile strength of the glass itself is insufficient to prevent shattering, for it must be born in mind that the standard number of pictures per second (16) must be shown in order to maintain the continuity of motion, such as we are all familiar with at the "movies". This fact allows but 1/64th of a second of time in which the glass negative or positive must be started and stopped in motion between the periods of rest; 3rd, the weight of glass plates necessary to equal 1,000 feet of film alone would prohibit the commercial use of glass for this purpose.



Henry W. Joy, who developed and perfected the Spirograph after ten years' study

The inventors of the now perfected Spirograph apparatus had first to solve by what means the foregoing difficulties could be overcome. The first step was to abolish the idea of obtaining the negative direct in a camera, as the physical construction of any fast emulsion would not permit of the reduced size of picture. The Spirograph Master-Negative is now obtained by slow reduction from a moving picture positive film, a special machine having been constructed for this purpose. This machine is virtually an ordinary moving picture projector fitted with a special optical reduction system projecting the miniature pictures upon a photographic glass plate whose movement is geared to alternate with the movement of projection, the spiral order of recording is obtained by gearing designed for the purpose of automatically generating a spiral after the manner of cutting a scroll in a lathe.

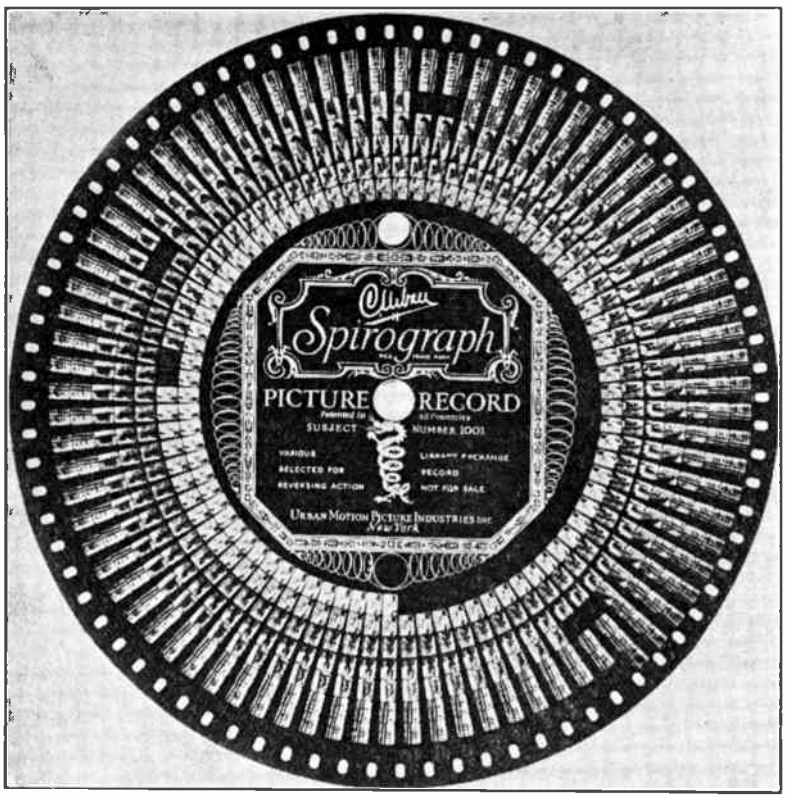


The simplicity of the Spirograph Projector makes it possible for anyone to use and operate it

The negative plate rotates intermittently upon a common center and receives the impression of approximately 35 pictures per minute. It is perhaps needless to point out that the photographic plate used for the purpose of obtaining a Master-Spirograph-Negative must be coated with a suitable emulsion, the ordinary slow plate being totally unfit for this purpose and it required many years of research before this difficulty was solved. To make the Spirograph a commercial success, it was absolutely imperative that the definition of the original moving picture positive film be maintained throughout the process and finally to the product placed on the market. This has now been accomplished. Having obtained the Master-Spirograph-Negative, it is transferred to the printing department, where by means of a simple photo printing process, as many copies or positives can be obtained as desired.

The Spirograph set up so the pictures may be seen through the eyepiece

The positive or record is printed upon a square of non-inflammable stock or base in preference to the ordinary celluloid base on account of the fire hazard of the latter; although the fire risk of the Spirograph projector is nil and it is impossible to fire ordinary celluloid by stopping the machine indefinitely. The use of the "non-flam"



How the Spirograph eight-inch film disc looks. Note arrangement of pictures and small amount of space given to titles

has been decided upon to avoid the fire risk of storing celluloid in quantities.

After the square of Spirograph positive is developed and dried, the circular record is punched out and transferred to the perforating machine where a circle of 100 small elongated holes are punched in regular order near the periphery of the disc. These 100 holes are cut to permit the intermittent gearing of the projector engaging same and so imparting the necessary intermittent rotary movement to the disc. This method reduces the inertia of the disc to a minimum; consequently the wear and tear of both the disc and projector is scarcely noticeable; in fact, the discs can be projected many thousands of times. The holes along the edge of the disc are slightly elongated with parallel sides. This is to compensate for contraction or expansion of the disc.

The Spirograph Projector is the only machine used in the system that is supplied to the public user. It virtually embodies the same fundamental principles as the everyday moving picture projector; i.e., the projector comprises a lamp, condenser, shutter, picture, projecting lens and intermittent mechanism; the distinctive difference being that whereas the ordinary picture machine uses a long ribbon film, the Spirograph Projector employs a flat disc with the pictures arranged in spiral order with the first picture starting on the outside or largest diameter circle. This procedure abolishes the trouble of having to rewind and also eliminate the troublesome handling of roll film.

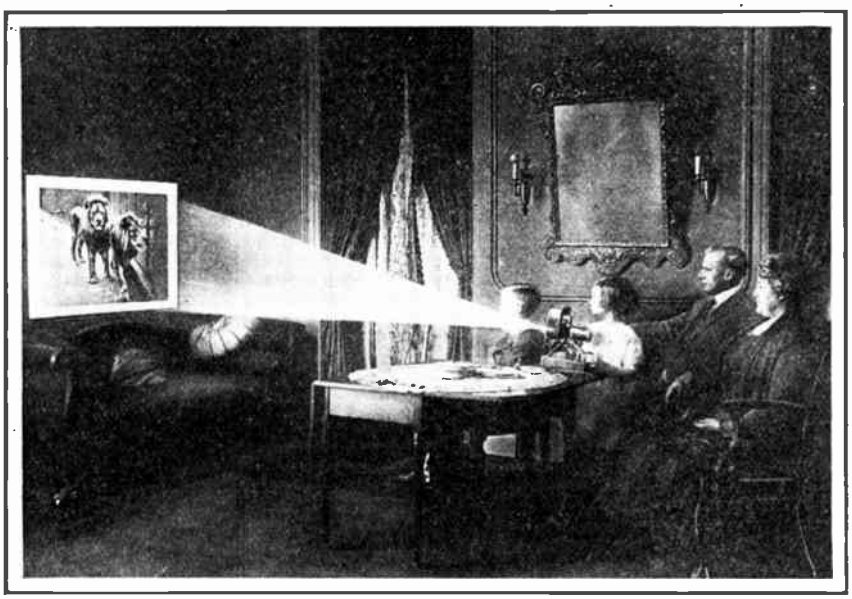
The actual size of the Spirograph picture on the disc is 7/32 of an inch across by 5/32 in height; the 10½ inch diameter disc contains 1,200 pictures, which is equal to 75 feet of film, exclusive of titles, as ordinary film is from 30 to 40% titles, it is admissible to state than a 10½ inch Spirograph record is equal to 100 feet of the ordinary film. Of course, titles are used in the Spirograph picutres, but not more than two pictures are devoted to any title, thus saving the available space for pictures. When projecting with the Spirograph the operator on coming to a title stops the machine with the title projected upon the screen for as long as is required by the audience to read same.

The lamp used for projection the Spirograph pictures is approximately 30 candlepower (with a concentrated filament similar to the type of lamp used in automobile headlights) working preferably at 6 volts. A lamp of this rating can be run direct off any form of 6-volt storage battery and when used on any voltage higher than 6-8 volts a resistance is necessary; when used on a 100-200-volt alternating current a miniature transformer can be used to better advantage than a resistance.

Any form of low voltage focus lamp can be used. With such a lamp as described, an excellently illuminated picture, 30 inches across, can be obtained at a distance of 18 feet; using the same lamp and lens any size picture smaller than 30 inches across can be obtained by decreasing the distance between the screen and machine and focusing accordingly. Should a larger picture be required a small arc lamp, consuming 3 to 5 amperes, must be employed.

The possibilities of diversifying the operation of the Spirograph Projector are unlimited, for, in addition to its regular function as a moving picture machine, the handle can be turned at will in the reverse direction for reversing the order of motion. The machine can also be stopped indefinitely when the focus lamp is used, without firing or blistering the film, so making an admirable stereopticon. When electricity of the usual home service cannot be obtained, resort may be had to a dry battery concealed in the base of the instrument or a storage battery may be used. Should it be desired to view a Spirograph disc in daylight, all forms of electric lamps can be dispensed with, a simple manipulation converting the projector into an animated microscope.

The Spirograph system can also be applied to the production of moving



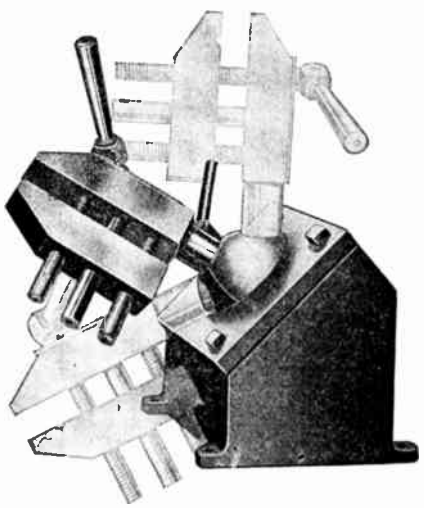
The Spirograph projector brings entertainment to the home circle and has great possibilities for educational use in shop, school or home

pictures in natural colors. To do this the Master Negative must be made from a natural color positive film, i.e., a film holding a black and white register of natural color values arranged in alternate sequence. To supply the color elements to the Spirograph disc, the rows of pictures radiating from the center are tinted uniformly red and green, according to the color value each row represents. When finished, the natural color disc resembles a wheel having 100 spokes alternately colored red and green. As the eye, or rather the brain, of the observer cannot retain color vision with the same rapidity that the disc is projected, an apparent blending of the two colors occurs, so conveying a picture in correct natural colors.

In the Spirograph system of "home movies" we have the ideal combination of all that is possible with moving pictures, giving to the world a means whereby all classes can be educated and amused, so producing in a very pleasant manner an extremely effective method of education where the orthodox methods sometimes fail. The projector weighs but eleven pounds and is so small it fits easily into a handbag. The records are of very light weight, as 25 of them tip the scales at about 6½ ounces.

NEW HAND VISE

WHEN small parts are to be drilled or repaired, the usual form of hand vise must be supplemented by a monkey wrench to keep it from turning on the drill press table under the torque when drilled. We illustrate herewith a recently devised hand vise



New hand vise

that seems to fill a real need that has existed for some time. It will be a very handy tool for jig makers, die sinkers, jewelers, machinists and even for the home-mechanic.

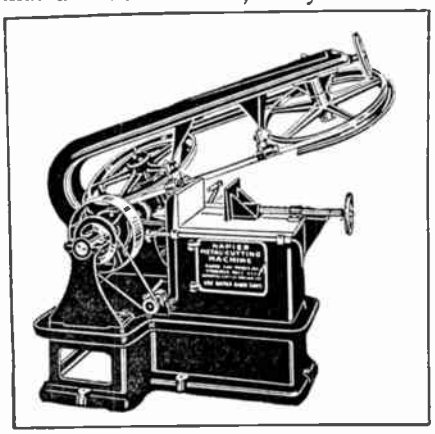
One of the many features is the arrangement by which one lever operates two screws which open or close, partly jaws. A "V" is machined in the movable jaw so that the vise can be used for round or flat work. Attention is directed to the handle extending from the vise which makes it possible to use it in connection with any ordinary form of bench vise or with a special Grip-Tite device, which is made by the same makers.

The handle of the device is easily inserted in the holder and a one-fourth turn of the piston lever on the base member opens the ball socket and permits of turning the vise in almost any desired direction as indicated. When the piston lever is tightened the ball socket is securely clamped and the vise is held at any desired angle.

CONTINUOUS CUTTING HACK SAW

IN cutting soft metal with the ordinary form of hack saw, it is evident that no useful work is done during the return stroke of the saw. In cutting soft metal, it is apparent that continuous cutting is just as advantageous as in other machining operations. When rapid production is necessary, milling has superceeded planing and sharpening on many classes of work on account of its greater speed.

The band-saw machine illustrated has been designed to do the same work that a hack saw does, but yet to do it



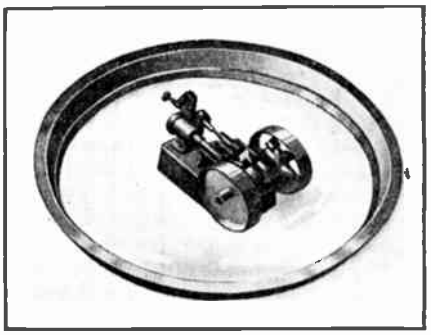
Continuous cutting hack saw

continuously. It is stated that a machine of this type will do twice as much work as a heavy-duty hack saw machine of practically the same size. The principle of operation is extremely simple, as it resembles the ordinary form of band-saw used in wood working except that the arrangement of the saw supporting wheels is such that the saw may be operated with the wheels horizontally placed. The general construction of the machine can be easily ascertained by studying the clear illustration presented.

The development of this machine has been made possible by the improvement made in the manufacture of metal cutting band-saws and on certain classes of work, it is said that this type of machine is more economical than the usual type of machine in which the saw frame is given a back and forth motion.

A SMALL MODEL STEAM ENGINE

THE small model steam engine shown herewith is not new, having been exhibited at the world's fair nearly 30 years ago; but when a correspondent of the *American Machinist* ran across it a few weeks ago he decided that it was worth photographing and presenting as a novelty to many of their readers, to whom the world's fair is very ancient history indeed. We know that many of EVERYDAY ENGINEERING MAGAZINE readers will also be interested in this diminutive power plant.

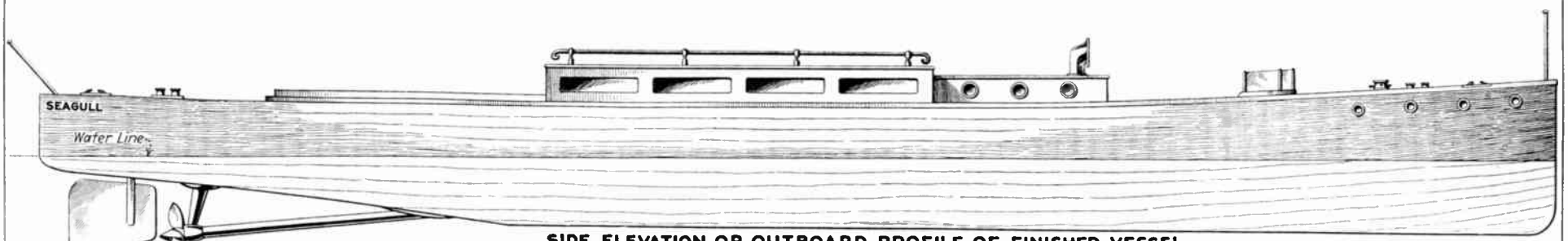


Small model steam engine

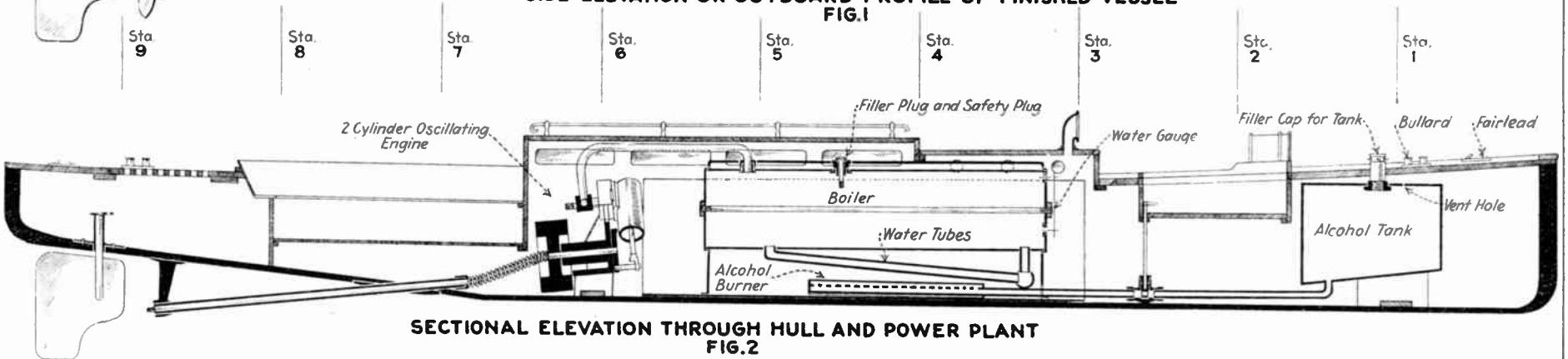
The thing upon which the model is resting in the engraving is not a pie-plate; it is the crystal and bezel ring of an ordinary-sized watch. The engine is made of gold, silver, brass and steel, and weighs 20 grains. The bed is ½ in. long; the bore of the cylinder is 0.083 in., the stroke 3/32 in. It has a perfect working flywheel governor, a cylinder lubricator and a throttle valve. There are stuffing boxes around valve and piston-rod that can be packed and the main bearings are adjustable for wear. The model was built by Charles H. Allen of Pittsburgh when he was but 19 years old. The construction occupied his spare time for 15 weeks.

NEW USES FOR STAINLESS STEEL

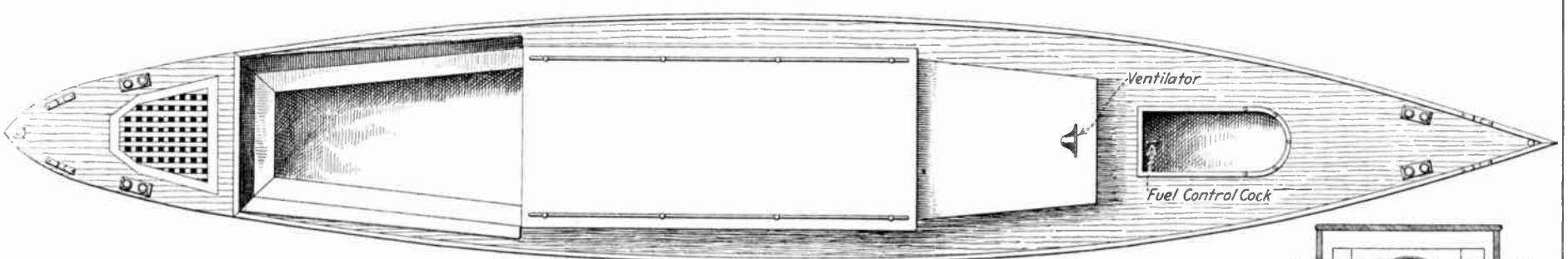
SINCE the Armistice there has been an enormous sale of stainless steel for cutlery purposes. The demand is increasing, and the labor and machinery in the Sheffield cutlery trade are inadequate to deal with the influx of orders. Stainless steel is being employed very largely in the manufacture of pump rods, valve spindles, valves and other parts which are exposed to contact with water, steam and other corrosives. The scientific instrument trade is using it for drawing instruments and other precision tools and for surgical instruments. It is being manufactured into stair rods, saucepans, and pans of varying shapes, fenders for the hearth, and even into pokers and garden implements; and butchers' rails, spikes, skewers, saws, and other butcher-shop requirements are being made from it. Stainless steel is also being used for golf-club heads, spurs, etc.



SIDE ELEVATION OR OUTBOARD PROFILE OF FINISHED VESSEL
FIG.1



SECTIONAL ELEVATION THROUGH HULL AND POWER PLANT
FIG.2



DECK VIEW SHOWING THE ARRANGEMENT OF FITTINGS AND CABINS.
FIG.3

A STEAM DRIVEN MODEL CABIN CRUISER

Designed by Wm.A.Helms

Dimensions:-

Length overall 39 inches
Beam 6-3/8 in.
Draft 1-3/4 in.

Scale in Inches

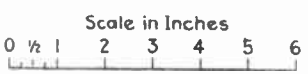
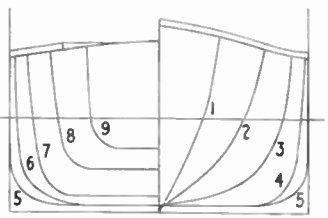
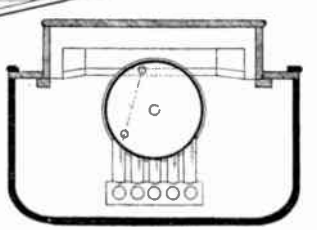


FIG.5



BODY PLAN MOLDED FIGURES



SECTIONAL CUT THROUGH HULL AND BOILERS
FIG.4

How to Construct a Steam-Driven Model Cabin Cruiser

By Wm. A. Helms

AT various times I have seen model steamers of all types and what impressed me most was the crude imitations in regard to the ship fittings and the shape of the hulls. These were usually very heavy and clumsy and entirely out of proportion with each other and with the original vessel which the model was supposed to represent. Therefore I am describing in this and following articles different types of model steamers, paying special attention to have them true to scale, the hull as well as the fittings. Any vessel equipped with the proper fittings is a credit to the builder and will be a model to be proud of. For this reason the model described here is not built to break speed records, but I am sure it will appeal to the model engineer, who appreciates a good-looking and seaworthy craft.

This does not mean that I do not approve of those who build model speed boats. On the contrary, I hope to satisfy those readers later with the description of a record-breaking model speedboat. To build a successful boat of that kind the builder must be very experienced in the handling of the tools and must be able to do accurate work. And it will be a great advantage to him to have first built model boats of ordinary models.

Specifications

The model described here is a 39-in. cabin cruiser with a beam of 6 3/16 in. and a draft of 1¾ in. The hull is made of wood and cut out of a solid piece. The deck is made out of ⅛ in. board of white pine. The cabins and foot railing are made out of ⅛ in. mahogany board. The fittings, such as bullards, fairleads and ventilators are made of brass and highly finished. The hull is painted in two colors, green and white, while the deck houses are finished in mahogany with port holes made of brightly polished brass rings. This finish assures a very realistic and pleasing appearance. The boat is operated by steam. The engine used is the double cylinder single acting oscillating engine described in the September issue of this magazine.

The boiler used is a small water tube boiler of the type being used in model locomotives and is fully described in a separate article. The method of firing is by a plain alcohol burner of special design to suit the small head room available.

The propeller is 1¾ in. in diameter, three-bladed and finished from a bronze casting. The shaft runs through a stern tube let into the propeller post and fitted with stuffing boxes. The rudder is made of stout brass plate and soldered to a 3/16 in. brass stock which passes up through a brass tube fastened to the bottom of the boat.

Hull Construction

In constructing the hull there are several methods from which a choice may be made:—(1) the solid block model; (2) the bread and butter hull; (3) the built-up hull; (4) the metal hull. I do not want to go into the merits or demerits of the different methods and leave it to the reader's own choice. But for those who have no experience in model boat building, I will describe the solid block method, which I favor.

Hull Cut from Solid Block

The hull is cut out of a block 40 ins. long, 6⅜ in. wide and 4 in. deep. Plane the block all over, except the ends, so that bottom, sides and top are square to one another, and flat. Then mark out along the top and bottom the longitudinal center line. This finished, mark the water line and cut out of a piece of paper the side pattern of the hull as shown in Fig. 1 and secure it to the sides of the block using the water line as a guide. Next cut the deck pattern and fasten it to the top of the block, using the longitudinal center line to line it up. Then cut the shapes of the hull according to those patterns. Next mark off on the block the longitudinal ordinates or stations 1 to 9 (see Fig. 5) 4 in. apart. These should be square across the bottom and top and down the sides. Then cut the patterns of those ordinates out of cardboard with the help of Fig. 5. They are used to gauge the hull when it is being cut down to shape, which is the next step. Having the outside finished and smoothened with sandpaper, we hollow the block out, so as to have the hull when finished a uniform thickness of not less than ⅛ in. The sharp edges of broken glass pieces are very handy in taking off the high spots of a hull.

Having finished the hull, and before finishing the deck and cabins, we have to install the engine, boiler and propeller shaft. After giving the inside several coats of varnish or shellac, carefully measure out the space where the boiler is to be placed and line the inside of the hull for a space of 10 in. with a thin layer of asbestos, and cover this with a very light piece of sheet aluminum, this is done to prevent the heat from the alcohol lamp from blistering or burning the hull.

Then we find the point of entrance of the propeller shaft into the hull and drill a hole of 3/16 in. diameter to admit the shaft, and fasten the stern-bracket on the bottom of the hull. Having the propeller and propeller shaft in place, we install the engine, and connect the propeller shaft with the flywheel by means of a flexible joint. The engine used has been described in the September issue of this magazine. It is fastened to the bottom of the boat with the help of wooden sleepers.

In the next issue I will take up the construction of the cabins and fittings and finish the installation of the power plant.

NEW METAL ALLOY

DURING the war an Italian engineer, Adolfo Pouchain, after a series of experiments succeeded in producing a new alloy of zinc and copper, which has been given the name "Blakmetal." This alloy quickly demonstrated its usefulness in Italian industry, and by reason of its special qualities promises to attain similar success throughout the world. The industrial value of a product which is stronger than steel and less corrosive than copper is evident, and it is claimed that Blakmetal, which has passed the experimental stage, possesses these qualities. The most important characteristics are stated to be as follows: (1) The highest known breaking point; (2) the highest limit of elasticity; (3) perfect homogeneity; (4) high resistance to thermic action, and (5) high resistance to chemical action.

Blakmetal is extremely well adapted for almost any kind of manipulation. It can be successfully cast, turned, drawn, forged, rolled and stamped. While its development is still in progress it has already proved especially useful in aeronautic and marine construction on account of its light weight, its unusual strength, and its anticorrosive qualities. In its different forms it may be substituted for steel, brass and aluminum, and for certain uses has important advantages over these metals.

A MODEL WATER TUBE BOILER

By Wm. A. Helms

THE boiler described here is specially designed to be used in small model boats in connection with the twin cylinder single acting oscillating engine described in the September issue or the single cylinder double acting oscillating engine described in the August issue. Special attention is paid in the construction to keep the height of the boiler as low as possible so that it can be used in scale model boats where only a limited space is available. The height is only 3 9-16 inches.

The boiler consists of a 2-in. outside diameter brass tube 8 1-2 in. long and 3-64 in. thick. The ends are spun out of 3-64 in. sheet brass. They are held in place by a 1-8 in. stay and are silver soldered to the tube.

The five water tubes are made of 1-4 in. O. D. copper tubing and are to be fastened to the boiler tube before putting the ends in place. The joint tube is made of 1-2 in. outside diam. brass tubing, wall thickness 1-32 in. The ends are closed by 2 discs which are silver soldered in place after the holes for the vertical tubes and the slanting tubes have been drilled and threaded. It is necessary to silver solder the water tubes into the joint tubes as the threads alone will not be sufficient to keep it steam tight.

We proceed by drilling the necessary holes for the water tubes into the main boiler tube. The five holes for the verticle tubes are drilled 1-2 in. from the end of the boiler. The holes for the slanting tubes are drilled 6 15-16 of an in. from the end of the boiler. We now take the water tubes and fit them into the bottom of the boiler and silver solder them in place. The drawing clearly indicates their position.

Next we drill the holes for the safety valve and steam pipe bosses. Having soldered them in place we take the water gauge and fasten it to the boiler end which is placed nearest to the vertical tubes. (For description of water gauge see the August issue of this magazine.) We then silver solder the end plates in place and put in the stay. The latter is made of 1-8 in. steel rod. This finishes the boiler proper.

The flame-guard which also serves as support for the boiler is made of 1-32 in. sheet brass. The drawings clearly show the pattern and it is easily cut out and the boiler tube fitted into it. The alcohol burner is of special design and will be described in the next issue.

THICKER AEROFOILS

A REPORT upon the aerodynamic properties of thick aerofoils suitable for internal bracing deals with the results of a series of tests conducted at the Massachusetts Institute of Technology wind tunnel, with a view to developing aerofoil sections thick enough to permit of internal bracing and the use of cantilever wings without any external bracing of the airplane wing truss. The sections tested were based on the Durand 13, and were varied in section form, in thickness along the span and in chord along the span. Tapering both in thickness and in chord was found to be highly beneficial to efficiency, and some of the wings developed gave L.-D. ratios practically as high at angles corresponding to very high speeds of flight as the best of the wing sections for normal type, together with very much higher maximum lift co-efficients. In particular, it was found that the substitution of a thick tapered wing for R. A. F. 6 on a 3,600-pound fighting biplane with Liberty engine would increase the maximum speed by 18 miles per hour, due to the saving in parasite resistance by entire elimination of the interplane bracing. A copy of this report may be obtained upon request from the National Advisory Committee for Aeronautics, Washington, D. C.

It is stated that satisfactory results have been obtained, according to the *Canadian Engineer*, from the investigations carried out by Professor A. Stansfield, of McGill University, into the reduction of iron ores by gases at low temperatures with the electric furnace. Iron ore, iron and steel and their products are annually imported into Canada to the value of more than $150,000,000, and it is claimed that the development of economic methods of utilizing the low-grade ores existing in Canada would render the greater part of this importation unnecessary.

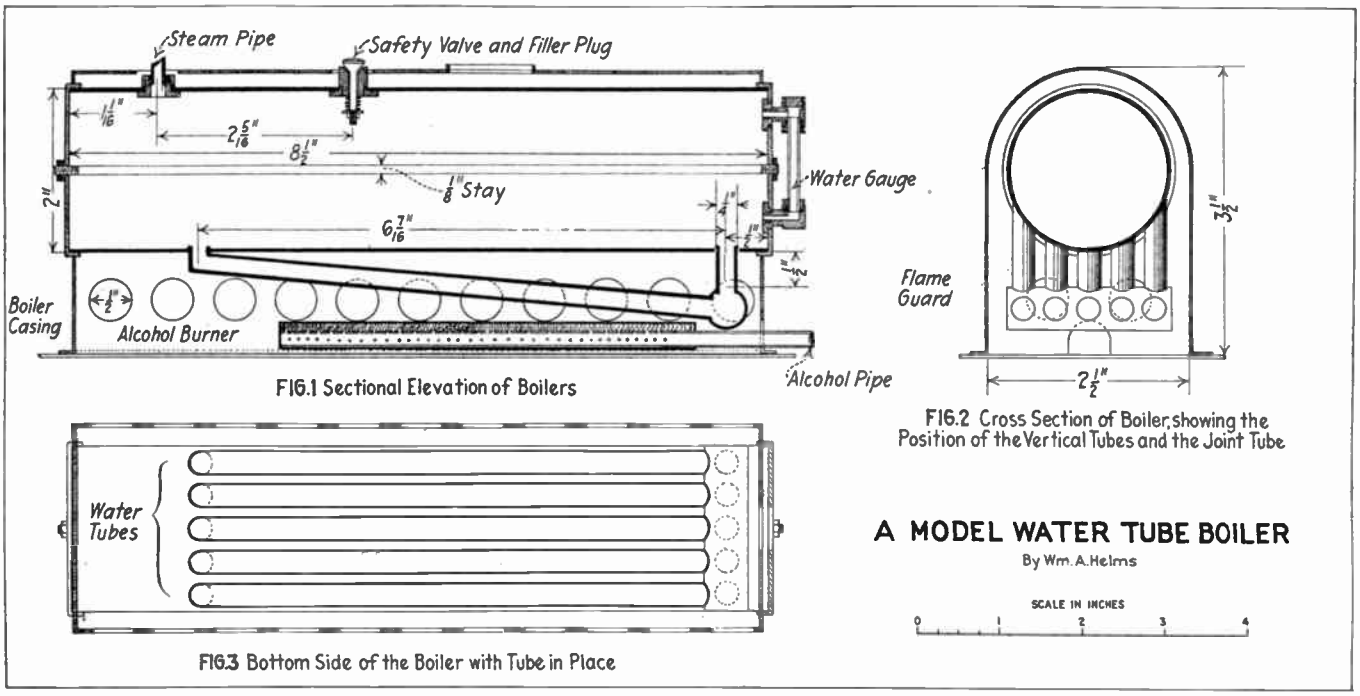


FIG.1 Sectional Elevation of Boilers

FIG.2 Cross Section of Boiler, showing the Position of the Vertical Tubes and the Joint Tube

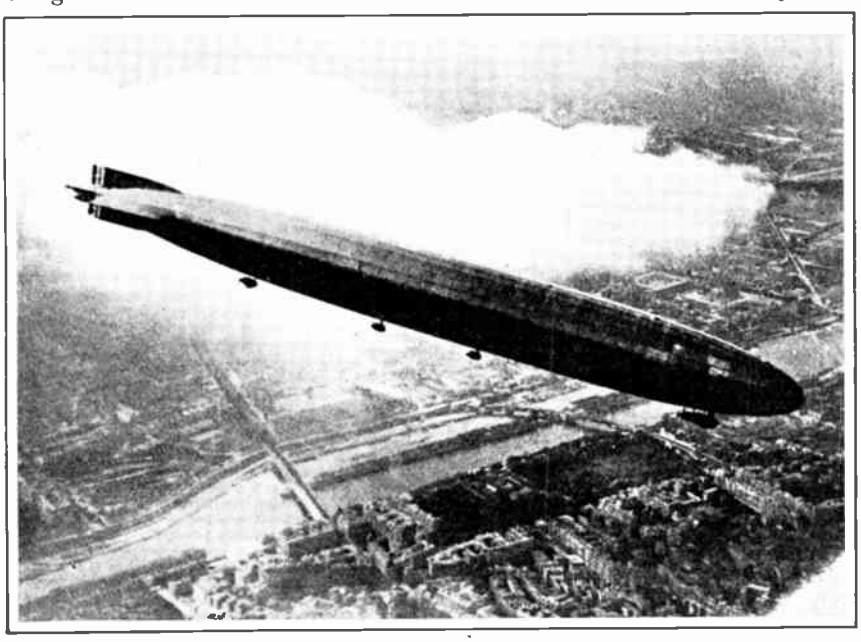
FIG.3 Bottom Side of the Boiler with Tube in Place

GERMAN ZEPPELIN L-72

THE accompanying illustration shows the large German Zeppelin L-72 which has been previously described in these columns, and which was recently surrendered to the French Government according to the Armistice terms. This Zeppelin was built especially to bomb New York, but was not completed in time to accomplish this sinister purpose.

It is one of the largest of the German Zeppelins, and it is stated that it not only carried enough bombs to do considerable damage in any large city, but that it had capacity enough to carry stores and fuel for 9,000 miles flight without landing. This would have permitted the machine to make the trip from the interior of Germany to New York, drop its bombs and return to Germany without having to land on the way.

It is fortunate indeed that the Armistice intervened to make the trip of this giant air-liner impossible. It is reasonable to assume that if it had accomplished its purpose, and there was nothing available in the American



The German Zeppelin L-72 in flight over Paris

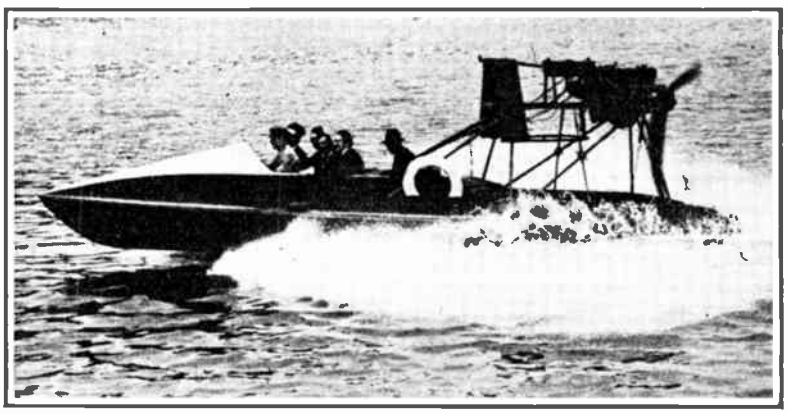
forces home defensive equipment to have prevented it, that the American public, of one large city at least, would have had considerably more respect for the war-time possibilities of aircraft and the public at large would demand considerably more defense against attack by enemy aircraft than the present careless Government policy gives us.

PORCELAIN WORKED LIKE GLASS

WE learn from *Die Naturwissenschaften* (Berlin) that a Bavarian firm has lately succeeded in producing porcelain vessels which are highly resistant to changes of temperature. For the solution of this problem it was necessary to produce a glaze having exactly the same co-efficient of expansion as the mass of porcelain vessels highly resistant both to temperature and to fracture since the cracking and bursting of porcelain apparatus at abrupt changes of temperature is usually due to the creation of strains between the glaze and the mass as a result of unequal co-efficients of expansion of the two materials. These new porcelain vessels, on the contrary, can even have holes fused in their walls by an oxy-hydrogen blowpipe without cracking. Moreover, separate pieces of porcelain can be fused together exactly like glass, so that a porcelain tube, for example, can be fused into the wall of a dish. Finally, this new porcelain can be softened and blown like glass. These qualities seem to assure it a wide usefulness.

AIR PROPELLED SPEED BOAT

THE illustration below shows a speed boat of French design that is propelled by an airplane engine and an air propeller. As will be evident, the passengers are carried in the front cockpit, while the power plant is mounted at the rear of the hull. The engine is a Hispano-Suiza aviation type and is supported by a substantial, but light framework of steel tubing, which carries the entire power plant high enough so that the propeller swings clear of the hull. The radiator is mounted at the front end of the framework and is triangular in shape, while the fuel tank for auxiliary supply is carried back of the radiator. The main fuel tank may be carried in the hull and gasoline supplied to the upper tank by a pressure pump. This power plant installation is especially well adapted for speed boats of the displacement or hydroplane type and ought to be very valuable for use in shallow water. Great speeds are possible with craft of this construction.



Speed boat propelled by Hispano-Suiza motor and aerial pusher screw

MANY USES FOR GLYCERINE

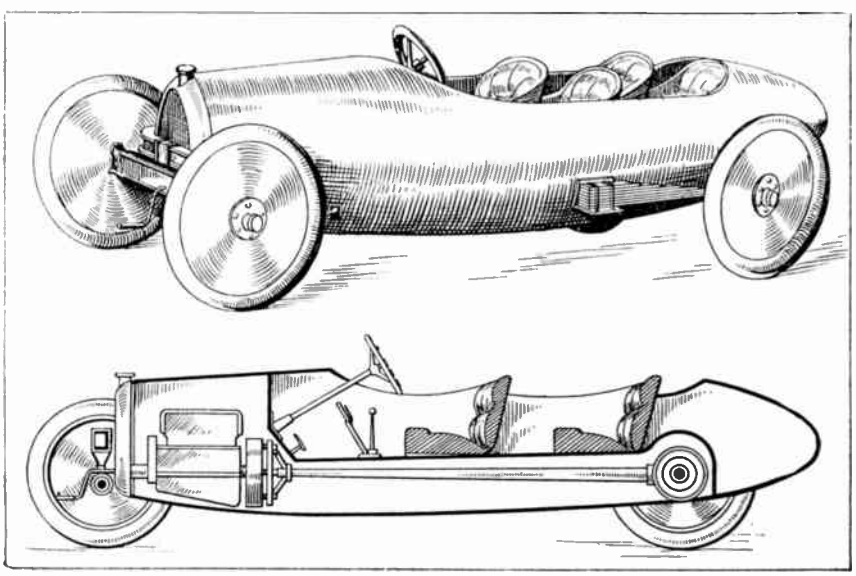
THE diversified uses to which glycerine is put indicate its importance in commerce. Most of the distilled glycerine finds its way into the manufacture of explosives, such as nitroglycerine, dynamite and the more recently developed high explosives. These are generally a combination of nitroglycerine, with guncotton or nitrocellulose and the resulting product is known by a great variety of names. Commercially pure glycerine is a well-known reagent in pharmacy and medicine, where nitroglycerine itself is sometimes employed. Glycerine enters into a number of technical processes, such as the manufacture of soaps, inks, water-proof paper, and for the production of such plastic masses as printing rollers, and other masses used in the art of reproduction. Glycerine is also used in gas meters and tubes which must withstand great cold, and for filling hydraulic jacks. It is one of the important items in sizing textiles and in that treatment of wine, beer, and vinegar known as "scheelizing".

Machinery for a great paper mill in Alaska is reported to be on its way thither. The new mill is to be near Juneau, a town familiar to tourists who have made the Alaska trip. Water power is to be used exclusively.

EVERYDAY MOTORIST

A FRAMELESS CAR

FOR years past designers have aimed at reducing the height of the main center of gravity of the car, and for years, also, the difficulties of obtaining sufficient axle and ground clearances together with unhampered movement for the rear axle and transmission when the seats are low down, have baffled their aims and stultified their efforts. It, therefore, becomes a matter for some comment when a firm of the reputation of the Lancia Co. takes out patent specifications for a design in which the body actually forms the frame and is so arranged as to allow an unusually low center of gravity.



Drawings showing construction of new Lancia frameless automobile

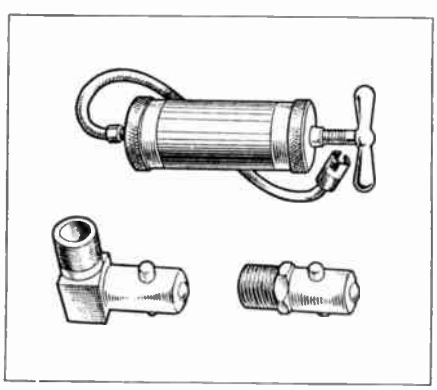
In the two illustrations given herewith, which are reproduced from an English contemporary, *The Autocar*, an attempt has been made to visualize the idea set forth in the original patent specification. The body consists of a stamped sheet steel shell, and it combines the function of a body with that of a frame. At the front of this shell is attached horizontally a form of stirrup, to which in turn is attached a semi-elliptic transverse spring, shackled at each end to the forks of a straight-front axle. Fore and aft location of the front axle relative to the body is obtained by the use of a radius rod on each side, running from the bottom of the axle back to the body. Suspension for the rear axle consists of long, quarter-elliptic springs, the butt ends of which are attached to the body at a point where a channel rib, forming part of the front-seat support, crosses and stiffens the body.

An essential feature of this specification is the use of a channel section rib or tunnel running longitudinally from the front portion to the back, and forming also a compartment open at the bottom, in which the propeller shaft or tube can rise or fall, this tunnel, of course, coming between the seats. Clearance for the rear axle is given by a similar tunnel running transversely across the back of the body. These channels may be made by stamping the sheet metal forming the lower portion of the shell to form a longitudinal member, thus improving the stiffness of the body without, to any extent, reducing the foot-room capacity of the seating accommodation. By this construction it becomes possible to lower the body shell, and therefore at the same time the plane of the seats very considerably, and also to bring the base of the shell as near to the ground as is possible consistent with safety. In the original specifications and drawings, from which the accompanying sketches have been prepared, no mention is made of the gear box, nor is one shown. It may possibly have been incorporated in the rear axle.

It will be recognized that this is a highly interesting patent, and not only should it have a very great effect upon improving the stability, the road-holding qualities and the suspension of a car so designed, but it conceivably would have the effect of reducing the weight to a very great extent. There are, of course, a number of points in this design about which one would like to know more, such as, for example, what steps are to be taken to render the engine and other working parts accessible from outside the car? Lastly, the wind resistance of a car made on these lines would be very materially less than that of present-day types, wherein the under gear is usually completely exposed.

NEW LUBRICATING SYSTEM

A CHASSIS lubricating system, known as Alemite lubrication, has been developed by a Chicago concern, with a view to obviating the trouble and messiness of the ordinary grease lubrication. The ordinary grease and oil cups are eliminated, and nipples containing ball check valves are substituted therefor. A compressor or grease gun of special construction, with a 15-inch flexible steel base, is adapted to connect to these nipples by means of a bayonet joint, and grease can then be forced into the bearings through these check valves under a high pressure, which insures that lubricant will reach the remotest parts of the bearings. The cylinder of the compressor is made of No. 16 gauge steel, knurled to prevent its turning in the hand. The compressor with delivery hose complete can be readily stored in the tool box. Ball check valve nipples are made in four sizes, viz.: 5/16 inch with 32 threads, 1/8, 1/4 and 3/8 inch standard pipe size; they are made both in the straight and elbow type, the latter being used to make inconvenient places more accessible.



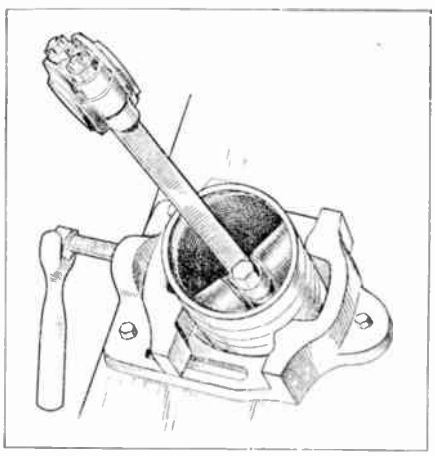
Parts of new lubricating system

The cars already equipped with grease cups integral with the shackle bolt,

the concern furnishes a cap and nipple complete, which is substituted for the old cap of the shackle bolt. In use, the bayonet coupling is hooked to the nipple by placing the steel protector opposite the coupling slot and by a slight pressure forward and a turn to the right an absolutely tight joint is secured. The flexible hose enables the operator to fill the bearing with grease from a comfortable position, and to force the grease into the bearings under a high pressure, up to 500 pounds per square inch, if necessary. It is claimed for the new system that it permits of lubricating a car in much shorter time than where grease cups have to be filled in the ordinary way, and besides, it is not necessary to grease the car so often.

HANDLING PISTONS WITHOUT DAMAGE

THE adjustable piston vise illustrated retains the piston by means of four lugs. Pressure is equally divided and the tool will accommodate sizes from 2½ to 4⅛ inches. It is an excellent tool when fitting piston rings, as the connecting rod can be dropped through a hole in bench and carbon

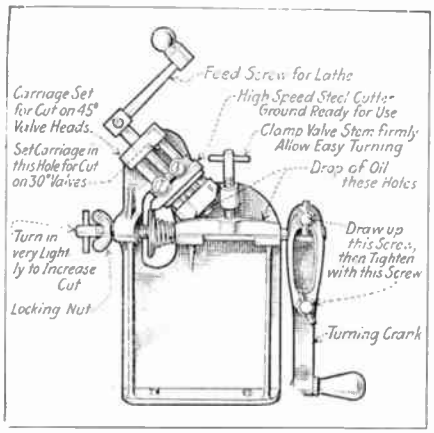


Piston vise to handle pistons without damage

scraped from the piston head and rings fitted. It is also useful when tapping for set-screws to hold wrist-pins or in cutting the cotter-pins, drawing bushings from pistons, etc. The piston may be held as indicated when removing the wrist-pin or reaming out the piston bosses or for clamping down the wrist-pin bearing or it may be reversed for piston ring work. Every garage man can use a device of this kind to advantage, as it will expedite his work.

SIMPLE VALVE-FACING LATHES

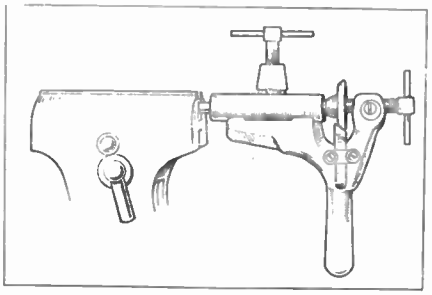
THE universal valve lathe shown at Fig. 1 herewith is designed primarily for the service station repair shop. It is a bench tool, combining the desirable features of much higher priced machines, is very simple to operate and does its work with accuracy. This lathe, it is stated, will reface any valve with 30- to 45-degree heads up to 2½ inches in diameter, and will true the hardest steel as well as cast iron valve heads.



Simple valve truing lathe

The valve lathe consists of a base casting that fastens to the bench, a detachable adjusting handle, a removable block placed over the valve stem when refacing the valve, an adjusting screw and spring holding valve face in correct relation with cutter, a high-speed steel cutter ground ready for use, a feed screw controlling the cutting tool, an adjusting carriage for 30- or 45-degree valves and an adjustable screw with wing nut, allowing the tension on the valve head to be increased or decreased.

The valve-facing tool shown at Fig. 2 is for truing up valves, valve faces and valve stems and is also useful in determining whether a valve is true or



Valve facing tool

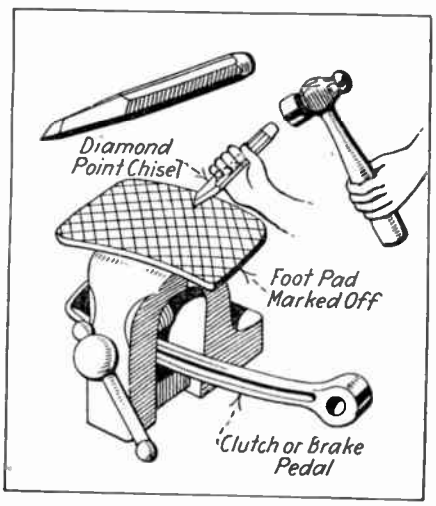
not. A valve with a crooked stem will not go into this tool, which tells the mechanic the valve stem is crooked. The adjustable sleeve feature means the cutting tool will be held true in revolving about the valve. A hollow-ground cutter is used made of tool steel. Three-eighths-inch and 5/16-inch sleeves are used, the two standard valve stem sizes. Oversize sleeves can be furnished at low cost and 21/64 inch oversize for Fords can also be had. A 45-degree cutter is standard, and a 30-degree or other special cutters can be secured.

In removing the Ford steering wheel to lubricate planetary gears it will be found advisable to use a wheel-puller to avoid damaging threads.

ROUGHING LEVER PADS

IN order to save money in manufacturing or for other unknown reasons, the foot pads on the clutch, brake and the reverse pedals of a certain make of popular light car, are now smooth, which makes it difficult for the operator to secure a firm grip as the foot is apt to slip off of the smooth surface, especially after the roughness of the casting is worn down.

Various forms of attachable rubber pads may be secured at a moderate cost that will prevent the foot from slipping as long as the pads are new but when the corrugations are worn or when the rubber is wet, the foot will slip from the pedals almost as quickly as with plain metal pads. This condition may be easily remedied at any time the foot pedals are removed by roughing the surface with a series of diamond-point chisel markings. The pedal is clamped in a vise and after the surface of the



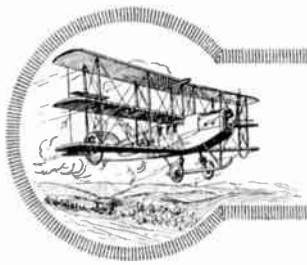
Method of roughing auto pedal pads

pad is chalked over, the horizontal and vertical lines are put on and at each intersection of the lines an amount of metal is raised, forming a rasp like series of projections. Either a round nose or diamond-point chisel may be used for this purpose.

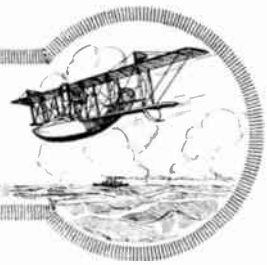
Another method is to make a series of closely spaced horizontally and vertically filed grooves with a three cornered file, this forming a corrugated surface, that is very enduring and that provides a good grip for the sole of the shoe.

PACKING FOR GASOLINE PUMPS

FOR packing fuel pumps on some stationary gasoline engines and in steam automobiles use asbestos wick-packing rubbed full of regular laundry soap; it will work without undue friction and will pack tightly. Common rubber-packing is not as good, as the gasoline cuts it out.



WHAT IS NEW IN AVIATION



PART II

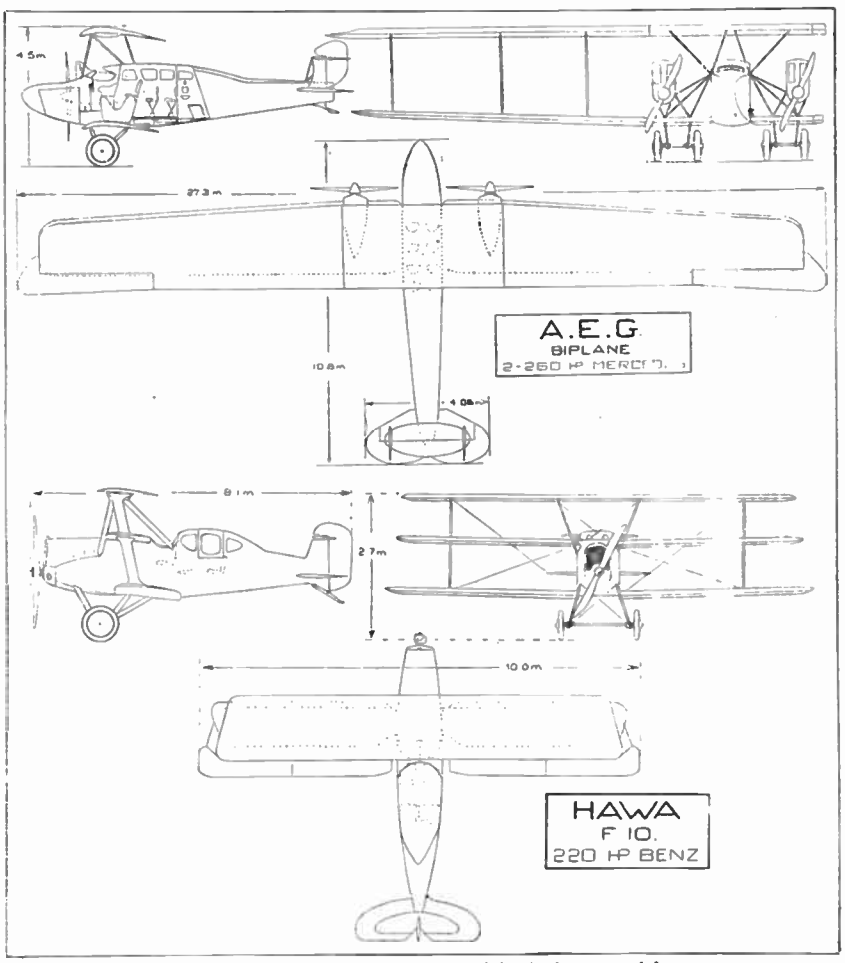
By Victor W. Pagé, M.S.A.E.

German Aviation Progress

German aviation has undoubtedly benefited by the scientific and constructional pioneer work of Professor Junkers. The Germans have instituted a lead in this line of aeroplane development which, greatly reducing the fire risk and increasing the lifetime of the aeroplane should go far to stimulate commercial aviation. The achievements of Professor Junkers were the last outstanding milestones of German war aviation and cover the two features of thick, unbraced cantilever planes, as shown in the Fokker biplane and parasol monoplane and the Brandenburg sea-monoplane-scout, another all-metal construction. Special attention to this form of work has probably been due to the extensive use of aluminum alloys in rigid airship building, an idea which is confirmed by the fact that most specimens are due to the aeroplane offshoots of the two foremost German airship yards, viz: of Zeppelin and Parseval.

Although Professor Junkers was convinced of the high efficiency of the "biplane less top plane" type of monoplane of which the J. L. 6 illustrated is a good example, he was ordered to make his first contour fighting machines as biplanes. His later monoplane developments including the peace-time commercial mount, have already been illustrated and described in part, so it suffices here to show the intermediate step of the enclosed passenger cabin variety, which represents an adoption of available war material to commercial conditions.

The widely advertised J L 6 monoplane which has numerous, splendid accomplishments to its credit and which has been demonstrated to be one of the most efficient flying machines ever built, is a modified form of the Junker biplane, all-metal airplane built prior to 1918. It is rather amusing to one who served in the American Air Forces abroad to see the efforts being made to claim as an American airplane construction, a type that had been used in warfare against the Allies by the Germans. The enthusiasm of the promoters of this airplane is certainly justified by its performances, but it is not ethical, to say the least, in the writer's opinion, to claim a construction for America that was probably first seen by Americans in a captured German airdrome in Belgium or to attempt to market all-metal airplanes in America as an American product that have the stamp of a German airplane constructor and that are equipped with engines of German manufacture.



Two post war German commercial airplane models

The A. E. G. concern holds a position of great financial strength in Germany similar to Vickers in England and Curtiss in this country and can thus afford to back their faith in commercial aviation by earnest efforts. Thus outside the peace doings, resulting from the research and pioneer work of Professor Junkers in wireless and metal aeroplane building, the A. E. G. commercial adaptation of their twin-engined bomber is the only after-war German type that has been employed to any extent. It has carried out the ærial mail contracts secured by "Die Deutsche Luftrederei." The latter company is by far the most important of the air navigation firms in Germany and is financed and affiliated with the A. E. G. concern under the management of one of the oldest German pilots, Mackenthun.

The main dimensions of the A. E. G. German commercial model, in fact, the converted G. 5, with an enclosed passenger cabin added, are shown on the accompanying scale drawings from The Aeroplane, of London. The nose of the fuselage has been turned into a luggage space and acts as a buffer in case of overturning. There is seating accommodation for six passengers beside the pilot and observer, and aft of the cabin a lavatory compartment is fitted. Gasoline tanks are mounted both below the pilot's cockpit and the passenger cabin.

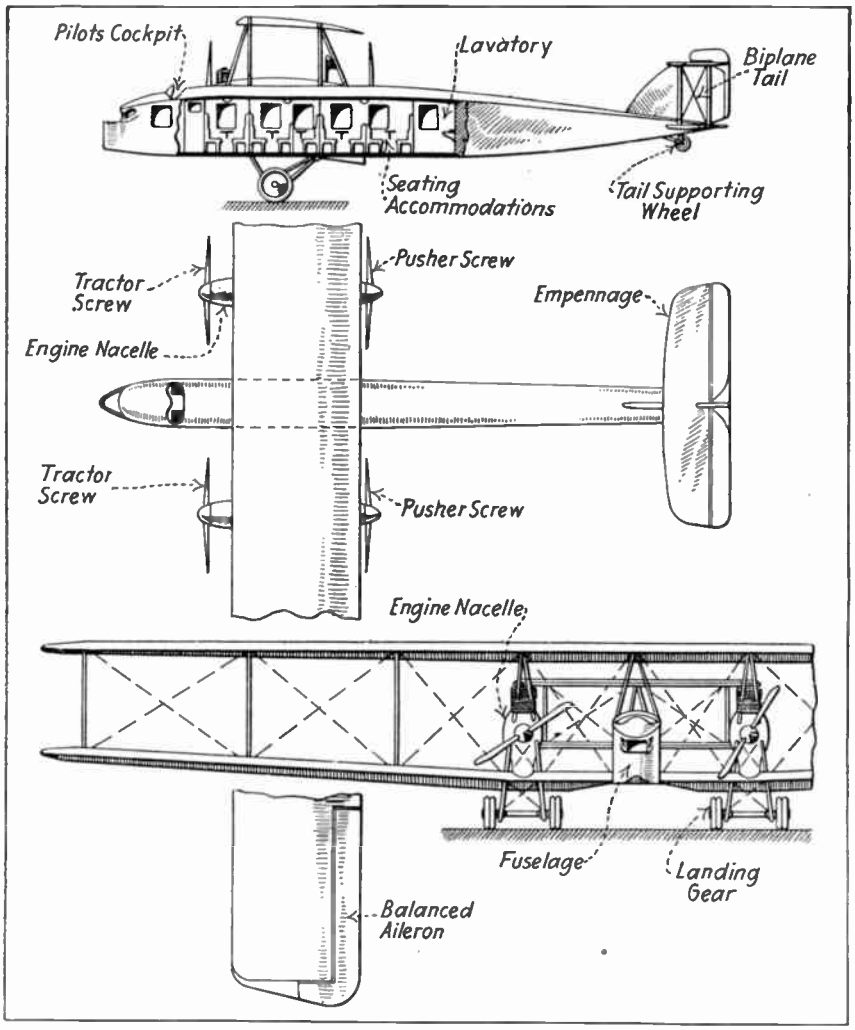
The Hawa triplane made by another prominent German firm (type F. 10), is provided with a compartment

between the motor and the pilot for 200 kilos, of luggage or mail, which also acts as a safety buffer in case of overturning, and separates the engine from the gasoline tanks and the greater part of the pipes. The central position of the passenger cabin has also been arranged so that most other parts will give way before the cabin comes in collision in a smash. The triplane has seating accommodation for six passengers, one beside the pilot and two on folding seats at the wall aft him, the remaining seats being disposed as indicated in the plans.

To maintain the maximum fuselage strength no full entrance door is provided, but instead one of the half top deck type. Six windows are provided, two of which can be opened; bull's eyes, or portholes give accommodation with the pilot in the front and heating is provided. The cabin extends aft the seats for about two-thirds of its length, giving ample space for hand luggage, hats, umbrellas, etc. The top tail plane can be adjusted acording to the weight carried. Gasoline from the two main tanks is pumped to the carburetor and there is in addition an emergency gravity tank. The engine is a 220-hp. Benz.

The specifications follow:

Type of Machine	F. 10
Biplane or triplane	T
No. of seats	6
Maximum span	11.546 m.
Chord, top	1.7 m.
Chord, middle	1.2 m.
Chord, bottom	1.7 m.
Gap	1.21 m. 1.38 m.
Stagger	0.3 m.
Length overall	45 m.
Area of wings	45 m.
Weight empty	1,080 kg.
Engine	230 hp. Benz.
Weight per sq. ft	35
Weight per h. p.	6.9
Weight of gasoline	190 kg.
Hours' flight	4
Speed at 2,000 m	175 kil.
Ceiling	6,500 m.
Climb—	
To 1,000 m	4.5 minutes
To 2,000 m	9.5 minutes
To 3,000 m	16 minutes



The Aviatik Staaken 1,000 horsepower commercial biplane model

AVIATIK GIANT AIRCRAFT

THE Aviatik Company was one of the German manufacturers that took up the production of giant aircraft, producing first under license the Gotha twin-engined bomber G. VIII and later the Staaken multiple-engined R craft. In the original Zeppelin products the power plant was four side engines in tandem pairs and one tractor engine in the body nose; but the Aviatik firm fitted the interplane power eggs with 220-h. p. Benz tractors and a 530-h. p., 12-cylinder engine of the same make for the pusher drive. It is reported in Flight, our English contemporary that these 1,500-h. p. Aviatik-Staaken giants were thus the highest powered aircraft in service on the German side at the end of the war.

From the experience thus gained. the building of a 2,000-h. p. giant was started upon in 1918, but its completion was interrupted by the revolution This machine was of the central power plant type and instituted yet another solution of the engine arrangement problem. The four 12-cylinder Benz engines of 530 h. p. each are mounted athwartship side by side and each drives its own screw through a transmission shaft. Two of these are tractors and two pushers. The engines are started by compressed air from the mechanics' position. The petrol tanks. of 8 hours' capacity, are bullet and fireproof, carried below the engines. Radiators are mounted in the slipstream of the tractor airscrews.

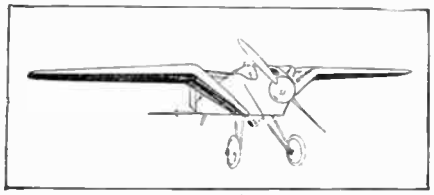
The wing arrangement is a triplane with extreme stagger of the middle one in regard to the top and bottom ones. an arrangement based upon research work at the Gottingen wind tunnel. The main dimensions are 55 m. span by 27 m. overall length and 8-5. maximum height. Including 6 hours' fuel. the useful load amounted to 7 tons. The estimated performance was a climb to 5,000 m. in 2 hours and a speed at 3,000 m. of 145 to 150 km.

The fuselage accommodation starts at the nose with an open platform for the captain, next an enclosed navigating position. Then follow the open cockpits for two pilots, with the wireless compartment below. The engine-room is separated off by a bulkhead. The longitudinals are built-up hollow spars and the cross-members of tubes, as are the engine mountings. The undercarriage is steel sprung and the wheels rubber, wooden, or steel tyred. As in other giant aircraft, the tail-skid has been replaced by a sprung wheel undercarriage, which is steerable.

The wireless equipment comprises dynamo, sender and receiver, and the instrument-board and navigator's post resembles those of airships. The lighting is electric, current being supplied from the wireless dynamo. Electrical order transmitters, an engine-room telegraph, and a mail dispatch tube are fitted. Each person is provided with a parachute, stowed away, but easily accessible. For civil use after the Armistice the Staaken 1,000-h. p. giant, with two interplane power eggs, hous-

ing four 250-h. p., 6-cylinder Benz engines has been adopted. The performance of the specimen turned out has been a total, useful load of 3.6 tons, being 7 hours' fuel, the crew of six men and 18 passengers with their luggage. A speed of 125 k. p. h. is attained.

This civil model is like the bomber type, with wings of 22.5 m. span and a



Louis Clement racing monoplane

twin-strut biplane tail of 9 m. span with divided top elevator. The interplane power eggs are slightly changed, as the engine cowling goes to the bottom planes and encloses the petrol tanks, two of which are provided for each engine. Altogether the wing engine installation has been preferred as the best for passenger-carrying. The engine vibration and the noise caused thereby is reduced, as is the danger from carburetor fires. Double planking of the body is used at the passenger cabin for heat insulation. The luggage compartment is above the passenger cabin, with easy access through hatchways.

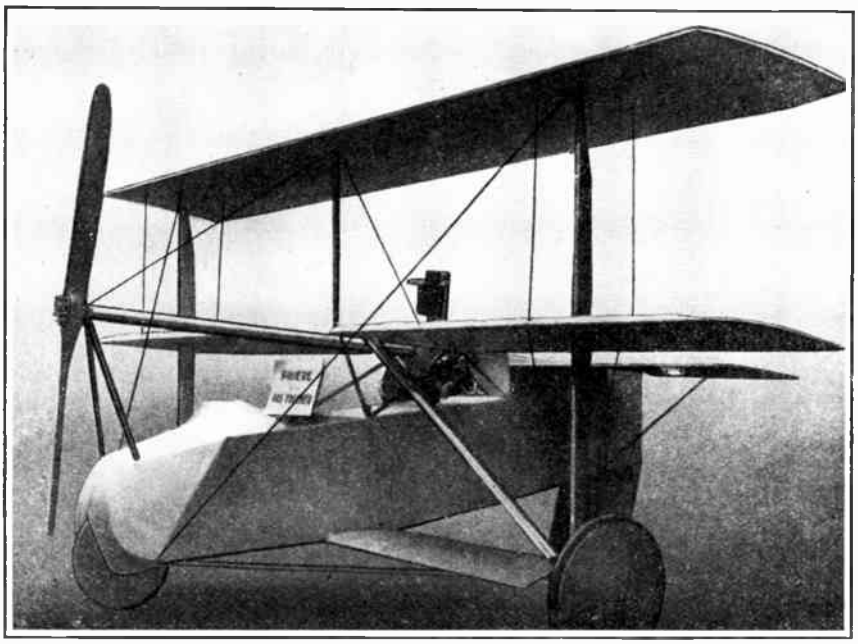
LOUIS-CLEMENT AIRPLANES

THIS firm, one of the earliest pioneers of all metal airplanes, has developed two curious machines. Of these, the more extraordinary is a racing monoplane, fitted with 180 h. p. Hispano-Suiza, cantilever wings, a folding chassis, and a retractable radiator. The fuselage of this machine is built throughout of steel tubes, wire braced, and of small cross section.

The wings spring from the lower longerons, and at their roots have a great dihedral angle for a distance of roughly 1 m. when—having arrived at the level of the upper longeron they bend to the horizontal. From the point at which the bend a steel tube strut runs to the fuselage top longerons from each spar.

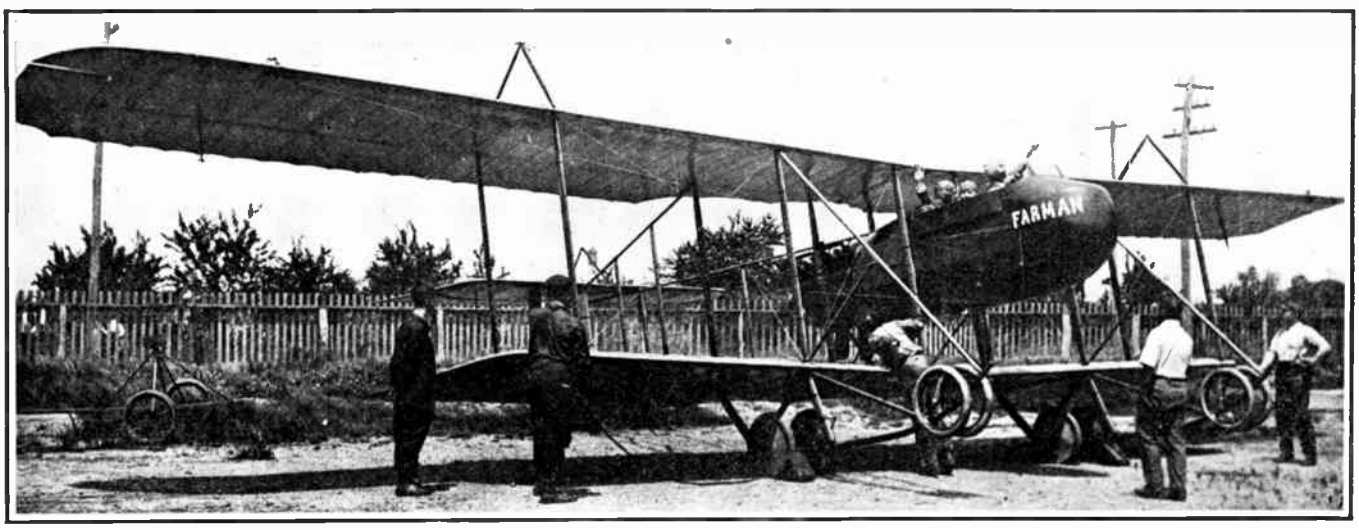
Apart from these struts the wings are entirely unbraced and all loads are taken by the wings' spars as cantilever beams. These spars are riveted up duralumin box girders, with a maximum depth at the angle between the horizontal and the sloping part of the wing, tapering thence both to the wing root and to the wing tip. At the maximum point the front spar is about 7 in. by 2 in. and appears to be of about 10 gauge thickness. Very narrow ailerons are fitted to a false spar in the rear of the main spar.

The undercarriage consists of two Vees of half streamline tube, that is, flat on one surface, each Vee carrying one wheel on a rigid overhang stub axle. These Vees are each pivoted on a hinge carried on the lower longerons of the fuselage. The rear leg of each Vee has an extension welded on, projecting upwards into the fuselage, about 6 in. long, and between these two extensions there is provided a telescopic screwed strut—after the manner of a large wire strainer. There is no other connection between the two Vees, and thus this strut, in compression, is all that prevents the two halves of the undercarriage from spreading outwards. When this strut is closed—by rotating the part corresponding to the strainer body—the two Vees fold outward and finally lie on the surface of the inclined part of the wing, the wheel ensconcing itself in a large hole cut in the under surface of the wing.



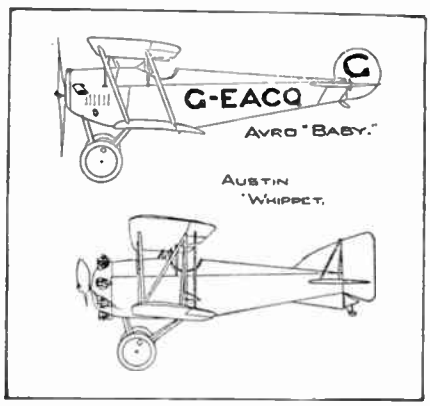
Unusual triplane built by Louis Clement

An unusual form of light triplane that appears to be an "aviette" with a



The Farman three-passenger pusher type biplane now being demonstrated in the United States has a specially designed landing gear of the skid and wheel type

motor attached has also been developed and is illustrated. The bottom wing on each side carries a light wheel at the wing tip. On the bottom wing a fuselage, built of light steel tube and covered in fabric, provides accommodation for the pilot and carries at its forward extremity, a third wheel and at



Two light English sporting types

its after end a tail plane elevator and rudder. Behind the wings, above the fuselage, a Y-shaped Anzani engine of 35 h. p. is mounted on a light tube cradle, and drives an airscrew by a long shaft encased in an aluminum tube, which is in front of the pilot's seat and is supported on a three-steel tubes of ½" dia. and about 2 ft. length from the nose of the fuselage.

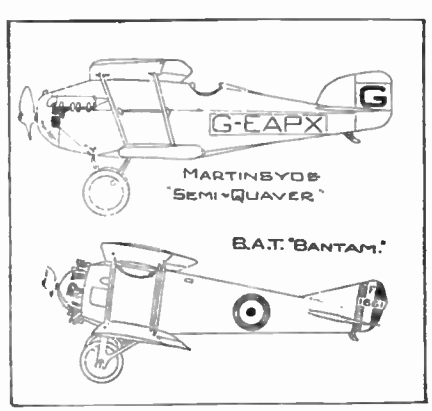
The wings are mounted on two pairs of center section struts, springing from the fuselage and there is one interplane strut on each side, which spreads out to embrace both spars on the bottom wing, but which only supports the front spar of the two upper wings. These wings are warped about this strut by wires to both leading and trailing edges. The machine has 13 sq. m. of surface, weighs 90 kg. empty, and is designed to carry 80 kg. of load, one light pilot and a little fuel and oil.

FARMAN THREE PASSENGER AIRPLANE

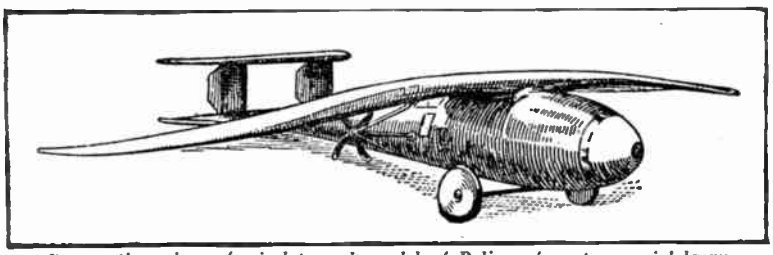
ONE of the problems which confronts airplane designers endeavoring to design types of airplanes suittable for sporting or commercial use, is to provide maximum safety of the occupants in event of poor landing. This is also important on types of planes that are to be flown by their owner, who may not be a skilled pilot in every respect, as flying skill can only be obtained by experience.

The Farman plane illustrated is a three-passenger type that has a very substantial landing gear, which is of the skid and wheel type. Four wheels are used on each skid, two substantial wheels being fitted under the lower wing to carry the main portion of the weight coming on each skid, while at the outer ends of the skids, two lighter wheels are mounted which prevent the plane from nosing over either on taking off or landing.

The passenger carrying cockpit is mounted between the two planes and has seating accommodations for the passengers in front and sufficient room for the installation of the airplane power plant in back. The power plant drives a pusher screw so that the passengers are not subjected to the air blast produced by the usual form of tractor screw. This also makes for greater cleanliness because any oil or smoke from the engine is discharged at the rear of the passengers instead of in front of them. The empennage is carried by an out rigger spar and strut construction as usual with the pusher type airplanes.



Recently designed English racing biplanes



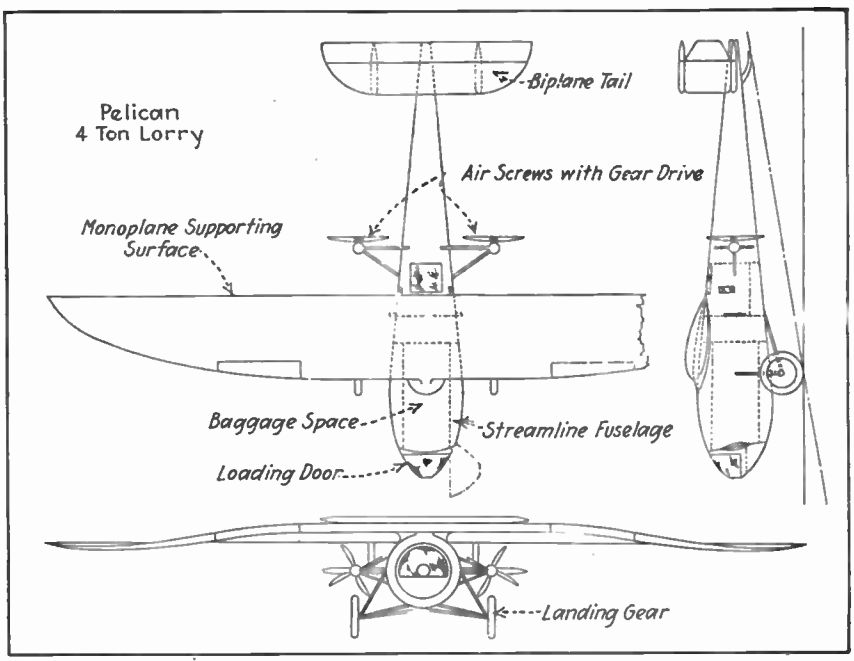
Perspective view of wind tunnel model of Pelican four-ton aerial lorry

SMALL BRITISH RACING AND SPORTING TYPES

Of the several types of machines built by the Martinsyde Co. the most prominent in the public eye is the "Semi-Quaver," a single seater scout, which is amongst the fastest airplanes in the world. The wings span a little over 20 ft. and the engine is a 300 h. p. Hispano-Suiza. A similar machine, though one somewhat less highly specialized, has been officially timed to do 161 mph., and an even higher speed is expected of the Semi-Quaver, which is a racing model.

The Bat Bantam is a high performance, single seater scout with monocoque fuselage, the cockpit being so arranged that the pilot's head projects through a circular hole in the top plane. The engine is a 200 h. p. stationary radial A. B. C. giving a speed of 146 mph. at 10,000 ft. and a climb of 18,000 ft. in 18 minutes. The undercarriage is quite out of the ordinary, the wheels being set wide apart and each working independently in a vertical slide arrangement, without any common axle.

(*Continued on page* 69)



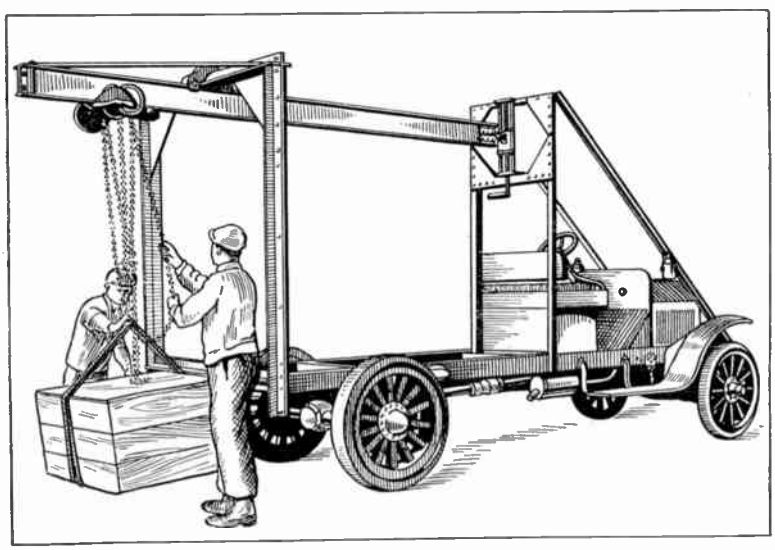
Drawings showing unusual wing design of Pelican four-ton aerial lorry

USEFUL AND INTERESTING INVENTIONS
AUTOMOTIVE - MECHANICAL - ELECTRICAL

MOTOR TRUCK CRANE MAKES LOADING EASY

THE motor truck shown in the accompanying illustration equipped with a special truck crane gives an interesting example of the specialized equipment which has been developed for different industries in connection with motor truck transportation.

The crane consists of an arrangement of steel I-beams which can be bolted to any motor truck chassis, and so arranged that the upper part forms a supporting beam for a differential hoist which rolls on it as on a trolley. This upper supporting beam is so constructed that it can be quickly inclined forward or backward by means of an adjusting device at the front end. The load may be locked at any point on the beam by means of a brake on the trolley, and can be easily controlled by one man. The supporting upper beam projects out some six or eight feet to the rear of the motor truck so that a load can easily be rolled out to a shipping platform or on the ground well away from interference with the platform of the machine itself.



Motor truck crane makes loading and unloading heavy objects easy

In operation the driver of the motor truck (who can handle the entire work without assistance) merely slings a bridle around the heavy object which is to be loaded. He then, by means of the chain-hoist, raises the load slightly above the body of the motor truck. The screw adjustment at the forward end is then manipulated so as to slightly lower the forward end and the load is pushed forward to its resting place in the platform. The process of unloading is, of course exactly the reverse. The whole operation is so easy and simple that it takes almost less time than to describe it, and the driver is able to do the work of two or three men.

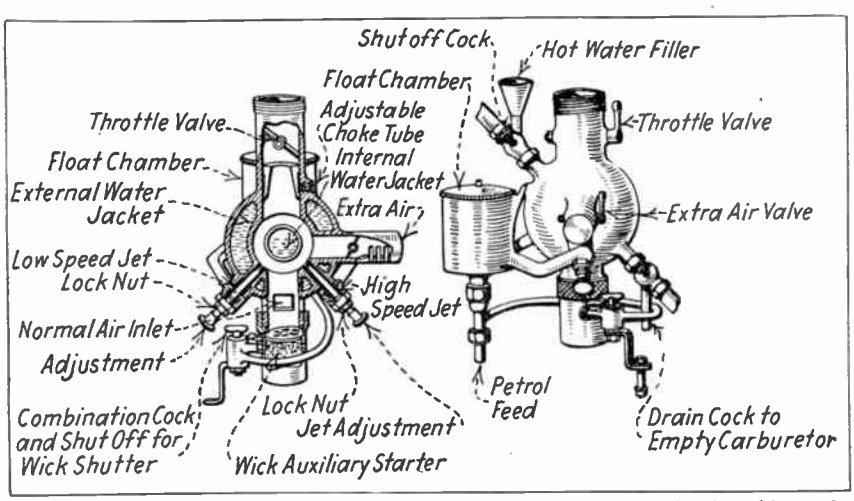
This device is built in several capacities up to five tons. It is especially valuable in handling heavy, unwieldy objects, such as boilers, lathe castings, monuments, concrete forms, and the like, or, in fact anything which is heavy and ordinarily hard to load by hand. By this device, the load can be quickly lifted over fences, out of pits, off the ground, or from a loading platform, and the saving in time and labor makes it a paying investment for anyone who has such loads to handle.

NOVEL ENGLISH CARBURETOR

DIFFICULTIES of engine starting in cold or damp weather are all too well known to the average driver. In the appended illustration is shown a carburetor of English origin specifically designed to overcome the trouble so far as gas mixture is concerned: no engine would be easy to start if the induction system, valve guides, and so forth, were full of air leaks, and the magneto and sparking plugs out of condition.

The main feature of the apparatus is the provision of a spherical mixing chamber, water-jacketed externally, and also internally, the latter being unusual, and consisting of a central sphere fed with water by horizonfal ducts which do not show in the cross section. The water-jacket is run in normal conjunction with the water-cooling system of the engine, but cocks are provided above and below the carbureter jacket, together with an overflow, in such a way that when starting from dead cold the upper cock can be shut off and the lower one turned so that all the water round the carburetor can be drained off. Permanently in position on the upper cock is a filler funnel into which about a half a pint of boiling water can be poured. As will be seen from the section, the jacket is so arranged that, not only is the mixing chamber covered, but water surrounds both the jets, which are easily adjustable.

Taken in mainly at the bottom of the carburetor, the air supply can be regulated by an additional air-port at the side of the apparatus, and controlled by a butterfly valve. For easy

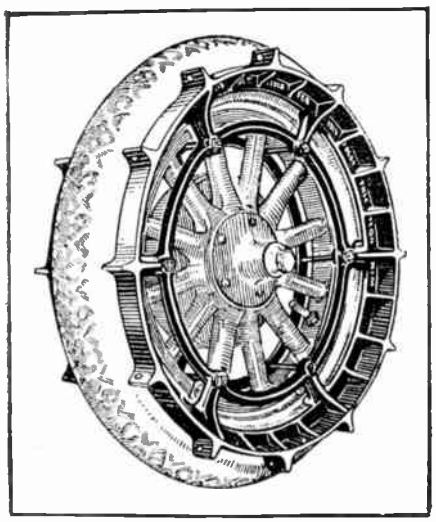


Novel English carburetor has heating arrangement to facilitate starting in cold weather

starting there is at the bottom of the main air intake a form of wick carburetor. This consists of a chamber holding a wick. The chamber is closed at the top by a shut off grid worked in conjunction with a petrol cock, and perforated at the bottom. When this petrol cock is turned on, it automatically opens the grid, and fuel soaks into the wick, providing a rich mixture, which can be drawn in through the bottom of the instrument. The baffle shut-off is provided to prevent a possible backfire reaching the wick after the engine is started. Apart from providing easy starting, this carburetor is claimed in its experimental stage to give an excellent fuel consumption efficiency.

TRACTION RIM FOR TRUCKS

THE action of traction rims such as that illustrated herewith, which is intended for both solid and pneumatic tired wheels is automatic, simple and practical. On hard roads they do not come into action at all as the rubber tires are then amply sufficient for traction. However, as soon as soft roads are reached and the tire sinks into the ground the traction rim comes



Tractor rim for trucks

into use. Its extra surface bearing, which prevents sinking, together with the many traction lugs, take hold so firmly that the drive wheel cannot spin, thus affording maximum traction. In case of a puncture or a blowout, a pneumatic tired truck equipped with Foley rims can be driven without danger to casing or tube. The rims on pneumatic tired trucks protect the side wall of the tires from tearing when operating in rutty road conditions. These rims are made of the best quality of electric steel castings. They are made in two styles, a split rim for the inside of the wheel and a solid rim for the outside. This dispenses with removing the wheel to make application of inside rim. Provision is also made for the quick application of non-skid chains, which are applied to the cleats on the rim for use on hard, slippery roads only.

COMBINED ELECTRIC HEATER AND COOLER

A KANSAS CITY, MO., lawyer and son have invented a device by which a room may be heated or cooled as desired. It takes current from an ordinary electric light socket and generates heat by means of coils. An electric fan, driven by a 1/30th horsepower motor, drives the heated air to all parts of the room. The mechanism is so con-

Combined electric heater or cooler

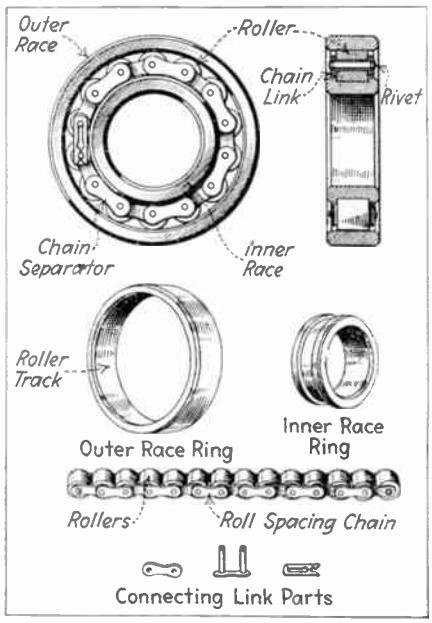
structed that while it heats a room it itself is cool. A small child could handle it while in operation without fear of being burned. In summer the fan may be used to cool the room, as one switch turns on fan and heater and another operates the fan alone. It is expected that this heater will solve the problem of heating small apartments where rates for electricity are normal.—*H. E. Zimmerman.*

THE CHAIN ROLLER BEARING

THE general tendency in the engineering world to replace ball bearings carrying heavy loads with roller bearings on account of their greater load carrying capacity has led to an interesting advance in the design of anti-friction bearings by the introduction of a new patent roller bearing. The device, which is illustrated herewith, is remarkable for its simplicity and its advantage over the usual type of ball or roller bearings is apparent from a glance at the accompanying illustrations.

The principal feature of the bearing is the employment of an endless detachable chain as a separating and guiding means for the rollers which in itself eliminates at once a number of the undesirable features possessed by other bearings, and provides a high capacity anti-friction bearing possessing almost the ideal theorical requirements. Each chain has a detachable link with a spring fastening clip, which allows the chain to be unwrapped from the inner race for inspection, cleaning or replacement. This is of particular advantage when the bearings are required for use with crankshafts, as in this case the inner races may be dispensed with and the chain with its rollers wrapped over and fastened round the crankshaft itself, provided that the diameter of this is made the same as the standard inner race. Thus the difficulty of threading the inner race or rigid cage over the crank webs is obviated and creeping eliminated. It should be understood that the chain roller bearing is designed to take radial loads only, and where a large amount of end thrust occurs it should be taken up by means of ball thrust bearings of suitable design.

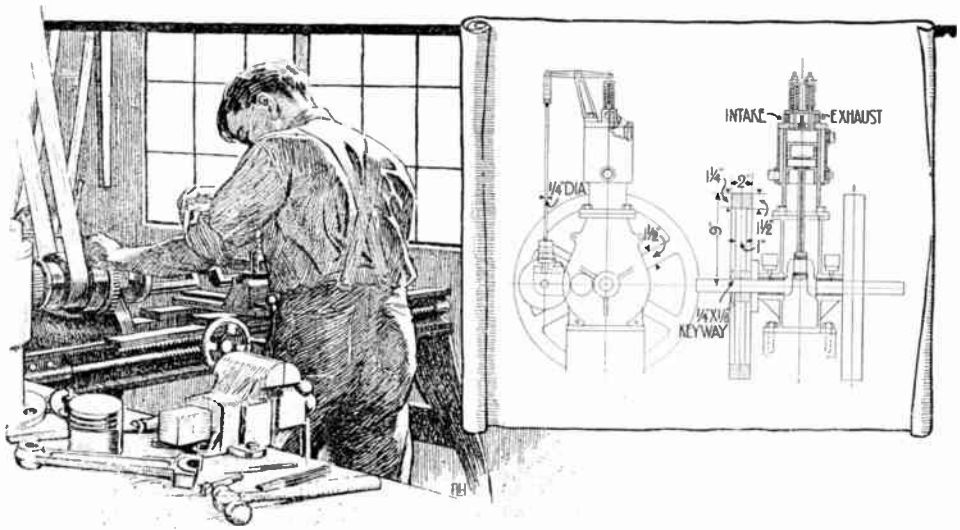
Bearings of this type have been running continuously for a long period under tests of the utmost severity and



New chain roller bearing

have given completely successful results. A number of distinct and valuable advantages are claimed for this bearing, which are summarized as follows: Maximum load carrying capacity, detachable cage, flexible cage, hollow rollers, minimum friction, highest speed capacity. E. H. LÉMONON.

In England serious efforts are now being made to recover potash from the fumes of cement kilns. One of the clays used in making cement has been found to contain from 2½ per cent to 3 per cent of potassium oxide, and a plant is being put down for its recovery. In the past flue dust has been used as a fertilizer on account of the potash contents, but this is the first time in England that the attempt has been made to really save it as chemical salts. The recovery of potash from shales and of phosphoric oxide from phosphate rock is also being done.



A One Horse Power Gasoline Engine of Simple Construction

By L. B. Robbins

THE gasoline engine herein described is capable of developing one H.P. (brake test) at 700 R.P.M. The designs and specifications are reproduced from an engine in actual use and is so planned that the work can all be done on a lathe, drill press and bench. It is a single cylinder, vertical, water-cooled engine with valves in the head and fired by jump-spark; powerful enough to pump water, saw wood or run machines in a small shop.

The accompanying cuts illustrate in complete detail, the proportions and dimensions of each part entering into the construction of this engine and will enable any capable pattern maker to build the patterns for the parts necessary. As will be seen, patterns are necessary for the cylinder, cylinder head, crankcase, piston, push rod guides, and flywheel. These all require cores as indicated. The remainder: rocker arm, gears, piston rings, timer casing and valve heads can be made by a simple casting process and should occasion no trouble. The builder may even see his way clear to turn some of these smaller parts out of solid stock if he has the conveniences and thus save pattern making.

If the builder is inexperienced in pattern making, let him keep in mind three essentials. Allow from a sixteenth to one-quarter of an inch oversize in castings to allow for finishing. Second: Allow for the usual shrinkage in castings. Third: Allow draft or taper on every large pattern so that it may be easily drawn from the sand. We will assume that the castings have been made and you are ready to machine them up and assemble your engine.

This is a practical and inexpensive engine that can be built by anyone handy with tools but possessing only little machine shop experience.

Machine Work on Cylinder

As the cylinder presents probably the most difficult work of all we will attempt that first. Face off the base and then clamp to the face plate. The boring can be done with a broad tool to eliminate tool marks and give as smooth a surface as possible. If tool marks are too self evident, grinding must then be resorted to. However, make the finishing cut to the inside surface of the cylinder very light; this is absolutely necessary where the work is being done on a lathe. At the time the cylinder is in position for boring the head end can be faced off and the water pipe holes drilled and tapped.

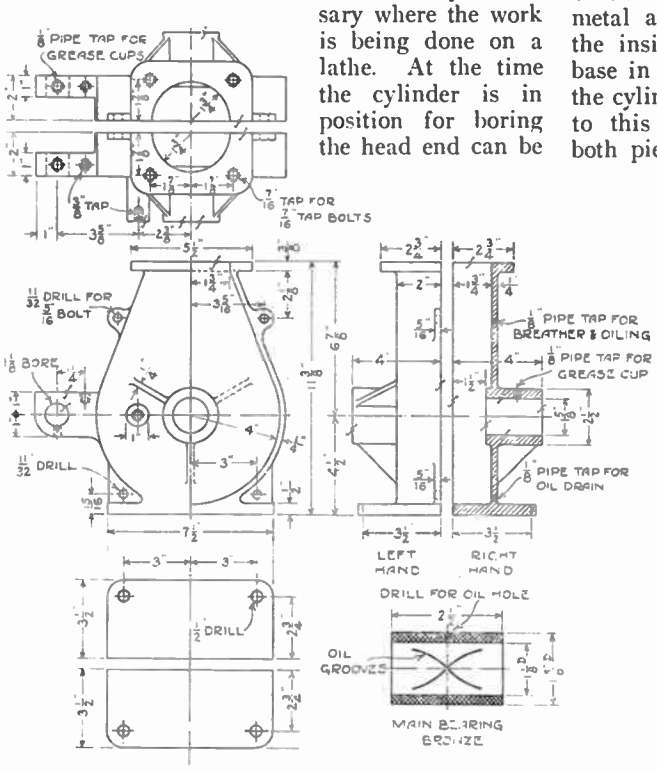
The cylinder head surface is next faced and each valve seat and guide turned. These two operations should be done during the same chuck setting in order that they may be concentric or in line. Then drill and tap the spark plug hole with a ½ in. pipe thread. The holes for the cylinder head tap bolts should then be drilled, after which the holes in the cylinder casting for the same bolts should be drilled, using the cylinder head for a jig.

Machining Piston Castings

The piston is placed in the chuck and rough turned inside and out. Then shape up a piece of iron with a large base supporting a solid cylinder of metal about 2 in. high and a fit for the inside of the piston. Clamp the base in the chuck, slip the piston over the cylindrical piece and pin it in place to this cylinder by drilling through both pieces and inserting a set screw. Center the whole affair and support the free end of the piston by the tail stock. This allows the grooves to be turned unhindered and the top of the piston to be faced off. The holes for the wrist-pin must be at right angles to the sides of the piston so the drilling of these should be done on a milling machine if possible, although it can be done on the lathe if necessary, and care is taken in doing the work.

Work on Crankcase

The halves of the crankcase should be faced off at the joints. Then the main bearing bosses should be bored together to bring them in exact line. Do this with a boring bar, being careful to bore them exactly at right



Details of engine crankcase showing simplicity of pattern needed

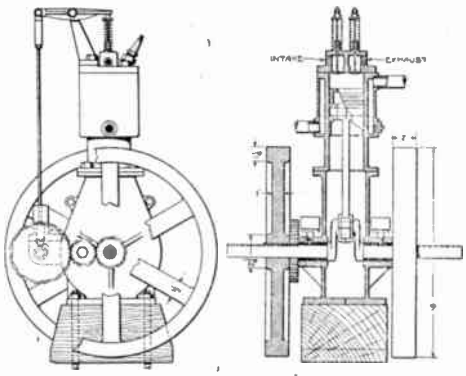
angles to the cylinder bore. The timing bosses should also be done simultaneously to insure perfect alignment.

To save gear cutting, purchase your timing gears from a gear supply house. Mount the intermediate gear on an adjustable bearing to allow for adjustment in case the center line distance is not quite correct. By using this gear it is possible to keep the entire train of gears of small diameter. Crankshafts are difficult things to attempt to forge, so you had better purchase a forging of suitable size from a manufacturer.

To machine this requires two separate operations. First, the crankshaft must be turned, then the crankpin. To do this make two special lathe dogs which will hold the crankshaft off center but the crankpin in center. These dogs must necessarily be offset to do this and suitable forms can be devised by the builder with the help of any good machinist.

First, rough-cut the main shaft, then set the dogs so as to bring the crankpin in center and rough-cut that. Then put on the finishing smooth cut and change back to the crankshaft again, smooth cutting that without change of tool. While the dogs are in place take fairly light cuts to prevent springing the shaft. By drilling a number of shallow holes tangent to each other and cutting away the walls with a chisel, the key way can be made without a milling machine.

A standard drop forging for the connecting rod can be purchased and machined up by the builder. It is bored on the small or wristpin end and fitted with a bronze bushing which can be finished to size. The large or crankpin end is lined with babbit. This is melted and poured about a mandrel somewhat smaller in size than the shaft. Paste a piece of paper about the mandrel before pouring the babbit so as to prevent the metal sticking to it. Insert liners or shims between the cap and the body of the rod before the metal is poured to allow some adjustment for wear. Then scrape the bearing to a fit.



Side elevation and sectional view showing construction of simple engine

Machining the flywheels is a simple turning and boring job. The key way may be cut with a saw and chisel, but if one can get access to a shaper, it will be better to cut the key way by machinery.

Valve cams are first turned circular and then excess metal milled or ground off. Filing will give the final finish. These must be case hardened and had best be done by those in that business, but a good job can be done by boiling the parts in potassium cyanide at a red heat for about half an hour. Great care, however, should be exercised in this operation not to breathe the liberated cyanide fumes as they are fatal even in small quantities. Perform this outdoors or under a hood.

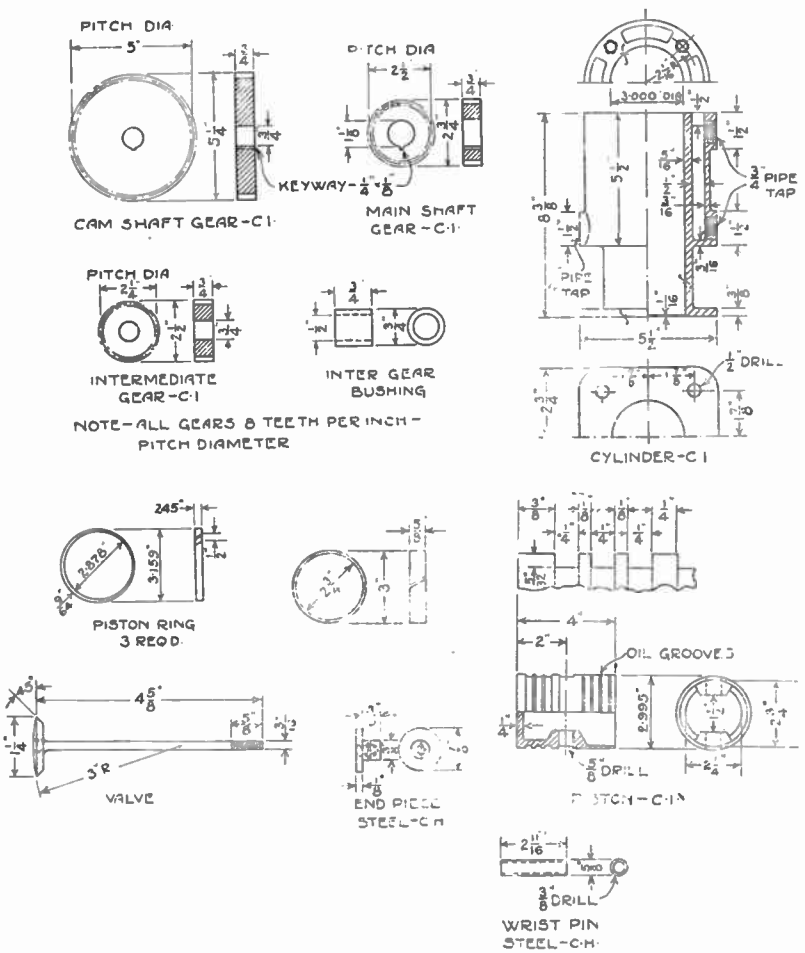
Setting the Cams

In order to set the cams correctly a small set-screw is provided by which they can be fixed upon the timing shaft and the timing adjusted. When in their proper position the holes for the taper pins or keys should be drilled and the cams riveted to the shaft. The exhaust valve should open about 20 degrees before the piston has reached the end of its outward stroke and should close about 3 degrees after the piston has reached the end of its upward stroke. The inlet valve should open at the end of the same upward stroke and close about 5 degrees after the piston has reached the end of the next downward stroke. These various leads are given to allow for the natural inertia of the gas. The valve timing can otherwise be adjusted by altering the length of the valve push rods. Harden the tappet rollers and wristpin the same way as the cams were done.

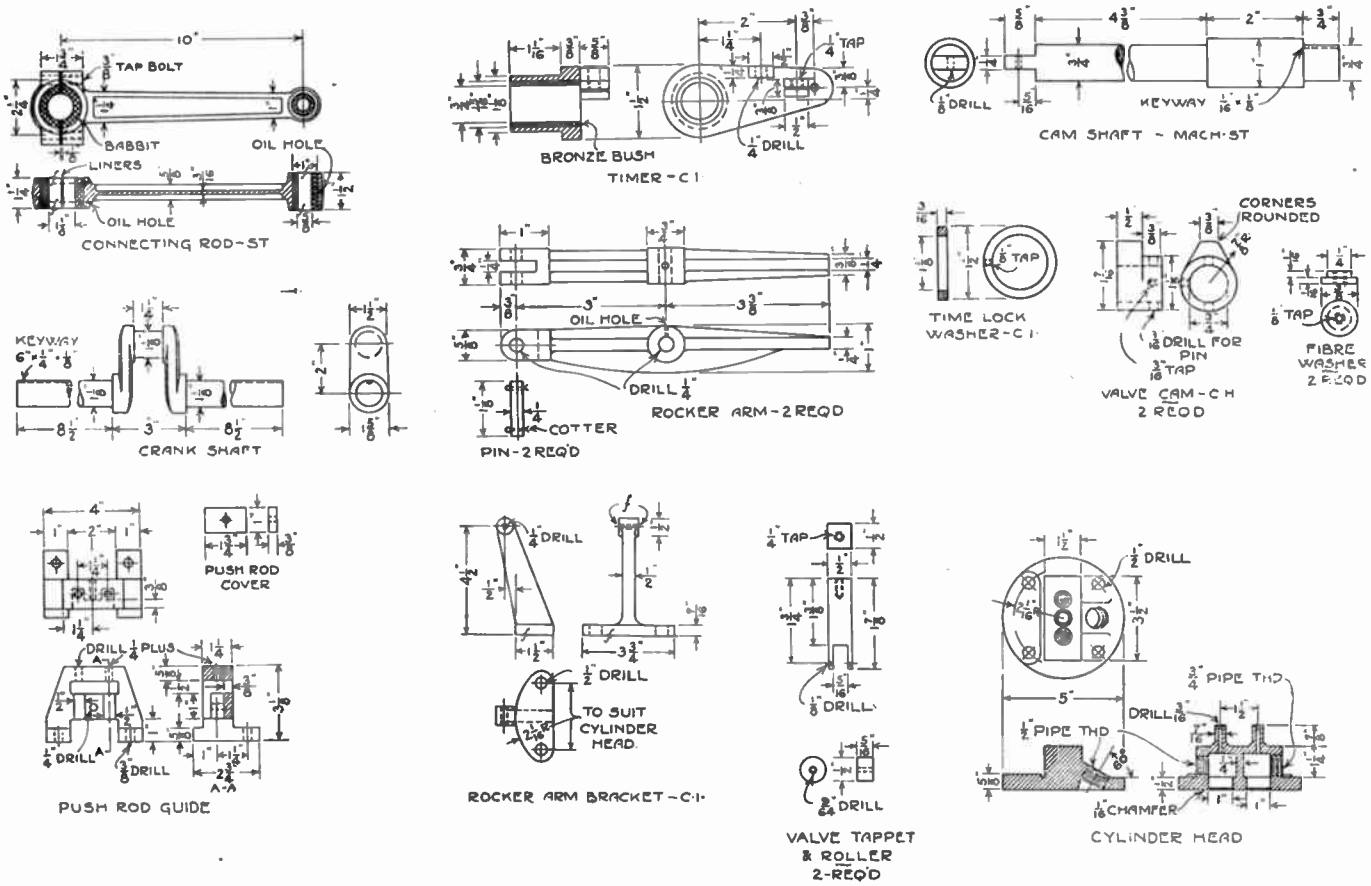
It is a question if it is not much simpler and easier to buy the piston rings already turned than to try and do them yourself. To cut a correctly fitting ring is no amateur's job. The correct size and offset is given in the detail drawing. In case you cannot get them the exact size needed, get those the nearest to it and finish them down yourself.

Grind the valves into their seats with valve grinding compound. Test them by pouring gasoline about the valve head and seat. If none leaks through the seat is tight. Valve springs for some light H.P. automobile will be found adaptable to this engine or they can be made up from spring wire without trouble by winding over a suitable arbor in the lathe.

After all parts are machined and fitted comes the assembling. Place a paper gasket, shellacked, between the halves of the crankcase and an asbestos or Moboline gasket under the cylinder head. Work all bearings in gradually and allow a bit of stiffness which will disappear as the heat and oil get in



Details of cylinder, piston and rings and parts of valve mechanism of simple engine



Details of connecting rod, crankshaft, cylinder head and valve action parts of simple gasoline engine

their work. Set up all bolts tight, but go over them once or twice more after the engine has been run in a short time.

The mixing valve or carburetor, exhaust pipe and muffler, batteries, timer, spark coil, spark plug, grease cups, switch, wire, etc., had best be purchased from a supply house. Trying to make any of these is needless work and will cost more than it does to purchase standard articles.

Connect the water-jacket outlets to the water tank so the pipe lines are inclined slightly and the circulation caused by the difference in water temperature is not impeded.

Slight modifications and improvements will, of course, suggest themselves to the builder, but if the general dimensions are followed as given here a successful engine is assured. Such an engine has been in constant operation for seven or eight years.

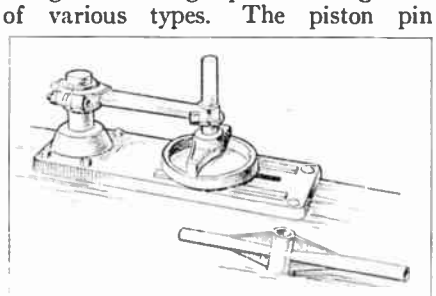
Even with the great advance in the cost of materials this ought to be built for around $35, exclusive of the cost of patterns and time. The ignition system parts and carburetor cost will depend entirely upon the units selected. The instructions apply only to the construction of the engine and do not consider the installation of auxiliary units because anyone competent to build the engine will have no difficulty in fitting the timer, carburetor and water tank and installing them in a satisfactory manner.

AVIATION AND THE INVENTOR

WRITING of inventions, we are inclined to believe that there is no field that offers more opportunity to the inventor than aviation. The science is really still in its infancy. Apart from actual constructional devices, there are so many obvious defects in the airplane that require remedies. Chief among them is the necessity for a braking device to give the machine only a few feet of run upon landing. Tall skids galore have been produced, but none can claim to be really effective. Brakes on the wheels have been tried, usually with the result of smashing the nose of the machine. An alterable chord on the wings has not proved altogether successful, and the alterable pitch of the propeller is not popular. The heliocopter may come in time, but it is a long way from perfection yet.—*Scientific American.*

CONNECTING-ROD JIG

THE connecting-rod aligning jig shown provides means for straightening and lining up connecting rods of various types. The piston pin



and crankshaft pin are for the Ford connecting rod, although other special piston pins and bushings, for any make of crankshaft, can be furnished if desired. This tool is a great help in the shop. The device is adjustable for various lengths of rod and provides a very accurate means of aligning rods or testing rods suspected to be out of line.

FORGING IRON-NICKEL ALLOYS

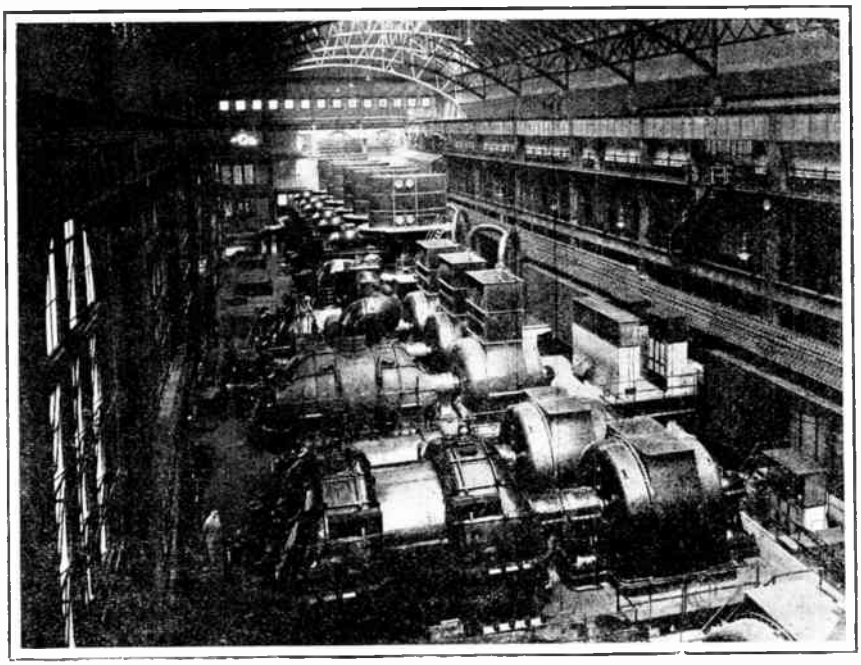
IT has been established that pure iron-nickel alloys do not forge satisfactorily at ordinary forging temperatures, and at the Westinghouse Research Laboratory an investigation has been under way to determine what treatment would make such alloys more readily forgeable. It has been found that aluminum, chromium, magnesium and silicon have scarcely any effect, but that in amounts of 2 per cent of the lesser constituents, manganese or titanium imparts the desired characteristics and makes the alloys forgeable.

It is believed that these elements have the ability to strengthen the amorphous inter-crystalline material to the point where it possesses greater strength than the crystals.

ELECTRICAL PROGRESS DIGEST

THE WORLD'S LARGEST ELECTRIC RAILWAY POWER HOUSE

THE accompanying illustration shows the biggest power house in the world—the East 74th Street "juice factory" of the Interborough Rapid Transit Company of New York, employed in generating electricity of railway use.



The largest electric railway power house in the world is located in the heart of New York City

In the foreground are new turbines just installed. The first a 40,000 horsepower Westinghouse double-compound turbine. Next is a 100,000 horsepower Westinghouse triple-compound turbine, said to be the largest engine in the world. The generators run by this triple-compound turbine are the three with air stacks. Farther on are six 7,500 horsepower reciprocating engines with generators about thirty feet in diameter. One of the old engines would weigh as much as the triple, which is more than twice as powerful as all six of the old engines. The 100,000 horsepower engine will generate electricity enough to run nearly half of the elevated, subway and surface lines in Manhattan Borough.

CAUSES OF TURBO-GENERATOR FAILURES

IN a paper recently presented to the American Institution of Electrical Engineers, Mr. P. Torchio, the chief electrical engineer of the New York Edison Company, classifies some of the large turbo-generator failures which have occurred in America within the past twelve to sixteen years. The size of generators investigated ranged from 5,000 to 30,000 kilowatts, the larger units being of more recent manufacture. The total failures, several occurring on the same unit, amounted to fifty-five, of which thirty-three occurred in armatures, sixteen in fields, four in armatures and fields, and two in terminals. From the analysis it appears that at least 30 per cent of the armature failures are the result of overheating of the windings and consequent damage to the insulation.

ELECTROLYSIS OF PIPES

IN a paper entitled "Some Aspects of Electrolysis of Pipes," presented to the American Waterworks Association, Professor G. Alleman points out that damage only occurs when the leakage current either enters or leaves the pipe. It can be easily calculated that one ampere flowing continuously from an iron pipe for a period of one year is equivalent to 20 lbs. of iron or 74 lbs. of lead, and it must be remembered the current which leaves the pipe at one point may return at another place if the electrical conditions are favorable. In consequence, and as supported by experience, the effect of the current may correspond to any multiple of these two equivalents. Iron pipes are not corroded when electrically negative, and the opposite condition applied to lead pipes, but it is also possible under certain conditions for lead pipes to be corroded when electrically negative.

PUPIN LOADING COILS

Our three cuts illustrate the celebrated Pupin loading coils. They used to adapt a line for long distance telephoning and a cable provided with them is said to be Pupinized. Their dimensions are based on a very elaborate calculation involving what is known as a Pupin constant. The object of the apparatus is to add self-inductance at intervals along the line. The loading cores are made of soft selected iron wire .004 inch diameter.

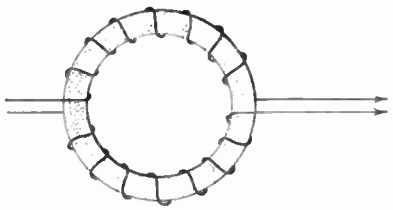


Fig. 1—Pupin loading coil for land lines

An annular core receives two windings whose direction is shown in the cut. Each coil magnetizes with the same polarity so that there is no mutual induction but only self-induction. After being put together the coils are immersed in an insulating compound after being wound with tape and placed in iron cases which contains the insulating compound. The second cut shows

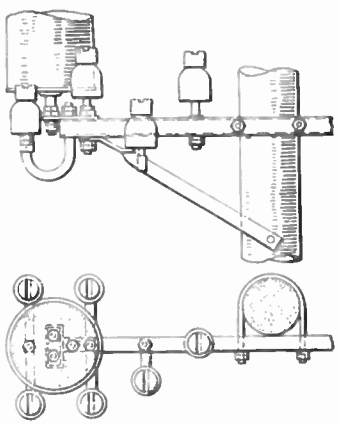


Fig. 2—Pupin coil mounting on pole line

the mounting of such a coil on a long distance telephone pole on aerial lines. There should be a coil for every nine miles. In underground work they are from one to two miles apart and in sea cables a nautical or sea mile in a stand-

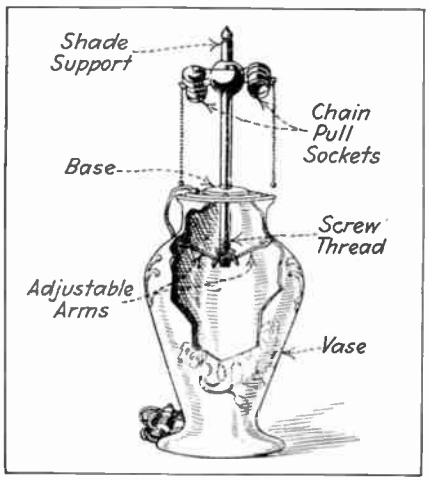
ard interval. A cable of a shape giving compact disposition of the coils is used which is shown in the third cut. The coils of course add to the length of the line. On the double line from New York to San Francisco which constitutes a complete circuit of 6,800 miles in the loading coils, these coils should be of the best quality with best

Fig. 3—Pupin loading coil in cables

class insulation and best types of insulators. Originally trouble was had with the bridle wires connecting the coils to the line.

ADAPTER FOR TRANSFORMING VASES INTO LAMP BASES

A VASE can be made into a base for an electric lamp with the aid of a special vase cover and support for lamp sockets which have recently been developed. The cover and lamp support are anchored and held in position by means of a device which consists of hinged arms that press against the inside of the vase. These arms can be

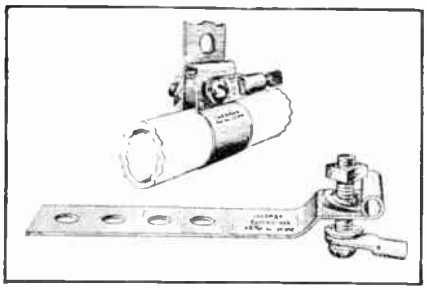


Adapter to transform vase into lamp base

screwed in or out so as to fit any size vase and are rubber-tipped to prevent the fracture of thin pottery. The extended position of the arms is maintained by the action of a small steel spring connected with the special hinge. The anchoring device is attached to a long screw, which allows adjustment to any length within the jar. If the vase has a hole near the bottom, the lamp cord can enter through this opening, or it can enter through a hole in the cover itself. Covers are made in four sizes: 3 in., 4 in., 5 in. and 6 in. Pull chain sockets which can be adjusted at any desired angle are used. Special ornamental silk shades are made for use with this adapter.

IMPROVED GROUND CLAMP

A GROUP clamp that compiles with the latest Underwriters' specifications has been placed on the market. The method of applying the clamp to a grounded pipe is shown in the accompanying illustration. The clamp is made of one piece of flexible sheet copper. It is placed around the pipe and drawn tight with a copper-coated bolt. The end of the copper strip is rolled inward to secure parallel surfaces for the head and nut of the bolt when tightened and bolt holes at short distances



Improved ground clamp

make the device applicable to various sizes of pipe. A brass washer prevents injury to the copper. The bolt head rests in a deep countersunk portion of the metal strip so that it will not turn.

A feature of the device is that it can be used either with wire or lug terminals, and the connecting wire is easily soldered to the clamp if so desired.

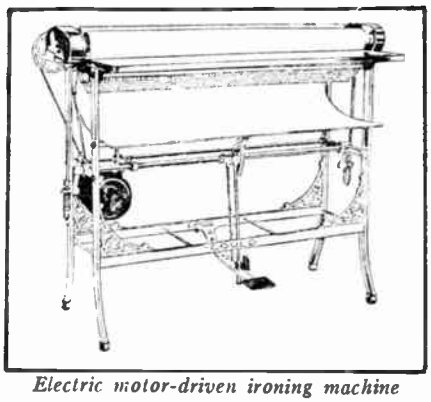
ELECTRO DEPOSITION OF IRON

AMONG the novel repair processes developed by the war is the electrolytic deposition of a thin layer of iron up to one-twelfth of an inch thickness on any simple cylindrical surface of wrought iron or mild or cast steel. Describing the method to the British Institution of Automobile Engineers, B. H. Thomas states that the iron is deposited directly on the surface without any intermediate film of copper, and can be heated to redness without apparent deterioration, can be carbonized or hardened in the ordinary way, can be filed and ground, and takes a high polish. The work being properly done, the adhesion was so strong that the film could not be chipped away from the metal beneath with hammer and chisel. In a heavy repair shop the motor vehicle parts reclaimed in this way included stub axle arms, steering swivel pins, brake and clutch shaft ends, change speed lever shafts, inside of wheel hubs, outside of axles, tubes and universal joint pins. The wearing qualities of the deposit on a high-speed journal do not appear to have been determined. So far the process cannot be used for cast iron or aluminum and its value would be much increased if it could give an adherent coating to such parts as worn gear boxes and ball-race housings.

ELECTRIC MOTOR-DRIVEN IRONING MACHINE

A MOTOR-DRIVEN ironer with an effective heating device has been brought out recently and is shown herewith. The heater is a gas burner of low consumption placed beneath the shoe. There are aprons at each end to prevent the rapid dissipation of heat by air currents, and the gas jets are arranged to give an even distribution of heat. Holes in the back of the shoe produce an additional drying effect, so that even excessively damp clothing can be ironed. The shoe is grooved beneath the first roller, giving additional ironing contact.

The electric motor is of 1/6 h.p. capacity and may be either a direct or alternating current type as desired. The motor is mounted on horizontal rods, and its position is adjustable for obtaining the proper tension in a belt



Electric motor-driven ironing machine

operating the roller mechanism. Pressing a pedal removes the rollers from the shoe sufficiently far for cleaning and polishing. When the rollers are down, there is not sufficient space to get the fingers beneath them. This insures safe operation. The machine is practically noiseless. Extreme lightness is another feature. The finish is nickel and white enamel.

TRAIN SPEEDS IN EUROPE

THE European railway schedules are not yet quite up to the prewar figures. Before the war the Northern Railway of France had an express running from Paris to St. Quentin, 95.7 miles, in 94 minutes. The North Eastern of England was scheduled to cover the 44.3 miles from Darlington to York in 43 minutes, while the Great Central Railway express from Marylebone, between Rugby and Leicester, ran at a rate of 61.3 miles per hour.

Heat Treating Alloy Steels

A Series of Simplified Articles Detailing the Various Methods of Heat Treating Modern Alloy Steels. This Installment Explains the Reasons for Careful and Uniform Heating and Rapid Quenching, Also Details Functioning of Multiple Treatments to Secure Fine Structure

By Victor W. Pagé, M. S. A. E.

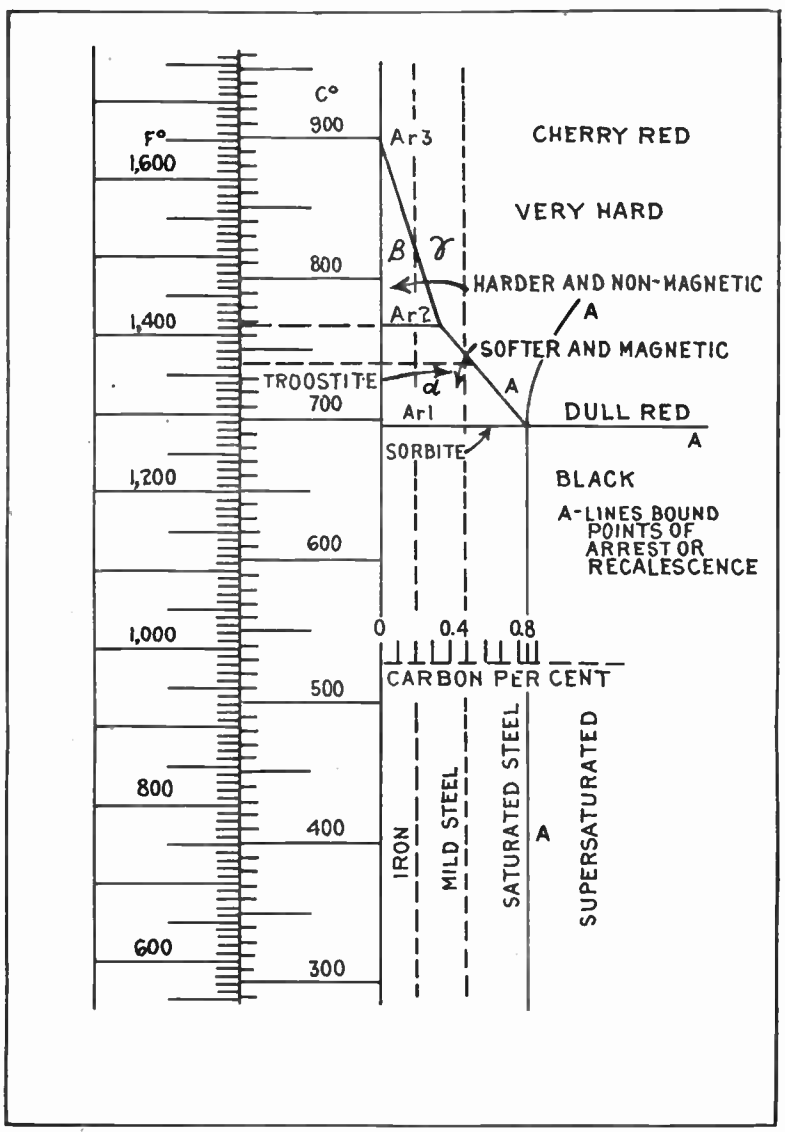
PART VI.

THE first law of hardening which has been known for many years to metal workers in general, asserts that sudden quenching after heating retains the steel in the condition that obtained as far as the molecular arrangement is concerned, at the temperature to which it was raised just prior to quenching.

The second law of hardening, which is of much more recent discovery and which has been touched upon to some extent in this series of articles, states that quenching heated metal while the heat curve is crossing an arrest or recalesence point produces the least amount of distortion and the maximum refinement of the molecular structure.

Heat treating, however, is just not the simple process of heating and quenching that many believe it is, as modern alloy steels require multiple treatments to bring out the best internal structural refinements and physical characteristics imparted by the alloying elements. Steel heated to a point where it is in the austenite stage, when cooled reverts with considerable rapidity into the martensite form with an attendant increase in hardness, which assumes a maximum value.

In the September issue of EVERYDAY ENGINEERING MAGAZINE we illustrated how various steel specimens appeared when examined under a microscope, but inasmuch as the cut used to illustrate micro-structure of annealed iron and steel did not reproduce well, we are presenting with this description another illustration which shows the photo-micrographs in a much clearer manner. The heat chart, or rather the chart showing the arrest point of iron —carbon alloys was also one that did not bring out the matter as clearly as it might. For this reason, we are showing the accompanying diagram, prepared by Roberts-Austen, which shows not only the arrest point, for various grades of steel, but it also brings out in a clear manner, by comparing Fahrenheit and Centigrade temperature scales just when these arrest points may be expected to take place.



Roberts-Austen chart showing arrest points for steels of various carbon contents, giving both Fahrenheit and Centigrade temperatures

The various alloying elements that have been described in preceding installments of this series, all have different result on the micro-structure of the steel and some of these elements make it easier to harden steel while others call for considerably more care in carrying on the hardening process. For example, the increase of carbon contents and the presence of such elements as chromium, nickel or manganese retards the transformation period. It is said that a 25% nickel-carbon alloy will produce austenite if cooled at atmospheric temperature. Therefore, to secure maximum hardness, the steel must be quenched with the utmost rapidity in the coldest solution and the most efficient conductor of heat.

Quenching Bath Temperatures

The hardness resulting from quenching heated steel varies with the efficiency of the bath as a conductor of heat and is also a direct function of the time required to cool to the atmospheric temperature. This point is a very important one in commercial heat treating where large quantities of hot metal must be hardened in a relatively short period of time. This has resulted in the development of various forms of refrigerating systems to keep the quenching bath as cold as possible. It also has called for the use of quenching baths of much larger volume than were formerly thought necessary. When the first heated pieces are plunged into the cold bath, naturally the quenching medium absorbs the heat and becomes

higher in temperature. It can be readily seen that it will not be very long before the bath will be at the boiling point and instead of quenching in cold water, one would be plunging the heated steel into very hot water and the resulting micro-structure would be entirely different from that obtained when the pieces were quenched in a bath of proper temperature.

Without the presence of an alloy such as chromium, it would be a difficult matter to harden metal on a commercial scale and secure the required martensite structure and if one was working with simple carbon steels, the resultant is much more apt to be a micro-constituent of a softer structure such as troostite or sorbite. A consideration of these facts brings out a number of practical points which must be observed in the heating and quenching of steel.

Heat Treating Precautions

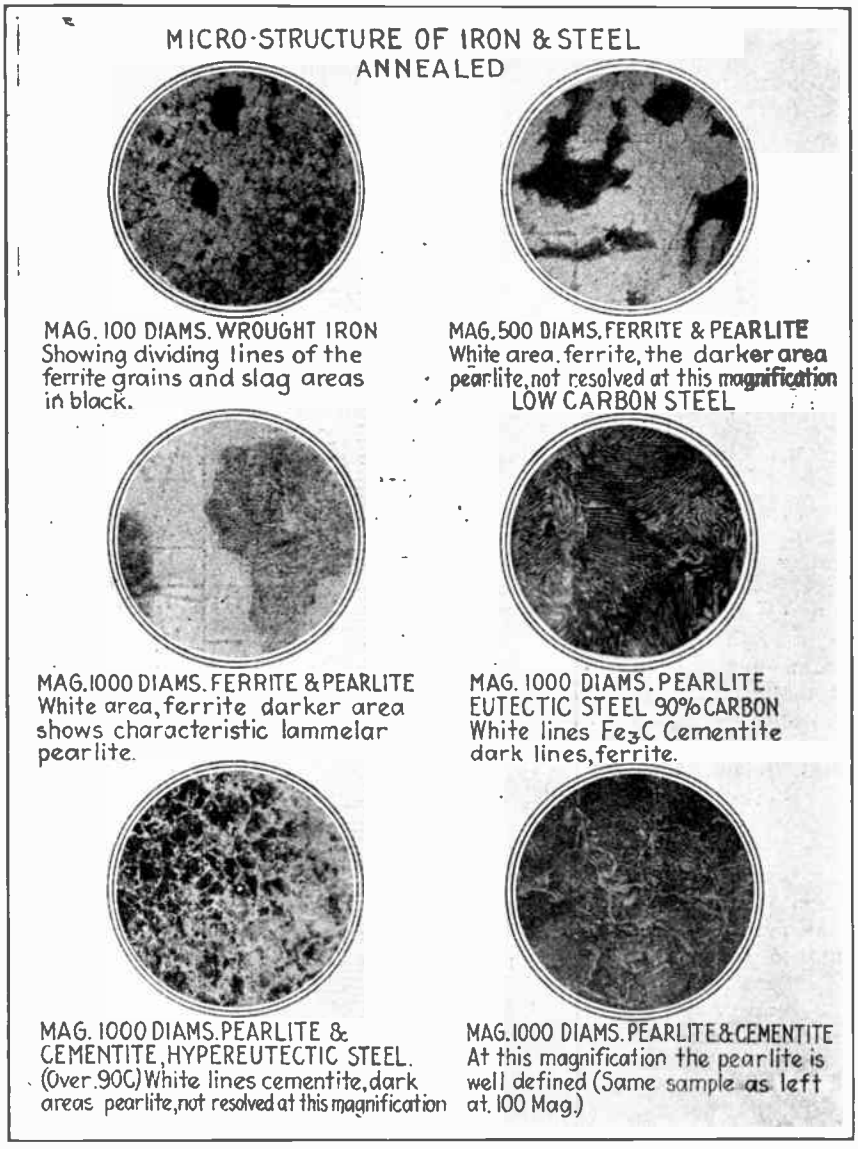
In the first place, the operator must select a furnace of such a form that the material is heated as evenly as possible and to so arrange the work that it shall not be touched by either flame or air draughts. As previously mentioned, steel exposed to an oil or gas flame, for instance, would be apt to scale excessively and might also become carburized. For the quantity production of tools or hardened parts such as ball or roller bearing race rings and other elements, the material to be heat-treated will undoubtedly be pre-heated before being placed in the final heating furnace. The modern hardening expert must use some accurate means of heat determination, such as the pyrometer and check it up frequently because the human element cannot be depended on in accurately determining temperature and no human eye is trained sufficiently to observe the temperature niceties and slight variation permissible to secure uniform hardening.

The most important of all the many considerations is that the operator must maintain the furnace temperature at such a point that the temperature of the molten metal or salt bath or heating muffle never exceeds the desired pre-quenching temperature, and even though this appears to be a slower method, the resulting fine quality of the work and the reduced number of spoiled pieces will certainly repay any one for taking care in heating up the metal. Having provided the proper means of securing an even rise in temperature, in order to do away with cracking and warping of the steel, the next requirement will be to procure the grade of steel that is best adapted for the work in hand and that will give the widest practicable range of control and the most uniform results.

Quenching Medium Important

It is not only necessary to take care in the selection of material, the temperature determining appliances and the heating furnaces, but after all these precautions are taken, unless the quenching medium is selected intelligently, all of the preceding care will not avail to secure hardened work of the proper kind. Quenching mediums vary widely. Various oils, such as whale and fish oil and specially developed mineral oils have been used as quenching mediums when work is required that is to be reasonably soft and very tough. Water is selected for work that is to be harder and the degree of temperature of the water will also have a marked influence on the hardness of the steel after quenching. If maximum hardness is required, then ice-cold brine would be used, this brine being made of various salts ranging from common salt to various chemicals that are not as well known.

An important factor to consider when oil or brine is used for quenching is that the constancy of the composition of the quenching bath is just as important as the maintenance of a uniform temperature. The troubles of the heat treater come to light at this point, because he must know that uneven heating will cause distortion of the work or even its micro-structure, especially if the piece to be treated is of irregular form. Uneven quenching will cause even greater risk of damage due to distortion. For example, if a ring of high carbon steel of uniform cross-section is quenched with its axis horizontal so that one side turns to martensite while the other is still austenite, the rapid increase of volume on the martensite side or that first cooled, will warp the piece all round five times as much as if the piece had been quenched with the axis vertical. Now if this trouble occurs with a ring of uniform cross-section, it will be apparent that difficulties will be increased according to the irregularity of the sections. That is why a great amount of care is needed in heat treating intricate dies and

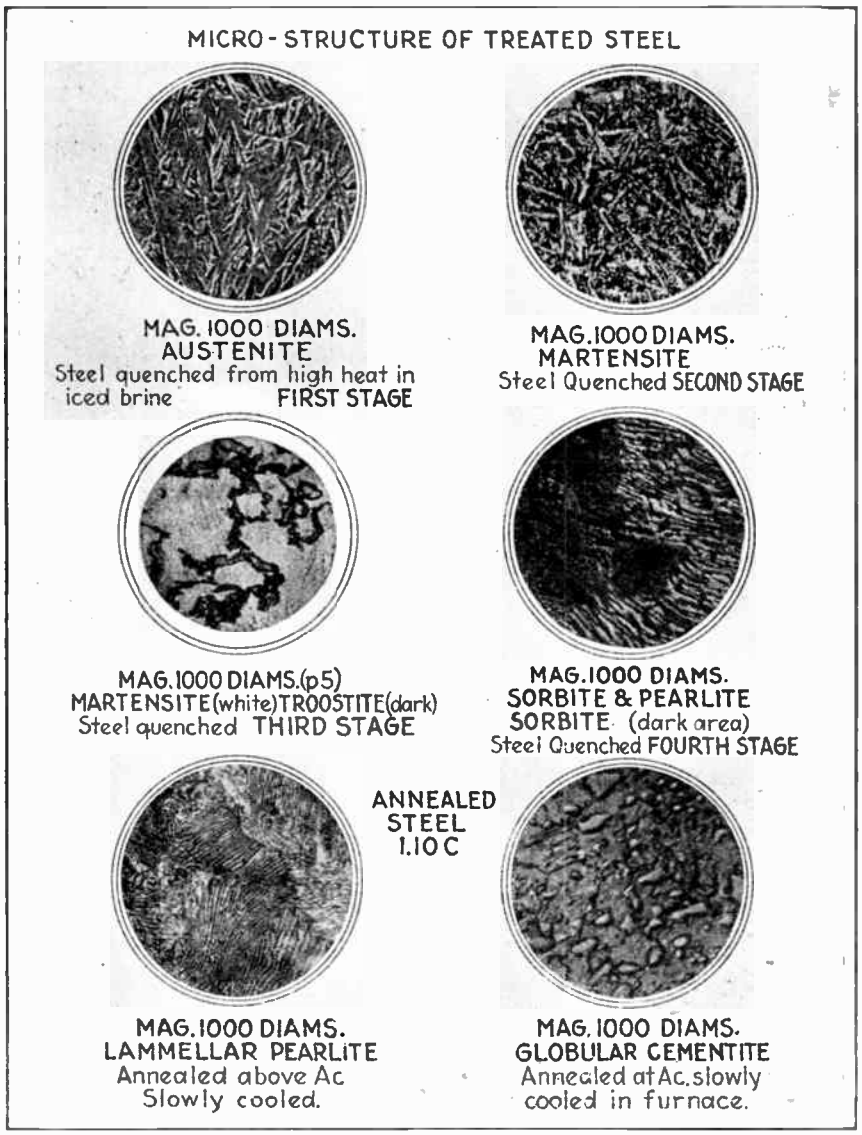


punches and such cutting tools as taps and reamers. If martensite structure is tried for a certain amount of room must be allowed for expansion as this is greater in unalloyed than in some alloyed steels.

Even if a hardening fixture is used as found permissible on production work, such as making bearing race rings, certain forms of gears, etc., care must be taken to see that the work is arranged properly, and that the dies have proper clearance that the piece is dropped in the water in the way that will cause all parts to become cooled at approximately the same time. The quenching will be done at an ascending heat to reduce scaling and care will be taken with the fire so that the pieces will be heated without direct contact with the flame. It goes without question, that the special treatment to be followed must be adapted to the characteristics desired and to the nature of the steel used and if the steel demands multiple treatments, it is well to know that if these are carried on within the critical range, they can only refine the structure.

Treatment to Refine the Grain

In low carbon and the ordinary run of carburized steels, the soft core or backing material, which is generally below .20 carbon, is only refined by heating it to Ac 3, which for that steel varies from 1,525 degrees to 1,600 degrees Fahrenheit before uniformly cooling or quenching it. The skin or case, however, represents an entirely different steel than the core, as it may carry anything from .80 to 1.10 carbon, but as this has been obtained at a temperature ranging from 1,650 to 1,800 degrees Fahrenheit, the very coarse grain due to that degree of heat is but slightly refined at 1,525 degrees and is not yet fine enough. In order to reduce the coarseness of the grain still further, these would be heated again and quenched at about 1,400 degrees Fahrenheit, and the resultant composite structure would be the finest that steel ranging from .80 to 1.10 would be capable of assuming. It will be apparent that in quenching tools that multiple treatments will be very desirable, as it is important to have no fixed lines of demarcation between the hard surfaces and the softer core.



It is always better to harden work previous to annealing because the internal strains, produced in fabricating the steel, are liberated in changing from pearlite to martensite and austenite and may seriously warp or crack the steel and even though the fracture does not take place during the heat treating process, it may occur some time later after the piece has been used. Most of the description in this installment has been in reference to the step in heat treating known as hardening. There are other processes fully as important in the multiple treatments, which must be given consideration. One of these processes is drawing the temper, which will next be described. A certain amount of care is also needed in annealing so that this matter will also be considered briefly in this installment.

Drawing

We have mentioned the eagerness exhibited by the austenite structure to transform itself into the original pearlite thru the martensite, troostite and sorbite stages. It is the function of the quenching bath to trap the desired structure. If the work has been done with sufficient haste the operator quenches at the martensite stage, but while here we have the greatest volume and hardness; we also have the greatest brittleness. This is relieved by the process of drawing.

It is known that in hardened steel when heated to 200° C. to 400° C. (392° F. to 752° F.) another very slight temperature arrest occurs. This point is called Ar_0. At the lower temperature the martensite of the hardened steel begins to change to the softer troostite; then to sorbite; then at the higher temperature to soft pearlite again without attendant increase in grain size.

Fortunately, such low temperatures (about 400° F.) are controlled much more readily than the initial hardening heat so that in this way just the proper structure is readily obtained, a thing almost impossible to do at the original quenching.

Annealing

Experiments have proven that steel may be annealed at temperatures below the main critical range even as low as Ar_0 (800° F.). While it is always desirable to anneal at as low a temperature as possible to avoid any growth in crystal size, we know that grain size is not altered if temperature does not exceed Ac_3 so that it would appear that the most beneficial results could be obtained by annealing under or within the critical range.

The purpose of annealing may be either to eliminate strains due to cold or hot work or to properly soften the steel for machining or cold working. For the relief of strains only, it would

(*Continued on page* 81)

AVIATION BRIEFS

THE LATEST RIGID AIRSHIP

IN the latest rigid airship, R-80, as developed by the Vickers people, particular attention was given to the elimination of unnecessary head resistance and the cutting down of weight, and the builders have produced in R-80 a ship of only 1,250,000 cubic feet capacity, whose performance in speed and endurance is equal to that of R-33 and R-34, which have a capacity of 2,000,00 cubic feet. The overall length of R-80 is 530, its diameter is 70 feet and its height 85 feet. The total gross lift is 38.5 tons at sea level and the disposable lift is 17.5 tons. At full power, the estimated speed is over 60 miles per hour, and the cruising radius at this speed is 4,000 miles and 6,500 miles at 50 miles per hour. On her trial, Capt. Little said the airship reached a height of 3,000 feet and a speed of about 46 miles per hour. It is estimated that the speed with the four 240-h.p. Wolseley-Maybach motors when working all out will give her a speed of over 60 miles per hour, at which speed the airship has a range of 4,000 miles, while at a cruising speed of 50 miles per hour she should be able to cover 6,500. The lifting power is given as 38 tons.

TESTS OF FOKKER AEROPLANE CHASSIS

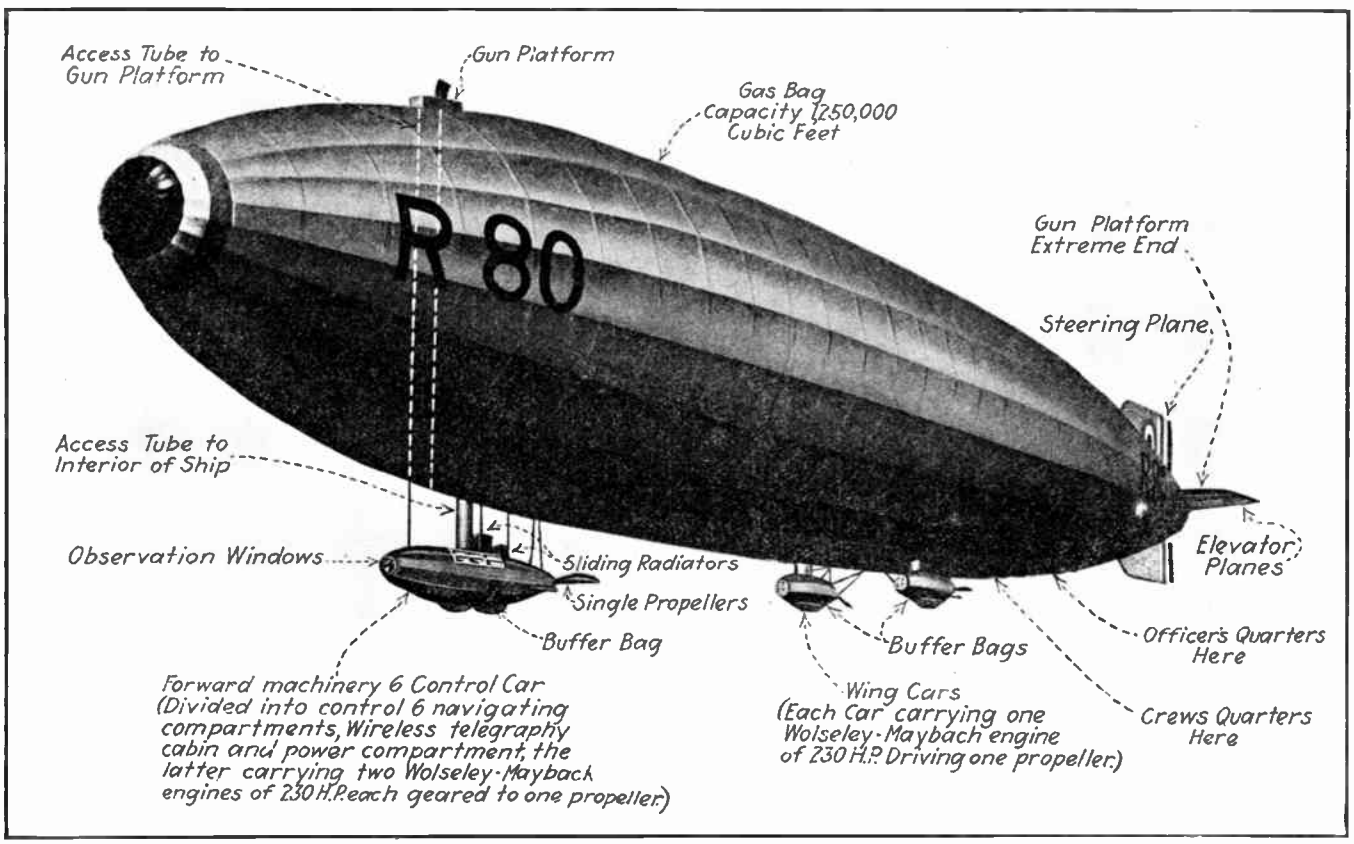
TESTS for strength have been made at McCook Field on the chassis of a Fokker aeroplane.

The chassis struts are seamless steel tubing of streamline section. Into the upper end of the strut is welded a ball which fits into a cup on the longerons. A bolt passing through both ball and socket holds the struts securely in place.

The struts are welded at the lower end to a box-shaped structure which also forms the support of the shock absorber. To this box is riveted an aluminum alloy cross member. The axle, which is 2 11/64 inches outside diameter, 0.160-inch wall steel tubing, moves inside this cross member. The axle fairing has a section similar to that used for the wings, so that it acts as a lifting surface, contributing about 4 per cent of the effective lift.

Spiral steel springs, built up and wound on the tubes and axle in a manner similar to that employed with elastic cord, furnish the shock-absorbing medium. The chassis, complete with wheels, tires and axle fairing, weighs 110 pounds. The action of the coil spring in absorbing shock does not seem to be as satisfactory as that of elastic cord. It was noted that when the load was removed the axle returned immediately to its original position, in contrast with the lag noted in tests where elastic cord was used. This would not be desirable, because the airplane would be apt to rebound more in landing. However, as rubber was difficult to obtain, the springs were used as a substitute by the Germans.

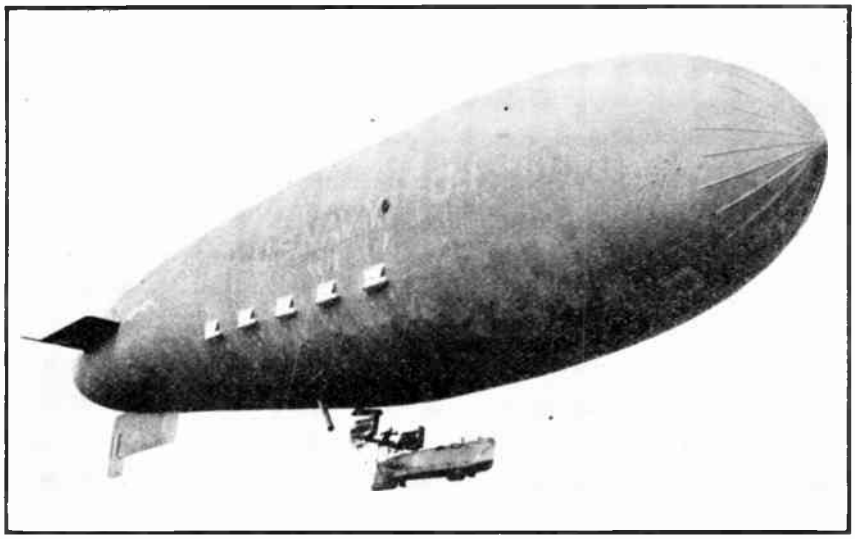
The strength of this chassis is well above the average for aeroplanes of this type. The unusually high strength, moreover, is obtained with only a slight increase in weight. Allowing 10 pounds for the weight of the lifting surface construction, the net weight of 100 pounds is the same as that of the Ordnance Type "D" and only 10 pounds more than that of the Curtiss-Kirkham biplane.



View of new British dirigible developed by the Vickers interests shows latest airship practice

D-1 TYPE NAVY DIRIGIBLE

THE accompanying illustration shows one of the United States Navy large, twin-engine dirigible balloons, which has been widely used for coastwise duty. It is of the non-rigid type dirigible. The gas-bag length is 200 feet, and there is an engine of a maximum speed of 58 miles per hour. The airship has a cruising radius of 1,000 miles and is capable of 20 hours' sustained flight.



Type D-1 Navy non-rigid dirigible with two engines

The car is equipped with the usual wireless and bomb-dropping device and with machine guns for protection purposes. It is stated that the car is of sufficient size to provide accommodations for a crew of six. This type of construction is one in which the United States Navy excels, and the craft illustrated is a particularly good example of the large, non-rigid dirigibles.

MAN-POWER FLYING MACHINE

CONSIDERABLE effort has been made by various inventors to devise aircraft that would fly without power. One of the latest attempts to build a machine of this nature is shown in the accompanying illustration.

The machine was devised by Mr. H. S. Dickson, an English inventor, and is supposed to be propelled by the muscular efforts of the man himself and not by any engine.

The machine is supposed to fly by the same wing-flapping principle used by a bird in rising from the ground. The measurements of the airplane are 23 feet, this being from tip to tip of wings, and from the nose of the machine to the tail length it is 14 feet. The machine weighs but 47 pounds, this being a remarkable structural feature in itself.

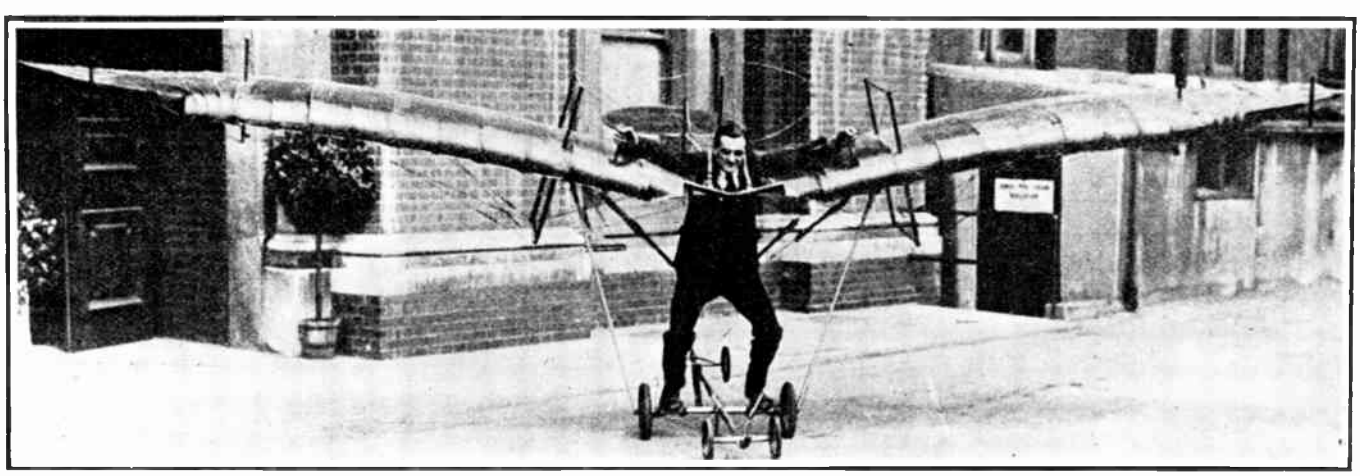
No authentic reports are at hand regarding the flying ability of this craft, but it would seem that its possibilities were somewhat limited by the amount of power the human being can produce. It might be possible for an athletic man to make a gliding flight or jump of a few feet from the ground by flapping the wings, but it is extremely doubtful if a machine of this character will make any definite contribution toward solving the problem of flying without mechanical power.

ZEPPELIN DEVELOPMENT

THE displacement of Zeppelin rigid dirigibles, which may be taken as a measure of their size, increased from 880,000 cu. ft. in 1914 to 2,400,000 cu. ft. in the middle of 1918, and during the same period the capacity of the engine installation grew approximately proportionately up to 2050 h.p. (seven engines). The speed increased from 50.3 ft. p. s. (40.5 m.p.h.) to 82.8 ft. p. s. (56.7 m.p.h.) and attained its maximum value in the newest small commercial dirigible Bodensee, which from the aerodynamic point of view, that is, with respect to ratio of efficiency to air resistance coefficient, has proven the best design so far. The proportion of useful load to weight of the airship empty, which is a most satisfactory index of the progress of design, has increased since 1914 from 0.7 to 1.9 in the largest types, but in the small commerial airship has dropped again to 0.76, this craft having evidently a relatively heavy engine installation.

NEW AIRPLANE SPEED RANGE RECORD

THE preliminary trials for the "Prix du Grand Ecart", offered by *L'Auto* to the French aviator in a French airplane who flies twice over a three kilometer course with the greatest difference between the two speeds, were held the beginning of July. There were three machines entered. M. Bossoutrot, on a Sport-Farman, was classed first. The mean time, out and back trips, for the slow speed was 7 min. 41.3 sec.; giving a speed of 14.6 m.p.h. The time for high speed was 1 min. 17.2 sec.; giving a speed of 87.1 m.p.h. These figures show a speed range of 1:5.98. When the Wrights first flew their speed range was about 1:12. It may easily be seen that tremendous advances have actually been made. Even during the war a speed range of 1:3 was considered very good.



The man-powered flying machine was invented by an optimistic Englishman who believes he can fly without mechanical power. He probably has been enlightened by this time

MANUAL ARTS AND CRAFTS

PROJECTS FOR THE SCHOOL, HOME OR SHOP

MOORISH TABOURET

THIS project is not a difficult one if you begin by making a firm resolution that you will work slowly with your eye and mind on the work at every instant and keep trying the joint edges with the bevel set at 60 degrees. Begin this project by laying out the hexagon headers B. This is easily done by roughly cutting 2-11 ⅛ in. lengths of ¾ in. board 9½ in. wide. Temporarily nail them together. Find the center in both directions, scribe a circle with a 5½ in. radius. You will observe that the circumference extends beyond the board on both sides. If accurately made these points where the circumference stops at the edges a-b-c-d are the length of those sides. Now set the steel compass point on a or one of these points, draw an arc intersecting the circumference. Do this at the other three points b-c-d. Connect these points, observing that a-b and c-d are parallel, also that the other four sides must likewise be parallel. If you can procure a protractor, check up the sides. They should be 120 degrees in relation to one another.

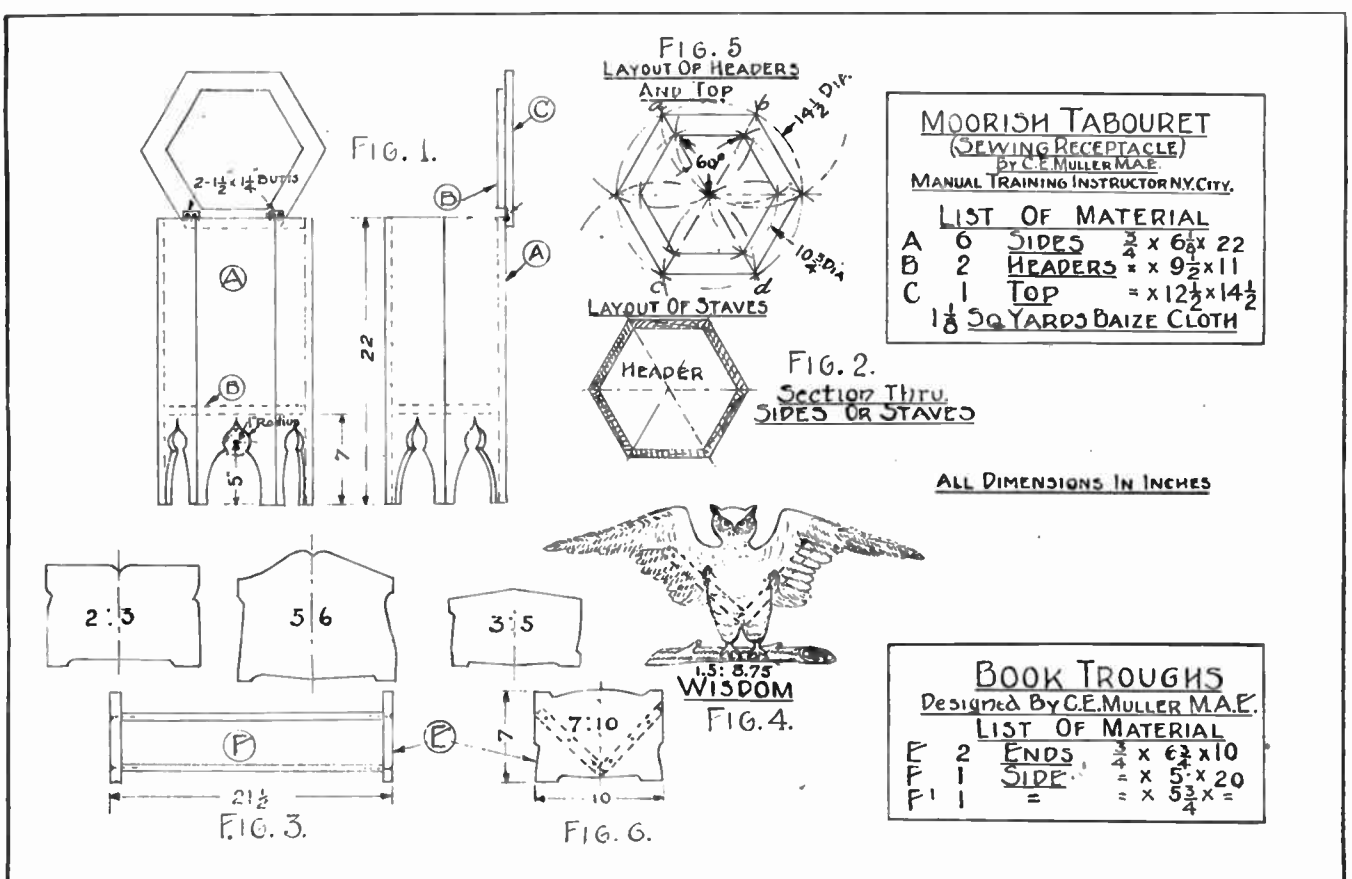
Next get out the sides, cutting out the design, a trifle more than 6⅛ in. wide to allow for planing the joints. Plane two edges checking with a 60 degree bevel. Then try on the header. You may check up by a straight edge. These joints should very closely coincide with the diagonals drawn through a-d and c-b. Temporarily nail this side on to the headers. Then proceed with the other five sides, fitting them on to the preceding ones. As each side is fitted, temporarily nail it in place. When the last one is fitted, glue and nail, then take off one side at a time, glue and nail in place before disturbing to the succeeding one. If you want this pedestal open do not glue in the top header but temporarily nail it in place until the glue is set at the joints, then it may be removed and used as shown in Fig. 1.

This header is then fastened to the top by three or four 1¼ in. No. 12 wood screws inserted through the header into the top.

This project may be stained and varnished as explained in the August edition to match its surroundings, or given one coat of flat white paint followed, when dry and sand-papered smooth, by a coat or two of white enamel. If this is to be used as a sewing receptacle it is advisable not to paint or stain the inside, but to glue in green or red Baize cloth or some similar material.

BOOK TROUGH

THIS project is so elementary that it suffices to say that the nine (one-half) contours of the ends will be ample to suggest others so that the individual may design one to suit his fancy. The sides F are nailed together, then the ends are lock-nailed as indicated in figures 3 and 6. The owl as the bird of wisdom makes a splendid motive for a design of this kind. The feathers may be represented by veining with a small carving gauge or "Vee" tool. Gum and white wood are particularly adaptable for this kind of carving. When stained brown with a touch of white on the breast the effect is very pleasing.



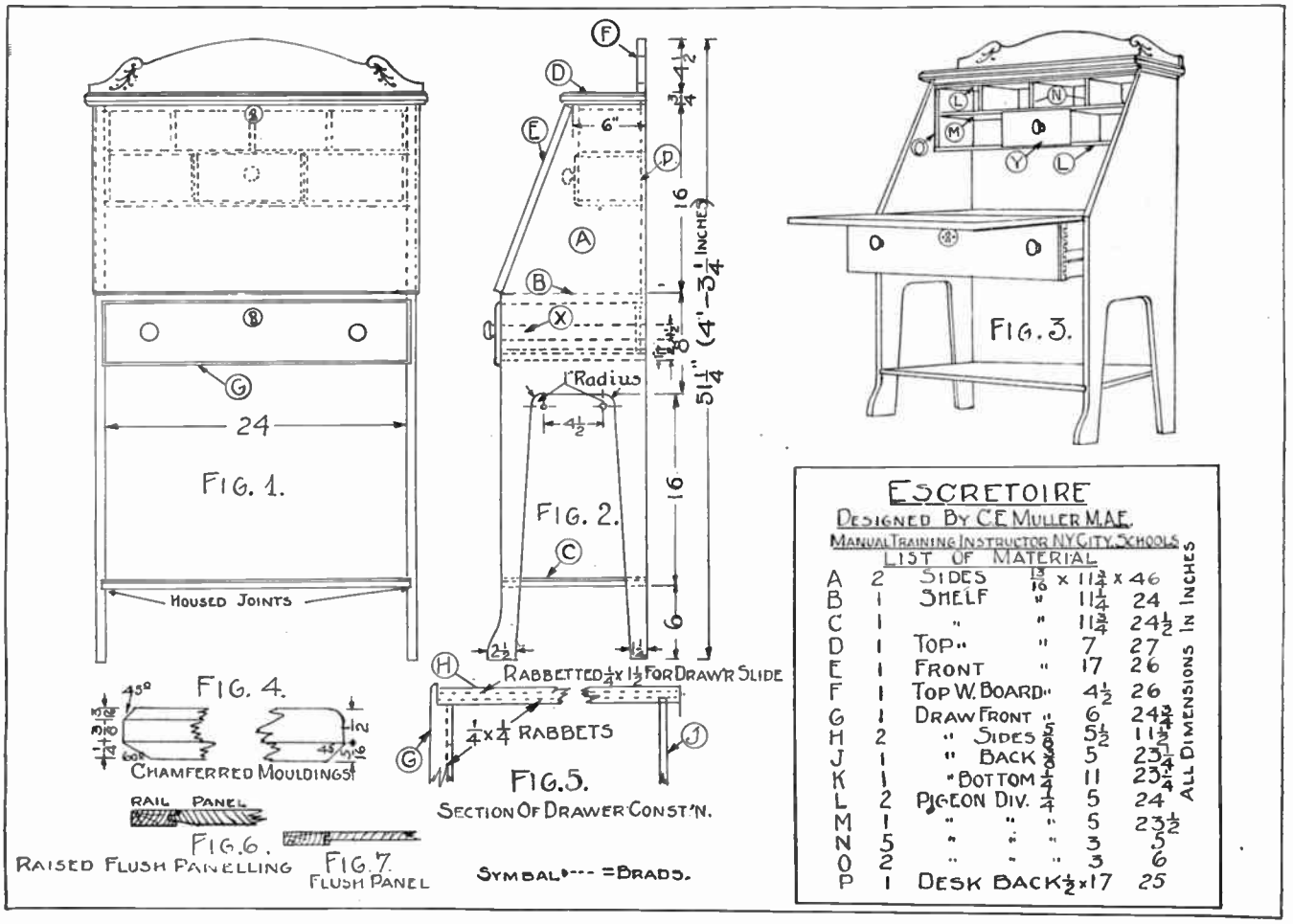


FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.
Section Of Drawer Const'n.

FIG. 6.
Raised Flush Panelling

FIG. 7.
Flush Panel

ESCRETOIRE
Designed By C. E. Muller M.A.E.
Manual Training Instructor N.Y. City Schools
List Of Material

A	2	Sides	13/16	11¾	46
B	1	Shelf	"	11¼	24
C	1	"	"	11¾	24½
D	1	Top	"	7	27
E	1	Front	"	17	26
F	1	Top W. Board	"	4½	26
G	1	Draw Front	"	6	24¾
H	2	" Sides	½	5½	11¾
J	1	" Back	¼	5	23¾
K	1	" Bottom	¼	11	23¾
L	2	Pigeon Div.	¼	5	24
M	1	" "	"	5	23½
N	5	" "	"	3	5
O	2	" "	"	3	6
P	1	Desk Back	½	17	25

All Dimensions In Inches

ESCRETOIRE
(DROP LID SECRETARY)

THIS desk is not near as difficult to make as it may appear to the amateur. The simplicity of construction is very gratifying to the average individual that cares more for the practical than the strictly ornamental. But by the particular selection of the grain, the carefulness in execution, the diligence in staining and finishing, this project will surely merit the appreciation of any one that desires the convenience of privacy and utility. Brown ash, quartered oak and chestnut are especially adaptable to this design, lending with their splendid marked grain a solid and substantial appearance offsetting the simplicity of design. White wood stained to imitate cherry also sets off the design. Cypress, if smooth, with a fancy marked grain, is also very satisfactory for strength, beauty and ease of accomplishing the operations.

If the sides A are more than 12 inches wide up to about 14 inches, they may be used full width by making allowances to the dimensions given. The additional width will add to the appearance and usefulness of the project. A rail may be added about 6 inches above and on three sides of the lower shelf to prevent books or magazines from sliding off The lid may be held up by small brass or iron-jointed braces or chains or the bottom drawer may be made with extra heavy slides to stand the weight of lid and the pressure exerted when used. This last method is only a makeshift and is not recommended.

It may be too obvious to need suggesting that the fanciest grain be selected for the desk lid, the large drawer front, and the top wall board as they are the conspicuous components. Next in importance are the two side members A. It is usual to fashion these first. They may be laid out separately or temporarily nailed together at places where the shelves adjoin so that the nail holes may be utilized for the nails that fasten the shelves in position.

Cut two lengths accurately 46 in. long, joint one edge for a working edge, then fasten together as above, plane to width, lay out the top taper, mark the centers for the upper corners of the legs, bore two 2 in. holes 4½ in. centers with an expansive bit. Be sure the boards are very tightly clamped together with a 3 in. square or larger block directly under these holes so that the bit may be operated clear through both boards. Ordinarily with the auger bit one bores until the spur or worm protrudes through the opposite side, then reverses the boring from the other side, but this will leave, with the expansive bit, a ring that is very troublesome to remove.

If care is exercised to bore the hole squarely, the next step is to draw the lines tangent to these corners to the bottom of the pieces and across, connecting the holes. Do this on the opposite side to better guide the sawing. The cross cutting may be done by a compass, keyhole or turning saw, or chiselled out if care is taken not to split the piece. If chiselled out, each piece must be separately cut, chiselling from both sides to the center (in thickness). Use the mallet with comparatively light blows. Surface plane the inside faces of A next.

The sides may be rabbetted to receive the components B-C, that is, the shelves may be housed into the sides ¼ in deep. This has no advantage except the strengthening of the lower shelf, where it is recommended for a possible excess load of unused books or when used as a catch-all The back panel R is ⅜ in. x 17 in. x 24¾ in. It should be rabbetted ⅜ in. x ⅜ in. into the sides A, ½ in. x ⅜ in. into the top shelf D and the shelf B.

The shelves B-C are next cut to size and surfaced planed on their upper faces only. The back is face planed on the inside only and this may be omitted if the grain is fairly smooth and carefully sandpapered. This and the pigeon-hole material may be made of any soft wood. The small drawer front is usually of the same material

(*Continued on page* 68)

CHEMICAL NOTES, RECIPES AND FORMULAS

COATING GLASS IN SUMMER

IN the summer season it is sometimes desirable to diminish the intensity of the solar rays in workshops, studios, verandas and the like. The following emulsion is recommended for the purpose: Water 570 parts, dry white pigment, such as whiting, 285 parts, powdered ultramarine 60 parts, linseed oil 85 parts. The white pigment, the ultramarine and the linseed oil are thoroughly mixed preferably in a porcelain mortar, then the water is added little by little so as to obtain a perfect emulsion. It may be applied to the glass with a brush or a rag.

GLAZIER'S PUTTY

WHITING 250 parts, linseed oil 100 parts. The whiting is first dried in a pan over a fire or in an oven. It is then thoroughly mixed with the linseed oil with hard rubbing and kneading until a desirable degree of consistency is obtained. As it hardens in the air it may be preserved for a certain time under water. If the hardening has not gone too far it may be readily softened by beating and kneading with a little more oil. It will be noted that it takes an astonishingly small quantity of oil to soften it.

CEMENT FOR FOUNDRY USE

THE following simple mastic is of use for filling up cracks and surface indentations in castings: powdered brick 90 parts, litharge 10 parts; the two ingredients are mixed up with enough linseed oil to form a firm paste or putty which naturally improves with working. It will be found that this mastic becomes very hard and will do excellent work in the filling up of imperfections in the surface of castings.

CEMENT FOR MOTHER OF PEARL

STRONG glue, which may be fish glue, is soaked in cold water for twelve hours and is then heated in a glue kettle or other double boiler until it liquefies; one-tenth of its volume of the water-glass solution of the shops, which is of syrupy thickness, is added to it, and the whole is thoroughly mixed. It is used for attaching mother of pearl to wood.

Much attention is being given to the extraction of gasoline from natural gas. Nearly thirty times as much was extracted in 1916 as in 1911. The development of the absorption process will increase the yield still further. The gasoline is absorbed from the natural gas in what may be termed an oil tower, a tower with a filling of baffle material through which oil is kept dripping. Through this the gas passes from below upwards against the direction of the oil and under pressure which is often the natural pressure of the well, although sometimes artificial compression is used. In the old process three-fourths of a gallon of gasoline had to be extracted from over a thousand cubic feet of natural gas to make the process pay. By the new process a smaller quantity, less than a pint per thousand cubic feet, pays for the extraction. The velocity of the stream of gas should not exceed seventy-five feet per minute and the tower should be so high that the time of contact of gas and absorbing oil will be about fifty seconds.

REMOVING RUST SPOTS

TIN chloride (stannous chloride) is made by dissolving tin in hydrochloric acid to saturation. The article is left in contact with the above solution for twenty-four hours, is then brushed off with clear water, then with water containing some ammonia, is rinsed out in water a second time and dried in sawdust.

WATER PROOF COMPOSITION

TWO solutions all made: Solution A—Water 1,000 parts, castile soap 25 parts; solution B—Water 1,000 parts, copper sulphate 6 parts. The material is saturated with solution A while it is very hot, passed through a wringer and allowed to dry. It is next immersed in solution B, also hot, and treated as just described. The process may be repeated two or three times, according to the judgment of the operator.

PRESERVING PEACHES

THE fruit must be perfect and thoroughly cleaned and preferably a little hard or firm in consistency. They are to be coated with warm paraffine or honey. Whichever is used is heated just enough to bring it to the liquid state and the fruit is plunged into this bath for a few seconds only, is removed and put to one side to drip. It is then put into hermetically sealed vessels, boxes or jars. They should be kept in a cool place. When the fruit is to be used it can be slightly heated to remove as far as possible the coating; they are then peeled and are ready to eat.

The element helium was found by studying the solar spectrum by Janssen in 1868. It was not until 1895 that Ramsey isolated it from the mineral cleveite. Prior to 1918 there were only a few cubic inches in the hands of investigators, and its value at that time is supposed to have been nearly $1,500 per cubic foot. It can be liquified and when it is it brings us within one or two degrees of the absolute zeros. In Ontario, Canada, there is a possible capacity of 2,000,000 cubic ft. of helium yield per annum from natural gas containing from .15% to .33%. In Alberta, Canada, possibly 10,000,000 cubic feet per annum can be obtained from natural gas containing .36%. In other parts of British American natural gas is known which contains 99% of nitrogen and a little helium only, while gas from some springs in France is credited with containing 5% of helium. In the United States wells give gas containing .99%. Rubberized balloon cloth is only seven-tenths as permeable for helium as for hydrogen. Skin-lined fabrics are as permeable for one as for the other. Helium with one-fourth volume of hydrogen is not inflamable. Helium is also used for filling in lamp bulbs and for audions. The following are the critical temperatures of liquefaction of four gases in centigrade degrees below zero. Oxygen minus 182.5% C. Nitrogen minus 193.5% C. Hydrogen minus 252.08% C. Helium minus 271% or 272% C. The greatest lay temperature for cryosyice laboratories in the world are the famous Kamerlingh Onnes laboratory in Holland and the one at the Carnegie Institute in Washington, D. C.

TYPEWRITER INK

TAKE castile soap 10 parts, glycerine 30 parts, water 90 parts, 95 per cent alcohol 20 parts, aniline dye of any desired color 10 parts. The soap is dissolved in the water and the aniline in the alcohol; the two are then mixed and the glycerine is added. If necessary they may be filtered through a wad of absorbent cotton in a funnel. It is advisable to use rain water or distilled water for the solution of the soap.

CHINESE CEMENT FOR PORCELAIN, MARBLE, ETC.

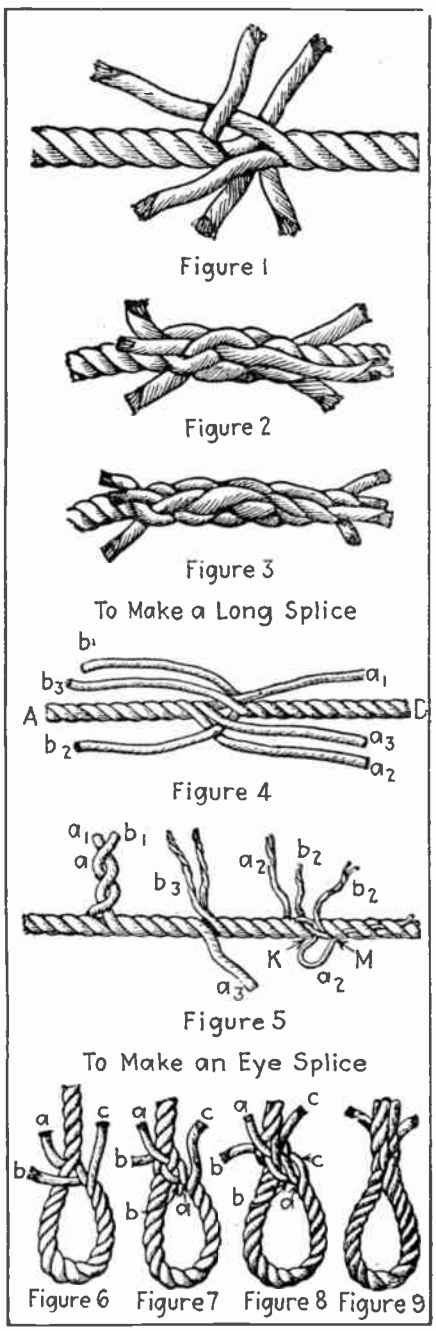
MIX dry the following: slaked lime 55 parts, powdered alum 6 parts. To repair objects of porcelain and the like, the above mixture, immediately before it is to be used, is rubbed up with a quantity of fresh blood serum, which is simply made by letting blood coagulate by standing and then pouring off the liquid. Enough is used to make a fluid paste which is at once applied to the surfaces to be joined, which are then clamped together and the cement is allowed to harden. It would be interesting to try a ten per cent solution of white of egg in this mixture instead of the blood serum.

To get pure carbon dioxide gas from the products of combustion of coke ovens the gases are passed through a solution of costic potash. This absorbs the carbon dioxide and eventually hydro-potassium carbonate, the bi-carbonate, is formed. From the solution of this salt pure carbon dioxide is obtained by boiling. It would seem obvious that the start could be made with a solution of potassium carbonate instead of the caustic solution. Oxygen is removed by passing the gas over hot copper or by acting on it with chromium chloride or acetate or with titanium chloride. If carbon monoxide is present the gas is passed over copper oxide which has been formed upon asbestos. Commercial nitrogen is generally so pure as to need no treatment, there being present in it only some of the rare gases. In hydrogen made from water gas there is danger of the presence of carbon monoxide; the latter attacks the steel of the containing cylinders forming iron carbonyles. In this way it corrodes the metal and injures the cylinders. It is suggested that hydrogen cylinders used for water gas hydrogen should be enameled inside. Commercial chlioride is now almost always produced by electrolysid and is very simply purified by liquefication.

For filling cracks in parquet flooring the the following formula is given by a French authority where such floors are very much in use: Melt together yellow wax 35 parts, powdered resin 20 parts, tallow 5 parts, when melted mix and incorporate with them 40 parts of dry white pigment, such as china white. It is applied to the cracks hot, and forced in with a putty knife. It is scraped off to remove the excess and bring it to a level with the surface. Red or yellow ochre, lamp black or any mineral color may be used to get the proper tint to match the wood.

How to Make Rope Splices

TO make a short splice, as shown at Figs. 1, 2 and 3, unlay the strands of each rope for a convenient length. Bring the rope ends together so that each strand of one rope lies between the two consecutive strands of the other rope. Draw the strands of the first rope along the second and grasp with one hand. Then work a free strand of the second rope over the nearest strand of the first rope and under the second strand, working in a direction opposite to the twist of the rope. The same operation, applied to all the strands, will give the result shown by Fig. 2. The splicing may be continued in the same manner to any extent (Fig. 3), and the free ends of the strands may be cut off when desired. The splice may be neatly tapered by cutting out a few fibers from each every time it passed through the rope. Rolling under a board or foot will make the splice compact.



To make a long splice, Figs. 4 and 5, the rope should be unlaid for a greater distance than for a short splice, and the ends brought together with strands interfacing. Instead of tucking at once, unlay a-1 (one of the strands of A) for a considerable distance, and in place of it lay up b-1 (the adjoining strand of B), thus working a strand of B into A for about a foot and a half or two feet. For convenience, twist up a-1 and b-1 together temporarily, as in Fig. 5. Turn the rope end for end, unlay b-2 (one of the strands of B), and in place of it lay up a-2 (the adjoining strand of A), a-3 and b-3 left lying beside each other without being unlaid. We now have three pairs of strands at different points of the rope. Beginning with a-2 and b-2, for example, separate each of these strands into two parts, and taking one-half of each strand, over-hand knot these together (K, Fig. 5) and tuck them as in a short splice, over one and under one of the full remaining strands of the rope (Fig. 5).

The other pairs of strands (a-1, b-1) (a-2, b-2) are similarly reduced, knotted and tucked. The spare half of each strand is trimmed off smooth, likewise the ends of the other halves after they have been tucked.

To make an eye-splice, Figs. 6, 7, 8 and 9, unlay a convenient length of rope. Pass one loose strand (a) under one strand of the rope, as shown in Fig. 6, forming an eye of the proper size. Pass a second loose strand (b) under the strand of the rope next to the strand which secures (2) (Fig. 7). Pass the third strand (c) under the strand next to that which secures (b) (Fig. 8). Draw all taut and continue and complete as for a short splice.—*Int. Steam Engineer*

DIESEL-ENGINE SPEEDS

THE Diesel-engine manufacturer is confronted by a decidedly dangerous competitor. In the last few years a number of surface-ignition engines have been built in sizes above 200 h.p. One European concern has installed engines of 600 h.p. and is now building a 1,000-h.p. unit. These engines are cheaper to build and are rapidly encroaching on the Diesel-engine field.

If the Diesel manufacturer does not wish to lose that part of his business devoted to units under 500 h.p., it will be necessary for him to increase the Diesel speed and thereby lower the manufacturing cost. There is no structural reason to prevent Diesel engines, when properly designed, from operating at speeds as high as 400 r.p.m. Units of 500 h.p., if operated at 300 or 400 r.p.m., could be manufactured at one-half the present cost. The chief objection that might be raised would be that this speed would be impossible for the air compressor. The compressor could be motor-driven or abandoned altogether. Lighter valve rigging and reciprocating parts would reduce the frictional loss, which in the present-day Diesel is excessive. Marine Diesels have been designed to operate at the higher speeds; provided with a suitable foundation, this same engine would have a life equally as long as has the present-day ponderous, slow-running machine.—*Power.*

COMPOSITION OF COAL

COAL is of vegetable origin, formed from plants which have undergone decomposition under pressure and at a temperature not exceeding 300 deg. Cent. The substance of coal may be separated into cellulose and bitumen by employing solvents; first pyridin, then chloroform and benzol. In the cellulose portion there are compounds which give, by dry distillation, phenol as well as compounds whose molecular structure is similar to that of the carbon molecule. It is improbable, therefore, that coal contains free carbon. Compounds are not numerous in the cellulose constituents. The bituminous constituents give compounds in which alkyle naphthene and unsatisfied hydroaromatic radicals are held together in large and complex groups. The presence of the aromatic group is doubtful. Under the influence of pressure the bituminous portion was strongly polymerised. Hydrocarbons are found only in the bituminous portion of the coal. Unsatisfied hydrocarbons (paraffin) are, however, present in small quantities only. The principal difference between the products of the distillation of coal at a low temperature and mineral oil is that in the latter there is no phenol which may be taken as proof that mineral oil has not been formed out of cellulose.

The world production of graphite has been about 120,000 tons. A new deposit is reported from Siberia, which is said to give a wonderfully good quality of graphite. The place is located ninety miles from the mouth of the Yenesei River.

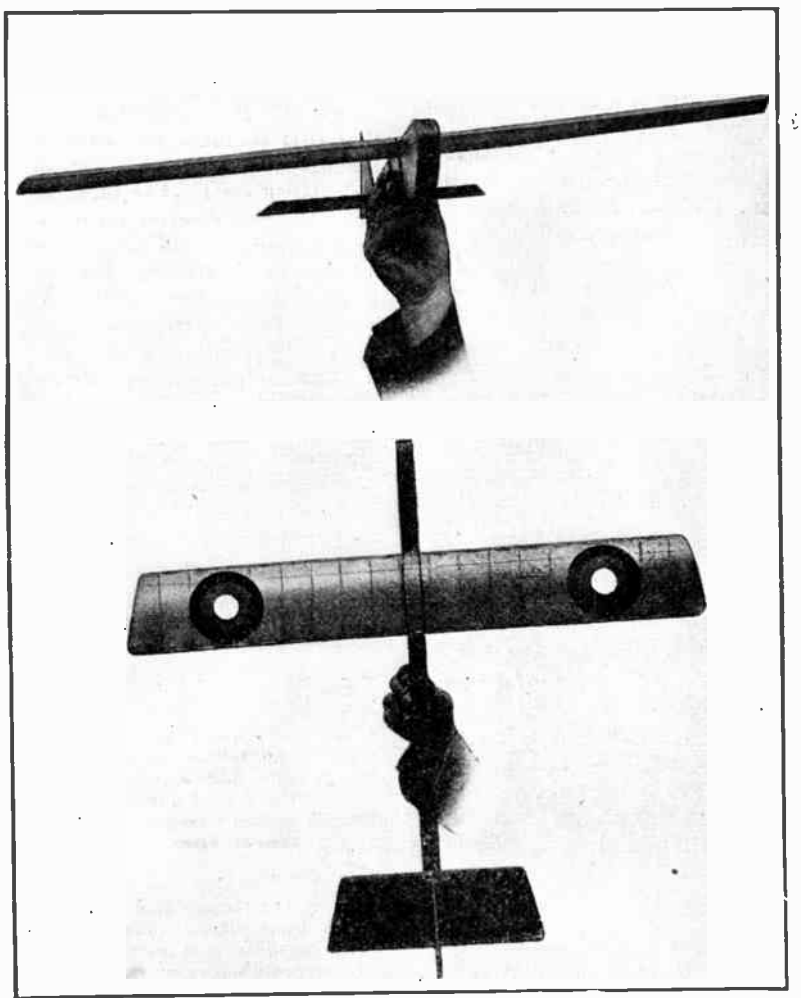
In Africa observation of the ant hills which there attains a very large size, has been found to give valuable indications as to the probabilities of the soil below them carrying diamonds. Particles of mica are the substance watched for as such is taken to indicate diamond-bearing soil.

A Simple Hand Launched Glider

By H. C. Ellis

THE fuselage, stabilizer and rubber of this simple glider are cut from Balsa wood. The Balsa for the fuselage is 7/8 in. thick. The wood for the stabilizer and rudder is 1/8 in. thick. Three ounces of lead is placed in the nose of the fuselage at the point shown in the drawing. This is accomplished by cutting a hole in the fuselage with a sharp knife, melting the lead in a ladle and pouring it into the hole, the bottom of which is closed with asbestos sheet. The ends of the lead slug are peened over to keep it from coming out of place.

The main plane is 31 ins. in span. The ribs are the solid type and may be cut from 1/16 in. spruce or Balsa of the same thickness. The reader will find it much more satisfactory if a metal pattern is used in cutting out the ribs. This will insure all ribs being the same. The trailing and entering edges of the wing are 1/8 in. reed. When thrown from the hand, it will make flights of several hundred feet and is a splendid and inexpensive device for practicing hand launching and also for learning the principles of airplane balance. As the wing is attached to the fuselage stick by a looped rubber band, it can be easily shifted to the front or rear until the proper balance is obtained. As the glider is so easily built, it is recommended for our younger readers, and even if one should tire of the glider, the main plane can be employed on modifications of any of the monoplane or biplane models previously described in which rubber strand motors furnish the power. The accompanying drawing shows the construction so clearly that further description is not necessary. The method of launching is shown in one of the photographs.



The illustration at top shows method of launching glider. The plan view below shows the simple construction of this model

NOTES ON AIRPLANE MODEL MAKING

Proofing and Coloring Silk

JAPANESE silk is by far the best material to use for covering, and is best bought ready proofed. If the model builder prefers to proof it himself I recommend him to stretch it on the planes first, and then give it an even coat of a mixture made of equal parts japan gold size and boiled linseed oil; this will dry with a glossy surface. The proofing may, of course, be colored before application, if it is desired to impart a color to the silk, by adding suitable paint powder to it. The following colors are most suitable: For green, gamboge and prussian blue; red, crimson lake; brown, Vandyke brown or burnt sienna; purple, crimson lake and ultramarine; blue, french ultramarine; yellow, either gamboge or yellow lake; black, lamp black.

Simple Steam-Chest for Bending

Many readers seem to find difficulty in bending model airscrews, skids, etc. This is usually due, I find, to inefficient steaming apparatus. A simple steam-chest for bending purposes may be made in the following way: Take a piece of brass tube of sufficient length and diameter to accommodate the largest spars, etc., to be bent. Fix this to the spout of an ordinary tea kettle, so that steam cannot escape between the joint; old kettles can effectively be employed. See that the lid is steam-tight, and having filled the kettle, place it on the gas ring or fire and the wood to be bent into the tube. Steam thus for ten minutes or so. In finishing the woodwork after bending it should preferably be lacquered since it dries flatter and is less liable to run into corners and give a messy effect than varnish. Cold lacquer should be used, and the colorless variety gives a cleaner effect. This lacquer, which I believe is made by dissolving celluloid in amyl acetate, can be put on hard woods without previously sizing it. Skids or ribs dipped in boiling wax are seldom known to warp after bending.

Building Compressed Air Motors

Accuracy in all portions must be aimed at. A 1/1000th part of an inch in some of the portions will make all the difference to the engine's efficiency; more especially is this so with the valves, which must be an air-tight fit. A small Drummond lathe is quite suitable for turning the various parts. Balance, too, plays a part of some importance in the efficient running of a C.A. motor. In connection with the latter it must be remembered that a piston, for instance, may only be a fraction of a dram heavier or lighter than the remainder, but under revolution a very considerable unbalanced force is set up, resulting in vibration and uneven torque. It is desirable that almost perfect reciprocation be obtained, otherwise the motor may only give 30 per cent. or 40 per cent. efficiency. Some of the commercial motors I have seen show an appalling lack of balance, albeit many of them are of sound design.

There has been a general avoidance of rotary engines, owing to a reputed wastage of power, but provided that the pistons are made a free fit within the cylinder and a suitable means is employed for packing them to ensure air-tightness, they are quite as efficient as

the stationary ones I have seen. In the latter respect, the familiar cycle-pump principle has been utilized to attain this end, and has been found to work extremely satisfactorily. The idea of its use is not new. I think the French first introduced it in some of their rotaries. By its use much circumferential friction may be eliminated between piston-surface and cylinder-walls, because the former need not be made an air-tight fit, since the powerful blast of air let into the cylinder-head at high pressure expands it, and so prevents leakage.

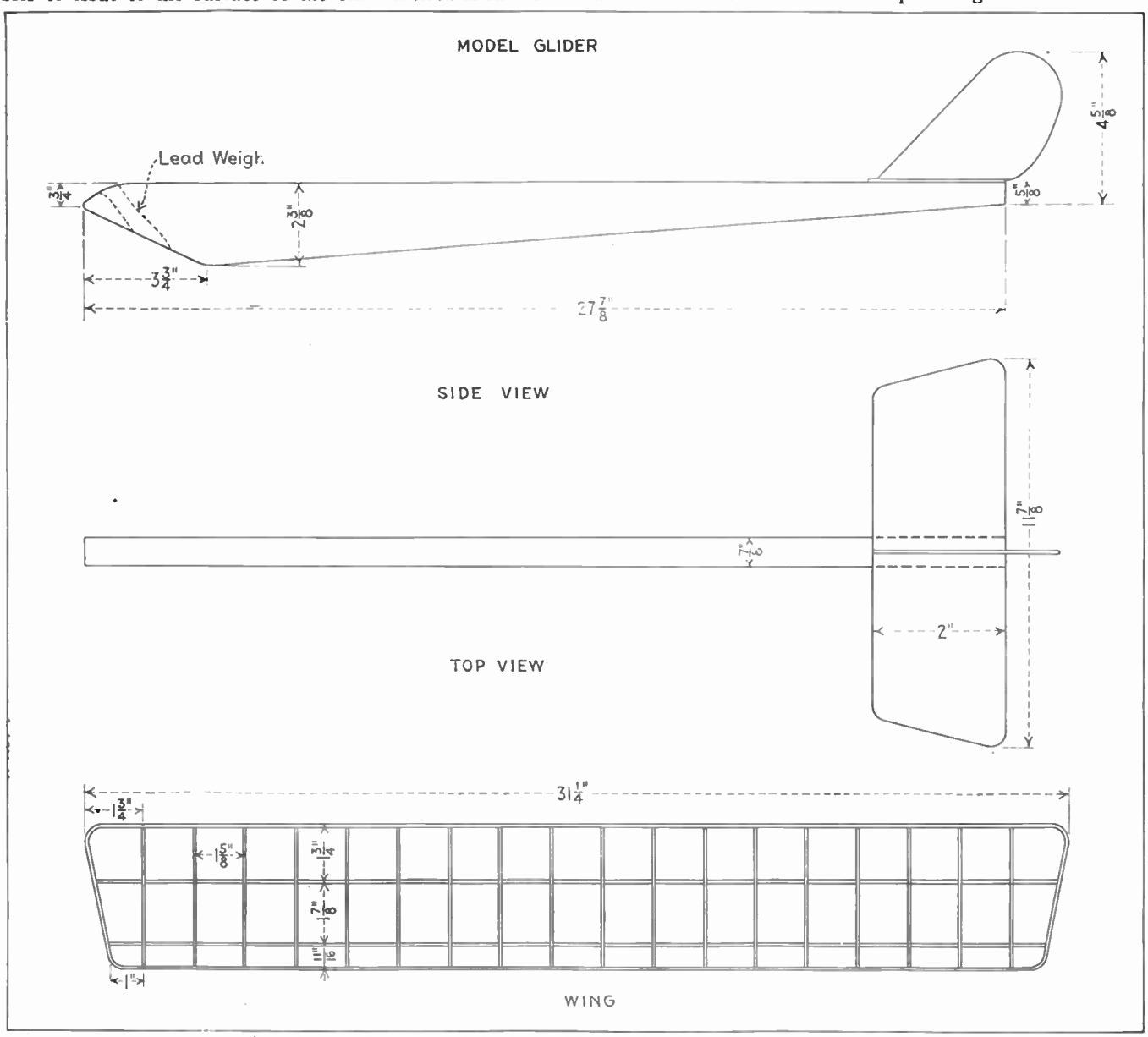
Testing Compressed Air Containers

In order that there shall be no leakage of pressure the container must be inflated to a pressure per square inch higher than it will normally be called upon to withstand, and entirely immersed in paraffin. Many leaks are bound to exist at first, and will reveal themselves by causing a series of bubbles to issue to the surface of the oil. These must be thoroughly stopped up, as the smallest leak will make a difference to the power developed by the motor. Do not use spirits of salts, otherwise within a couple of days the container will be quite useless; Fluxite or powdered resin in much better, as it leaves no deleterious acid residue. The most likely place for leaks to occur is along the seams, or at a place where the thin foil has been cracked or creased. A careful search must be made for them, because the minutest leak becomes enlarged after the container has been inflated two or three times.

Thin sewing-machine oil diluted with kerosene should be used to lubricate such motors. When a plant has been completed the thrust should be weighed on a spring balance, so that a model of suitable weight and area may be designed for it.

Making Hollow Spars

Hollow spars may easily be made, if a circular saw is available. Each one is planed up to its rectangular shape and size. The fence is then set from the saw blade a distance equal to the thickness of the flange of the channel. The table of the saw-bench is then tilted until only an amount of the saw projects equal to the depth of the channel. The prepared spar is now passed over the saw, taking care to keep it pressed against the fence. When both cuts have been made, the spar is laid upon the bench and the center portion (between the saw-cuts) pared away with a chisel, the depth of the channel and, consequently, the thickness of the web being kept uniform throughout. A small saw such as can be run between centers on a lathe is suitable for this sort of work. A table can easily be rigged up on the lathe bed out of some pieces of deal. Without the use of this saw it will be necessary to mark off from each, edge with a pencil, lines to the depth of each flange, and working up to these lines to cut the wood away with a chisel. The lacquer previously referred to may be used for polishing.



Drawings showing dimensions of simple hand-launched glider fuselage stick and wing frame

RADIO
TELEPHONE AND TELEGRAPH APPARATUS

Radio and Audio Frequency Amplifier

This Instrument is Made Up of a Tuned Impedance Coupled Radio Frequency Amplifier, Detector, and Audio Frequency Amplifier

By M. B. Sleeper

REPORTS from readers of EVERYDAY ENGINEERING who constructed tuned impedance coupled amplifiers of the type described in the March, 1920, issue showed such excellent results that a combination radio and audio frequency unit was built, the design of which is illustrated in the accompanying drawings.

TUNED IMPEDANCE COUPLED AMPLIFIERS

A tuned impedance coupled amplifier employs an inductance and shunt condenser between the output circuit of one tube and the input circuit of the next. The inductance and condenser must be tuned to the wavelength of the incoming signals, to give maximum amplification. In a receiving set using concentrated inductances, the coil and condenser may be identical in size with those in the secondary tuning circuit. If possible, the coupling circuit condenser should not exceed 0.0005 mfd. at maximum, for the larger the coil, and the smaller the capacity, the greater is the amplification. Moreover, this type of circuit operates at somewhat greater efficiency on long waves than short ones.

The combination of radio and audio frequency amplification is of decided advantage for the reception of weak signals over the two-step audio frequency amplifier, and equal to the other for strong signals.

DESIGN OF THE AMPLIFIER UNIT

A new method of construction is shown in the illustrations. Instead of crowding the binding posts on the front or back of the main panel, a bakelite plate 4 7/16 by 2½ in. is supported at the rear by two square brass rods, and all connections located upon it. If wooden cabinets are not used, several panels made up in this way will present uniform connecting plates at the rear. On the other hand, the unit can be placed in a cabinet, from the back of which a rectangular opening has been cut. Then all connections can be made at the rear, without securing any part of the instrument unit to the case permanently. Strips inside the case, above and below the back plate, strengthen the brass rod supports. It may be noted that this method of construction in combination with the cabinet, originated by the author, is being made the object of a patent application.

The amplifier itself is divided into three sections, each mounted on a bakelite plate, and suspended by short brass rods from the main longitudinal supports. Thus the construction of the amplifier can be altered without remodeling it entirely. Fig. 1 gives a front and top view, with details in Figs. 2 and 3.

FRONT PANEL

A 5-in. by 5-in. bakelite panel, 3/16 in. thick, was used for the front. The location of the holes is given in Fig. 3. All these holes were made with a No. 27 drill, allowing clearance for 6-32 screws, except those for the jacks, which were 7/16 in., and the observation holes, ¼ in.

Four holes for fastening the panel to the case or mounting it in other ways, were provided. Instead of putting the screws into the wooden case itself, 1-in. lengths of ¼-in. square brass rod were secured in the corners of the cabinet, and the holding screws put into threaded holes in the ends of the brass pieces. However, if the method of fitting the panels together, previously shown in EVERYDAY, is used, the holes should be ¼ in. in from the sides, and for 8-32 screws, should be made with a No. 18 drill.

Federal jacks, Fig. 4, a No. 1422-W for the detector stage, and a No. 1421-W for the amplifier, were mounted at the left. This method of con-

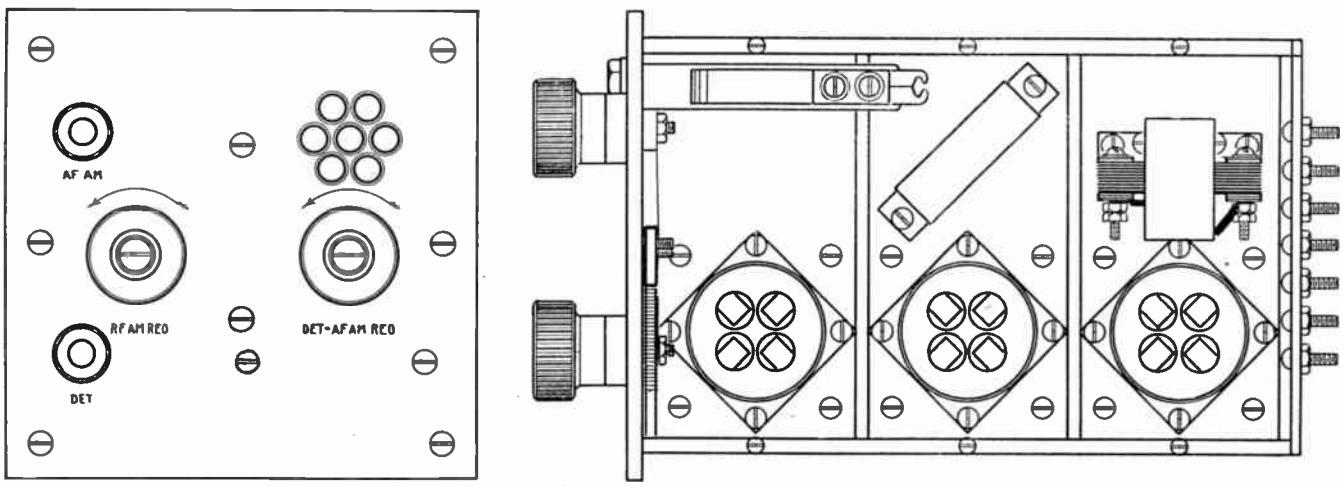


Fig. 1. Front and top views of the unit, showing the parts mounted on individual plates

necting the telephones is generally preferred because connections can be made quickly, and the plate circuit is closed automatically, at the detector stage, when the plug is removed.

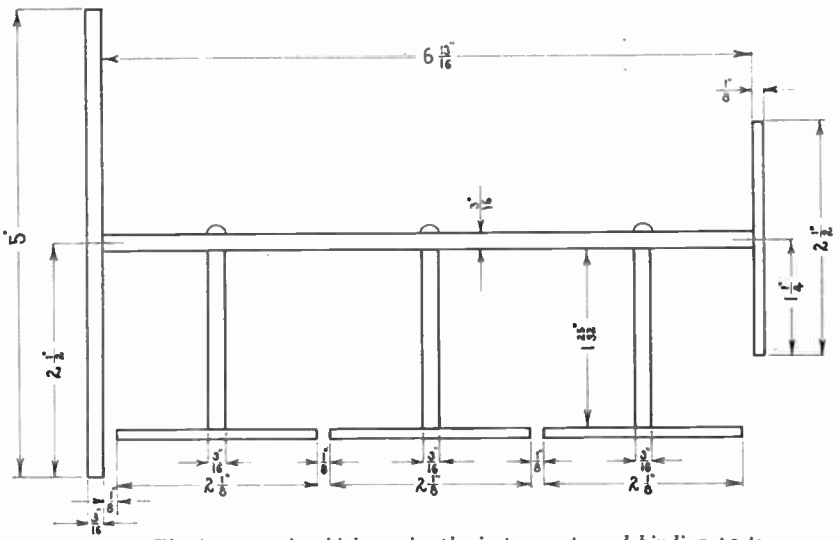


Fig. 2. The framework which carries the instruments and binding posts

Framework and Cabinet

Two 6 13/16-in. lengths, and six 1 25/32-in. lengths of 3/16-in. square brass rod, one ⅛-in. bakelite panel 4 7/16 by 2½ in., and three ⅛-in. panels 4 7/16 by 2⅛ in. were needed for the frame work. The end holes in the long brass rods were threaded for 6-32 screws, and the others for 4-36 screws.

The framework was made to fit in a box of ¼ in. material, measuring 5 by 5 in. outside. Inside, the box was 7 in. deep.

Radio Frequency Amplifier Section

The first section, mounted on one of the 4 7/16 by 2⅛ in. plates, has only an audion socket. This was of the Ace type. To allow room for the screws holding the contact springs, the round flange on the socket shell was cut down to form a square, the corners of which included the holes for mounting it.

Four holes 7/16 in. in diameter, on a circle of 5/16-in. radius allowed the pins on the socket to pass through the plate. The springs, of No. 24 spring brass, were cut 1⅛ in. long and ¼ in. wide. Phosphor bronze would have been better, but it was not obtainable.

Detector Section

The detector section differed from the one just described in only one respect—it carried a fixed grid condenser of 0.0005 mfd. Operation would have been improved, no doubt by the use of a grid leak condenser of the Esbro type, or the addition of a 1 megohm grid leak.

Audio Frequency Amplifier Section

On the audio frequency amplifier section were mounted a socket and transformer. The latter is shown separately in Fig. 5. This transformer, of the Wireless Improvement type, just fitted on the mounting plate. Other makes can be used, but this is particularly desirable because of its small size.

Rheostats

Small strips of fibre or bakelite, wound with No. 26 Advance wire, comprised the resistance elements. Exact dimensions are given in Fig. 3. Notches, made by hammering an 8-32 screw against the corners of the strips, held the wires in place. The resistance supports were fastened to the rear of the panel by ¾-in., 6-32 flat head screws. Holes in the strips were threaded so that no nuts were required. The extending ends of the screws served as stops for the contact brushes.

Arrows on the panel show the direction of rotation for the OFF position, although it might be better to have them point in the opposite direction in which case they would show the direction for increasing the filament brilliancy.

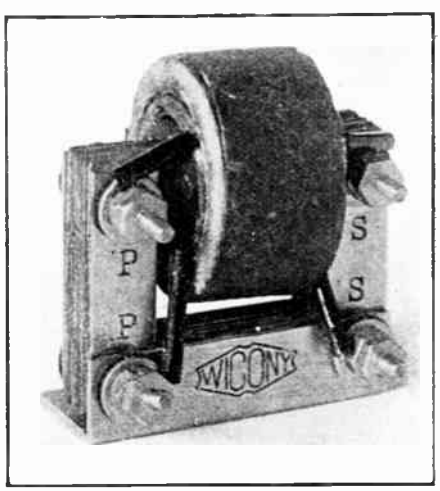


Fig. 5. The amplifying transformer

Connections

A diagram of connections for the complete receiving circuit is given in the upper part of Fig. 6. Binding posts on the rear panel are indicated by circles. Great care was taken in connecting the amplifier, for, if the leads from the radio and audio frequency tubes had been parallel and close together, howling would have resulted.

Separate filament lighting and plate batteries were provided for the radio frequency amplifier to reduce coupling effects. Binding posts for extra telephones, on the rear panel, were ordinarily short circuited when additional phones were not in use.

Operating the Amplifier

Fig. 6 shows the auxilliary equipment as it is connected to the rear panel, except that wiring to the loose coupler is only indicated by arrows. A concentrated inductance or other coil, shunted by a variable condenser, is put across the Z posts.

Experimenters who are familiar with tuning circuits have no difficulty in tuning the impedance circuit and handling the other adjustments at the same time. It is easier on long waves, for

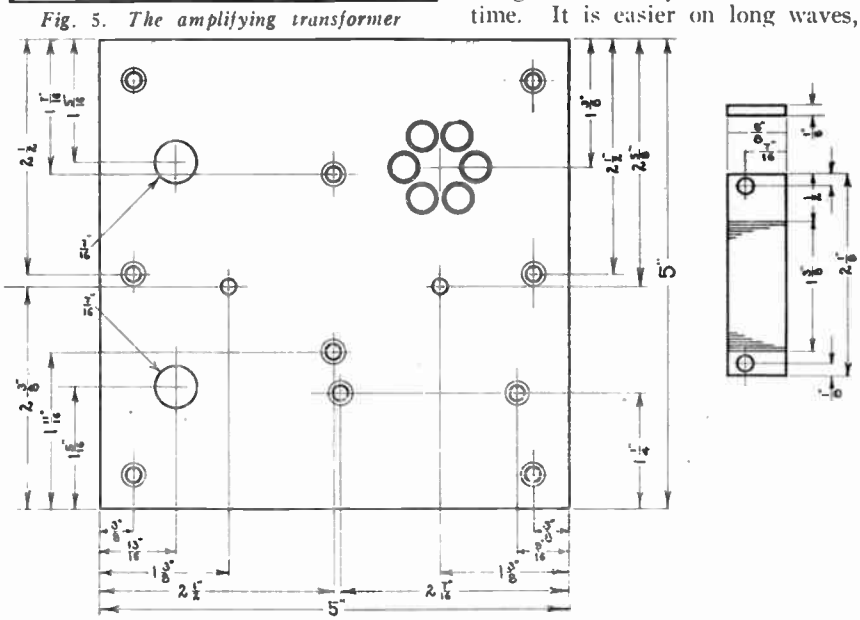


Fig. 3. Layout of panel and resistance units

the tuning is less sharp. Others use a switch to connect the secondary circuit directly to the detector, for standby work, and throw over to the radio frequency amplifier when the loose coupler has been tuned. A different and excellent method is to use this amplifier with a single-slide tuning coil circuit. Sharpness of tuning lost in that way is more than made up by the critical adjustment of the impedance circuit condenser, and the set is very easy to handle.

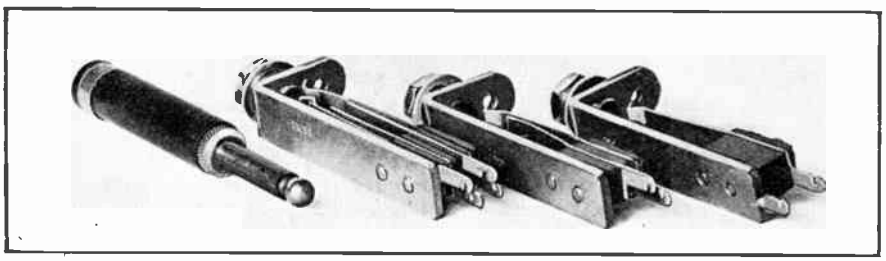


Fig. 4. Federal plug and jacks. The second and third from the left are used on this amplifier

the "splashing" that takes place when a jet of water at high pressure is directed into a body of still water. The "secondary" or liberated electrons may greatly exceed the "primary" or moving electrons in number if the velocity of the latter is sufficiently high. When provision is made for carrying away the secondary electrons as fast as they are liberated the conductor may emit electrons faster than it absorbs them. The significance of this phenomenon cannot be emphasized too strongly in vacuum tube work.

Consider the effect of gradually increasing the velocity of the stream of primary electrons moving toward a positively charged conductor. At low velocities they will all be absorbed by the conductor, but gradually, as the velocity increases, the number of secondary electrons will increase and the resultant current decrease until electrons are emitted at the same rate as they are absorbed. The resultant current is zero. Any further increase of velocity will actually cause a reverse current to flow.

Dr. Albert W. Hull has devised a tube which utilizes this principle. It consists of an evacuated glass vessel enclosing the usual filament for the emission of electrons, and a plate or its equivalent which, by reason of the high potential at which it is maintained, attracts these electrons. Unlike the usual plate, however, it is perforated, and some of the electrons shoot through the perforations owing to their momentum and strike a third electrode, thus bringing about the emission of secondary electrons in the manner already described. Care must be taken not to confuse the "anode," or perforated plate, with the grid of the audion; its function is quite different.

The tube has a number of applications which are described by Dr. Hull in a paper published in the Proc. I. R. E., vol. 6, No. 1, but its outstanding characteristic is its "negative resistance," i.e., the property it has of causing the current to decrease with an increase of voltage.

The Dynatron can be used as detector, amplifier, oscillator, or it may be used as a compensator for circuit losses by neutralizing "positive" resistance.

By introducing a grid into the tube, the number of electrons reaching the plate is controlled by the electrostatic field of the additional electrode, and the tube becomes a very powerful amplifier or oscillator.

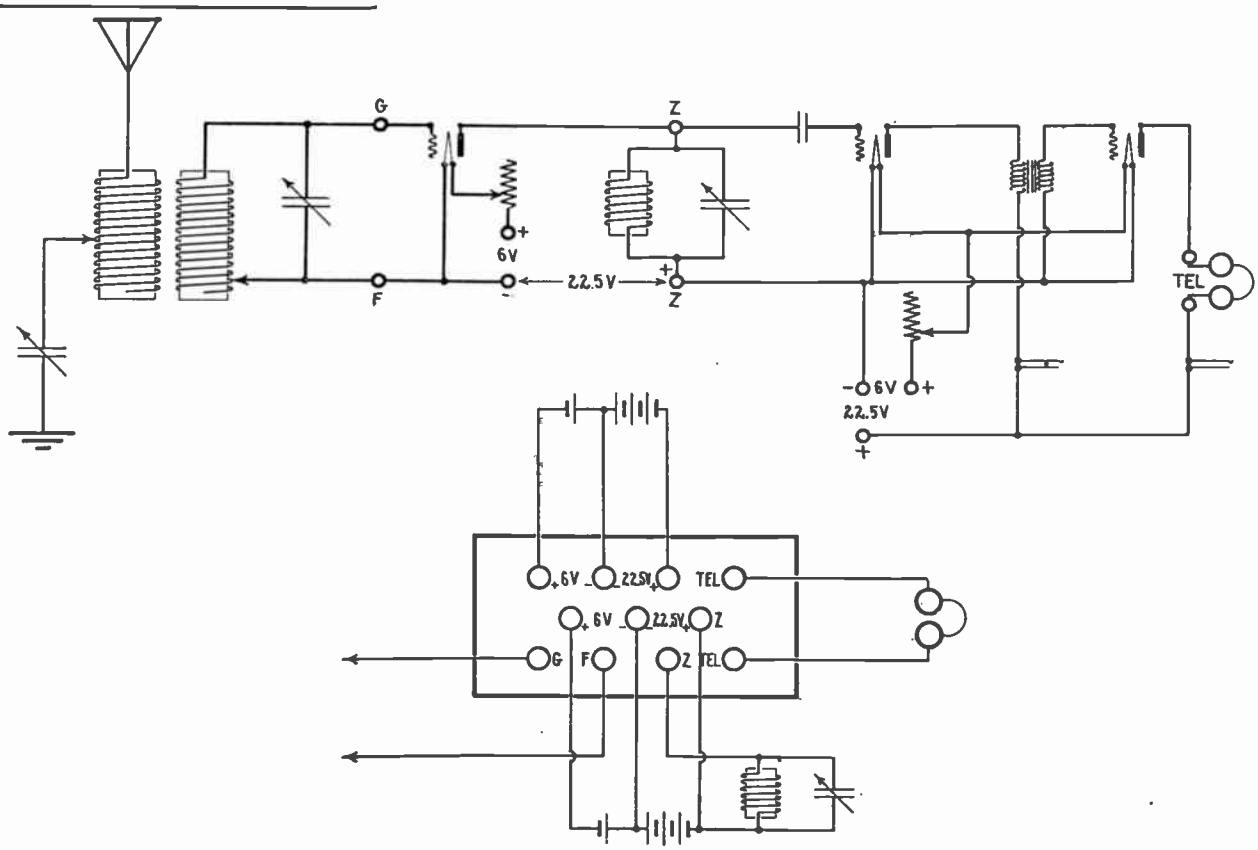


Fig. 6. Above, the complete circuit for the combination radio and audio frequency amplifier. Below, connections from the binding post panel to the exterior apparatus

SECONDARY EMISSION

ONCE in a while someone in a group of experimenters speaks of "Secondary Emission", a term which seldom fails to drop a blanket of silence on them. Really the expression is more simple than it sounds.

If a stream of electrons moving with a high velocity is directed on to a conductor it will disintegrate that conductor and liberate electrons therefrom. This effect is somewhat analogous to

Airplane Radio and Flight Conditions

The Use of Wireless Equipment on Transportation 'Planes and the Circumstances Under Which it Must Operate

SINCE cause must precede effect, let us consider first the purposes for which radio equipment is used in present day commercial flying. And here the distinction must be drawn between pleasant weather flights and the every day, every week schedule which must be maintained if airplane transportation is to be commercially successful.

The United States airplane mail can be taken as a practical example, for it not only operated on a 365 days in the year schedule, but from an experimental venture it has developed into an enterprise financially sound.

Few people outside of the pilots on the mail planes realize the distinction between ordinary flying, even as it was carried on in war times, and the transportation service. One can almost say that, in the latter case, "No flights today," is an order unknown. At the same time all possible precautions must be taken to safeguard the lives of the men in the machines and their cargoes. For this the radio operator and the wireless equipment is given almost entire responsibility when emergencies arise.

Let us take an airplane mail run in a Martin bombing type machine as an example of the use of radio in aerial transportation.

Before taking off the pilot is informed of weather conditions ahead with as much accuracy as can be obtained from the reports. However, these conditions change greatly over a period of several hours. As soon as the machine approaches the first land stations, the operator calls the station at one side of the course and then at the other, asking for information on weather conditions. Fortunately 90 per cent. of the storms are local. Therefore, if there is a storm or high winds on one side, the pilot deviates from his course in the direction of the fair weather.

Again, fogs or storms may be encountered suddenly. Then, by the radio compass, bearings can be taken on a ground station, and time saved which would be lost by straying from the course. If the machine is forced to land, either because of the storm or a breakdown, a land station is immediately notified of the fact, and the news relayed to the destination where another machine, operating on the next leg of the journey, would otherwise wait to no purpose. In the case of the mails, if a plane is forced to land the letters are forwarded by train.

Occasionally it happens that there is a storm at the hangars. The pilot is warned by radio and lands at the first convenient location, where he waits until the storm is over. Then proceeds to his destination and lands in safety.

These are the principal purposes for which radio is used. Now let us consider under what conditions the equipment must operate and the new developments needed.

At all times there is vibration. Designers, in the past, apparently have not considered that on the machine itself lock-nuts, pins, wrappings, soldered joints and many special devices are used to prevent the loosening of the various parts. Certainly if they had they would not have made instruments which in use almost fell apart. Moreover, the severe jolts sometimes experienced are sufficient to tear the parts from their supports. Therefore, while weight is an important factor, airplane radio equipment must be "built like a battleship".

Shock absorbers on the tube sockets do not prevent the transmission of vibration through the air to the glass parts. The tubes must be completely protected, possibly by surrounding them with a box formed of felt.

Interference from wind and engine noises has not been entirely overcome by the padded helmets, although those developed by the Western Electric Company have been found satisfactory. An interesting comment may be made here regarding the all-metal planes. On these the noise is so slight that a conversation can be carried on inside the machine, a distinct advantage for the radio operator.

Another essential feature is that, like the battleship, radio equipment must be water-tight. How many radio men know that, when flying through a storm, there may be several inches of water in the machine? And this at a time when communication is most needed. The slightest dampness in the amplifier makes the tubes squeal and causes other difficulties.

Rain storms have a still more serious effect upon the transmitter. In the mail service the ½ k.w. International radio transmitters, described in the July, 1919, issue of EVERYDAY ENGINEERING, are now used. This, however, is far from being the ideal set. First off, the generator propeller breaks frequently and is invariably destroyed by the rain. This is a strong argument for a generator driven from one of the engines.

Also the rain drives in around the joints in the cover. The driving force of the rain is so great as to make the hand or face bleed when exposed. Worst of all, the insulation of the antenna breaks down to a point where it is dangerous to operate the set and doubtful if it would transmit if it were operated. At the same time this is the best equipment now available for airplanes.

Transmitting antennas require further development before they will meet emergency conditions. As it has not been found practical to erect the antenna on the plane itself, the trailing wire is still employed.

When a ship passes through an air pocket it frequently drops and rises so suddenly in the heavy air on the far side that the weight, and sometimes the entire antenna, is snapped off. This not only makes trouble in the plane but on the ground as well. Farmers have complained that bombs have been dropped on their homes.

Still greater is the danger when a machine comes down through a fog and the pilot discovers that he is headed for a house or building. During this hedge-hopping the trailing weight strikes objects on the ground and breaks away.

Another disadvantage is the changing characteristics of the antenna due to changes in its position in relation to the machine.

This résumé of conditions under which radio apparatus on transportation planes must operate shows that before it can be termed at all perfect the following developments must be made:

For receiving apparatus—

1. Receiving sets must be of greater mechanical strength.
2. They must be moisture proof.
3. Noises due to mechanical vibration in the tubes must be eliminated.
4. The controls must be simplified.

For transmitting apparatus—

1. The wind-driven generator must be replaced by a more dependable source of power.
2. Insulation must be waterproof.
3. A substitute for the trailing wire must be developed.

Several special conditions and requirements have not been discussed, particularly those applying to single-seater machines. However, the small planes are being rapidly replaced by those of the Martin bomber type, for the future of aerial transportation lies in the large ships. If the developments outlined are carried to successful conclusions, flying will be much safer.

New Cabinets and Parts for Radio Instrument Construction

The American Radio and Research Corporation has Brought Out a Series of Cabinets for Standardized Panels as Well as Small Parts for the Instruments

THE standardized panel construction for radio equipment has in the past possessed an inherent difficulty, that is, there was no convenient method for mounting the panels and nothing to protect the apparatus from dust and dampness. So popular has this method of construction become, however, in spite of the disadvantage mentioned, that a series of cabinets for 5- by 5-, 5- by 10- and 10- by 10-inch panels has been brought out.

Figs. 1 and 2 illustrate the new cabinets. The two smaller sizes are 6 inches deep and measure 5 by 5 and 5 by 10 inches outside. The larger box, however, is 10 by 10 inches inside, so that four small boxes, combinations of the small sizes, or a 10- by 10-inch panel, can be set in the case. In commenting on the introduction of these boxes, Mr. Thompson, of the American Radio and Research Corporation, said: "Standardization of panel sizes and parts, as introduced originally by EVERYDAY ENGINEERING MAGAZINE, is one of the most encouraging advances in experimental radio since the close of the War."

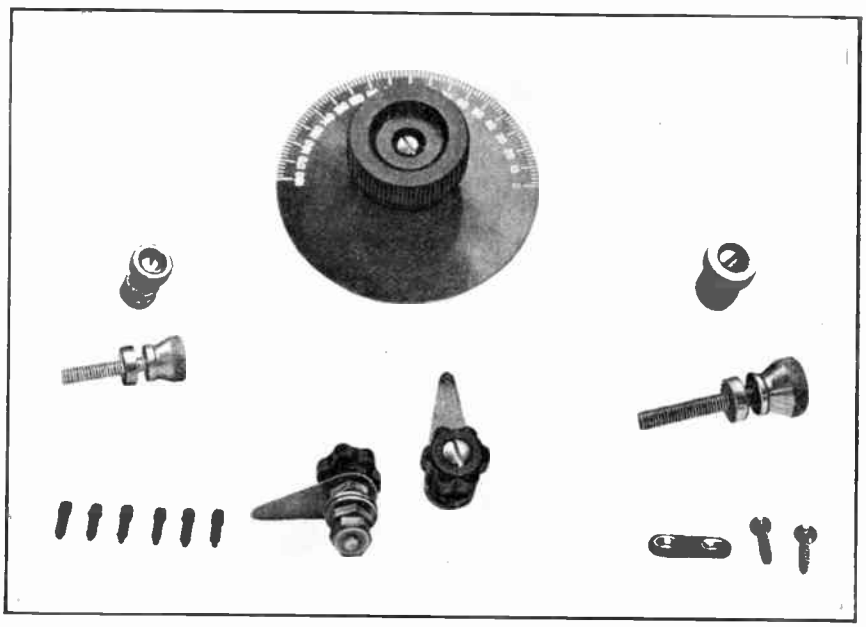


Fig. 3. Small parts such as these are needed by every constructor

These cabinets are made of chestnut, with a smooth, natural color gloss finish, although the experimenter can give them any other finish he desires. The depth is sufficient for all ordinary equipment, as large apparatus can be divided usually into smaller components. Where it is not desirable to mount a single instrument in a 5- by 5-inch box, combinations such as a tuning unit, a multi-stage amplifier, or a regenerative set can be fitted in a 5- by 10-inch box. The height of 4½ inches inside is sufficient to carry an audion tube in the box mounted vertically, while the 10- by 10-inch size will take a vacuum tube transmitter with the large sized bulbs.

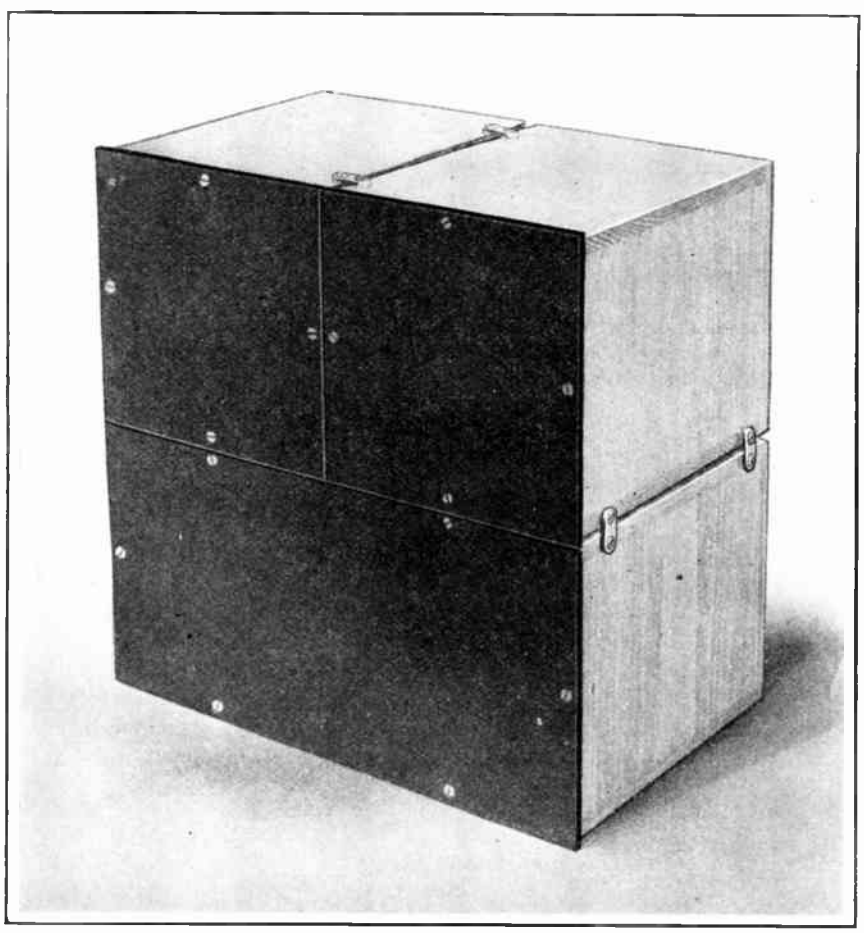


Fig. 1. Showing the appearance of a combination of boxes such as might be used for a regenerative receiver

It is interesting to note the effect of putting a vacuum tube in a closed box. Experiments on a 5- by 5-inch cabinet were made to determine the effect from heating. It was found that two tubes run steadily for twelve hours charred the inside of the wooden box, blistered the bakelite panel, and the tubes themselves were damaged from the excessive heat. This can be readily overcome, however, by using a large peep hole or several small holes on the front of the panel and in the top of the case above the tubes. If two or more rows of boxes are used the tube units should be at the top to permit the proper ventilation. This is the natural position for them as the tubes required very little adjustment, while the tuning controls, at the bottom, allow the operator to rest his arm on the table while making adjustments.

The 10- by 10-inch cabinet is sup-

plied with small brass pieces for mounting the panel. If the set is used for portable work, in which case the cover is needed, the panel is mounted below the front of the box; for stationary work, however, the panel may be set flush with the front.

The other parts, illustrated in Fig. 3, include a knob and dial, binding posts, switch points, and switch assembly. The dial, of a non-magnetic alloy, acts as a shield for condensers, eliminating the change of note as the hand is brought near the set when undamped waves are being received. The dial is insulated from electrical contact with the shaft. The knob for this dial and the individual knobs, are designed to take a 8-32 screw put in from the front or a ¼-in. shaft, held by a set screw. It is interesting to note that the engraving on the dial is so arranged that the indication increases when the dial is rotated in a clockwise direction.

The switch assembly and switch points are intended for use where very little space is available. A fluting on the shank of the switch point holds it in place when driven into the bakelite panel. The binding posts are somewhat similar to those used by the Bureau of Steam Engineering, in that the parts are assembled of an ordinary machine screw, the head of which prevents the thumb nut from coming off, while the threaded part passes through the panel and is held by a nut at the rear.

Here is one of the first definite indications that, more and more, the general design features of radio equipment will be standardized.

Transatlantic Sending Tests

Rapid Progress is Being Made in the Arrangements With English Experimenters Who Will Receive Our Signals

IN the September, 1920, issue of EVERYDAY an announcement was made of tests which will be held on February 1, 1921. Space this month does not permit the publication of the letters this month from experimenters who are planning to transmit to England. The following letter was received from Mr. Blake:

London, England,
Sept. 1, 1920.

Mr. M. B. Sleeper,
Radio Editor,
Everyday Engineering Magazine.

Dear Sir:

I am deeply interested in the proposed attempt on the part of American Wireless Amateurs to communicate across the Atlantic, and I need hardly say that I shall have great pleasure, not only in publishing an account in the *Wireless World* of what is being done, but in encouraging amateur men in this country to receive the signals from America.

Also please accept my assurance that in any similar proposition you can count upon my hearty cooperation.

Yours faithfully,
E. Blake,
Editor, Wireless World.

Just as soon as the names of those who will receive the test signals can be obtained, they will be published in EVERYDAY, so that the entrants in the contest can obtain any information they need concerning the receiving stations.

The Acme Apparatus Company as well as other manufacturers have offered cash prizes, the amounts and conditions to be stated in the November issue.

METHOD OF SELECTING THE WINNER

Considerable thought is needed to determine the fairest way to select the winner when several may transmit successfully across the Atlantic. The following system has been worked out tentatively, subject to suggestions:

1. Three to five receiving stations will be selected. Each is to have an audibility bridge of such proportions as to be suitable for measuring the strength of weak signals.

2. Each contestant, at his allotted time, will transmit his call for 1½ minutes, with a lapse between calls of ½ minute. Thus thirty calls can be made in one hour, during which atmospheric condition will not vary enough to put any station at a disadvantage.

3. Transmission will start at 10:30 P.M., February 1, 1921, and the complete schedule will be repeated at that time on February 3rd and 5th. Starting after the time signals, all watches will set alike, and there will be no overlapping.

4. Each receiving station will keep a record of the stations heard and their audibilities. At the conclusion of the tests, these records will be filed with Mr. Blake, who, with two other prominent radio men, will work out the results in this way:

a. Of the measurements made at the different receiving stations, the greatest audibility for each transmitter on each night will be noted, and added together to obtain the "audibility rating" for transmitter.

b. The highest rating will be given a score of fifty, and the others, scores in the same ratio.

c. For each night on which a station's call is heard, 16.666 will be added to its score.

d. Thus the station which has the highest audibility rating, and is heard on all three nights will have a score of 100.

For example, these readings are taken:

	A	B	C
1st night	10	—	5
2nd night	4	—	5
3rd night	—	25	5

These added show A=14, B=25, C=15. Since B is the highest, his score is 50, A's is $\frac{14}{25} \times \frac{50}{1} = 28$, and C's is $\frac{15}{25} \times \frac{50}{1} = 30$. A is given 33.332 for two nights, B 16.666 for one night, and C, 50 addition because he came thru all three nights. The scores, then are

(*Concluded on page* 65)

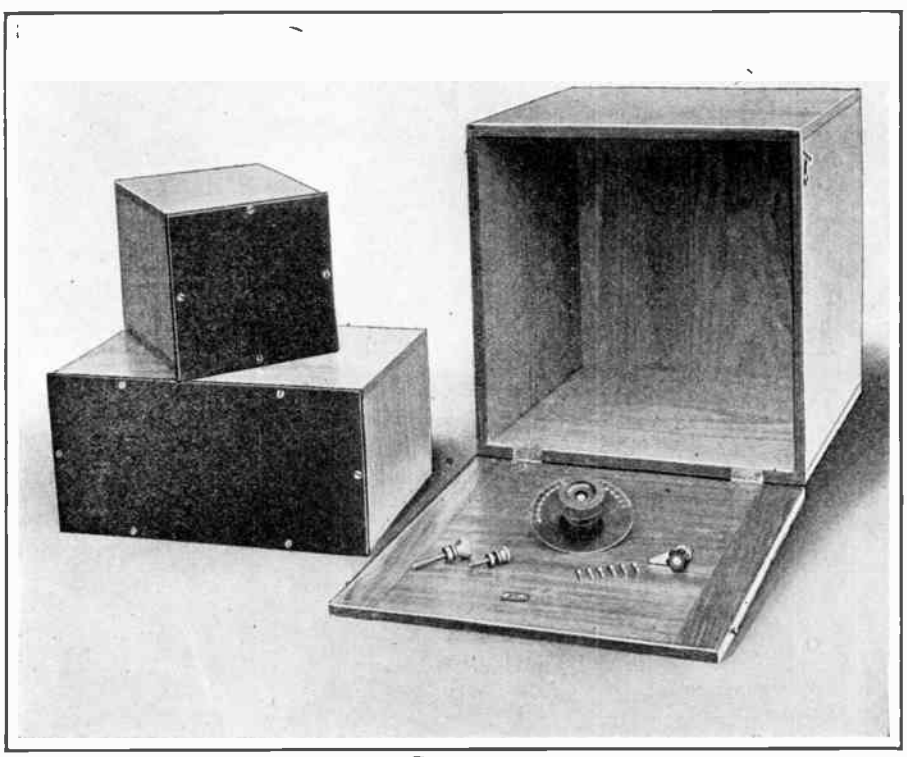


Fig. 2. A 10- by 10-in. panel can be fitted in the box, or the smaller complete cabinets

A Tube Set Operated on A. C. Without Rectification

Alternating Current is Applied Directly to the Tubes of This Transmitter Giving a Continuous Wave Completely Modulated at the Frequency of the Power Supply

PART I.

EXPERIMENTS have been conducted for some time, particularly by the Bureau of Standards, on vacuum tube transmitters using an alternating plate voltage. The results show a high efficiency from power input to antenna output, and the equipment is far less elaborate than that required for modulated telegraphy by the usual methods.

The application of alternating current, without rectification, to the plates of a tube transmitter is so new that it may require an explanation. With d. c. or a. c. the oscillating circuit functions in the same manner. Some sort of modulation is required to transmit by telegraph.

Ordinarily a buzzer or an audio frequency oscillator is used to modulate the high frequency oscillations. It must be remembered, however, that the effect on the receiver does not depend upon the total amplitude of the undamped oscillations, but upon the amplitude of the modulated part of the waves. To obtain 100% efficient modulation, therefore, the groups of modulated undamped waves must vary between zero and the maximum amplitude of the undamped waves.

Perfect modulation, resulting in maximum signal strength at the receiver is practically impossible to obtain. Better modulation can be obtained with the telegraph method than the telephone. This is the reason that a tube set transmits farther by modulated telegraphy than telephone, but farthest by straight undamped telegraphy.

The a. c. plate supply system does not depend upon the usual methods to modulate the undamped waves. Since the plate current, which supplies the oscillating circuit, is reduced to zero during one-half of each cycle, the oscillations and the radiated waves must be reduced to zero also. In this way, 100% modulation is obtained.

To make this more clear, the high frequency oscillations, generated in the transmitter, supply a carrier wave, which, of itself does not affect a damped wave receiver. Only that part of the carrier wave which varies at an audio frequency rate is useful. This can be compared to an elevator running between the first and twentieth stories of a building. If it only carries passengers from the nineteenth to the twentieth floor, it is operating at one-twentieth of its possible efficiency, or 5%. When it takes passengers between the tenth and twentieth floors, its efficiency is 50%. Then, though the amplitude of the run is twenty floors, only one-half is useful.

Small sets, using the ordinary receiving tubes, can be run directly from the 110-volt supply. However, a higher voltage, supplied by a step-up transformer, is needed to cover distances above a few miles, and the larger tubes are designed for 350 to 500 volts. Tubes operating on 750 to 1,000 volts will be on the market shortly, but insulation and other problems make it impractical for the average experimenter to build a transformer for more than 500 volts.

The set described in this article comprises only the tubes, transformer, and transmitting inductance. The transformer, operated from the house supply current, 60 cycles a.c., supplies a high voltage for the plates, and a low voltage for the filaments. A simpler and less expensive set could not be built, nor a more efficient one. Choke coils, smoothing-out circuits, and modulation transformers, are not needed. These advantages more than offset any objection to the low signal note.

In the first part of this article two types of transformers, a small one which delivers 52 watts at 350 volts or 75 watts at 500 volts, and a larger size giving 210 watts at 350 volts, or 300 watts at 500 volts are described. In the second part, which will appear in the November issue, the remaining parts and the operation of the set will be discussed.

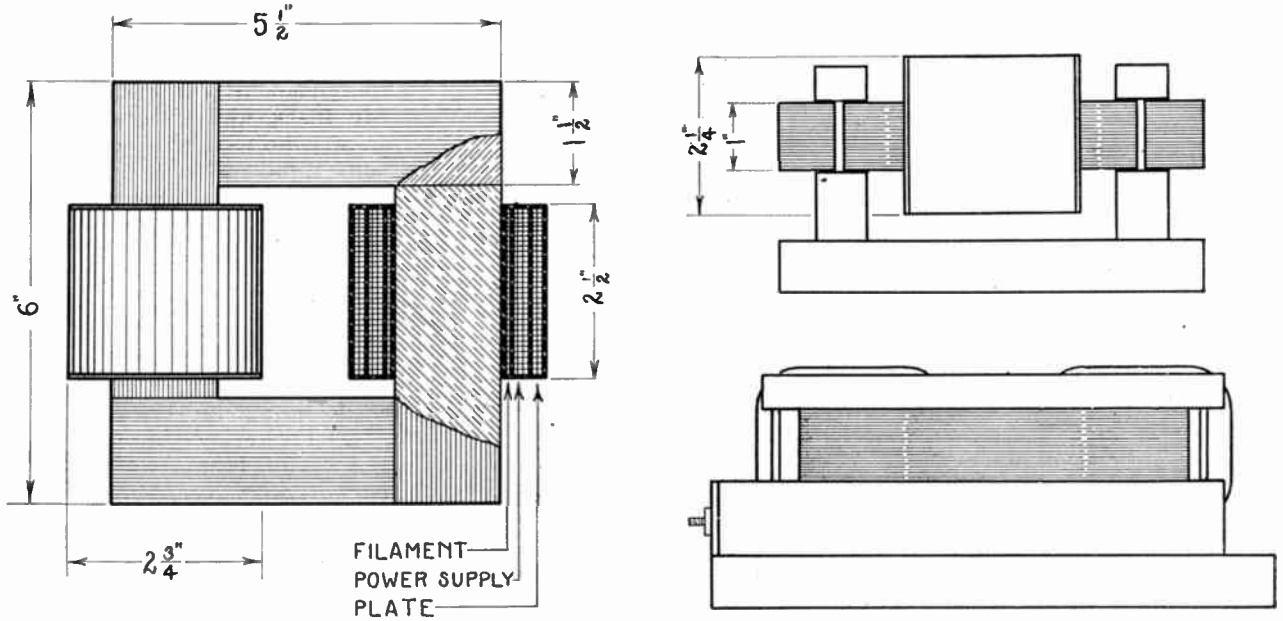


Fig. 1. Details of the smaller transformer and the method of mounting

The Transformers

While these transformers are designed particularly for this set, they can be used for any vacuum tube transmitter which operates from a 60-cycle, 110-volt supply. Rectifying tubes and other apparatus can be employed with

them if the experimenter prefers. The smaller size is for short range work, 20 to 50 miles, while the other is to be used on larger tubes such as are about to be put on the market, where transmission of 50 to 200 miles is essential. As a matter of fact, sets with an input of 300 watts have been heard over 500 miles, but this is not dependable communication. These ranges should be exceeded considerably with the circuit to be described in Part II.

Great care was taken in the design of these transformers to make them as easy to construct as possible, yet maintain a high efficiency. While the cores may seem heavy, they were made in that way to cut down the amount of copper. No difficulty from overheating will be experienced unless they are operated continuously for an unreasonable length of time. The wire sizes chosen are those easily obtainable. There are several companies which supply transformer iron cut to size.

Fig. 1 gives the dimensions of the core and coils. The transformer iron, 0.014 in. thick or thereabouts, should be purchased in long strips 1½ ins. wide. If eight pounds are ordered, there will be a safe margin. The usual overlapping method of assembly is employed. The two long legs should be made up first, and bound for 2¾ ins., at the middle with friction tape or, preferably, Empire cloth.

Then fibre or bakelite end plates are cut out and fitted on the core. String or tape, wound around the ends of the core, will keep these plates in position during the winding. As shown in the winding table, one layer of No. 12 D. C. C. wire is put on first for the 10-volt filament lighting circuit.

After a covering of tape has been wound over the first coil, the 110-volt winding, of No. 18 D. C. C. wire, is put on. This is followed by a thick covering of tape, over which the high voltage coil, of No. 26 S. C. C. wire, is wound. An outside wrapping completes the work. Two of these sections are needed as they are joined together as shown in Fig. 2. The 350-volt taps, at 800 turns, must not be forgotten.

50- to 75-Watt Transformer
Winding data for one leg

	Wire size	*Ft. required*	*Weight*	*No. turns*
Filament	12 D. C. C.	12	4 oz.	23
110 volts	18 D. C. C.	150	13 oz.	250
500 volts	26 S. S. C.	850	12 oz.	1,135
350-volt tap at.....				800

When the side legs of the transformer are assembled and the coils connected together, care must be taken to make sure that the inductances of the two sets of coils are not in opposition. That is, if the core were opened out in straight line, the direction of winding would be the same. Moreover, all the windings should be in the same direction.

Following are the approximate characteristics of the transformer:

Input.....110 volts, 60 cycles
No load.....10 watts, 0.1 amp.
Full load.....150 watts, 1.5 amp.

Plate Winding
60 watts, 350 volts, 0.15 amp.
75 watts, 500 volts, 0.15 amp.
Filament Winding
60 watts, 10 volts, 6 amps.

These characteristics will vary very slightly with the quality of iron in the core, and changes which may be introduced by the builder.

A convenient method for mounting the transformer is shown in Fig. 1. Strips of wood under the side legs support the core on the base, and bolts, passing from the base up to wooden strips above the core, clamp it firmly. The lower side view shows a bakelite plate, fastened to the longitudinal supports, which carries the terminals.

The method of constructing and mounting the larger transformer, Fig. 2, is similar to the process just described. Dimensions are given for the core, and winding data in the table.

210- to 300-Watt Transformer
Winding data for one leg

	Wire size	*Ft. required*	*Weight*	*No. turns*
Filament	12 D. C. C.	25	5 oz.	18*
110 volts	12 D. C. C.	110	37 oz.	130
500 volts	22 S. S. C.	550	18 oz.	595
350-volt tap at.....				417

*Two wires are wound in parallel, requiring a total of 25 ft. of No. 12 D. C. C. wire.

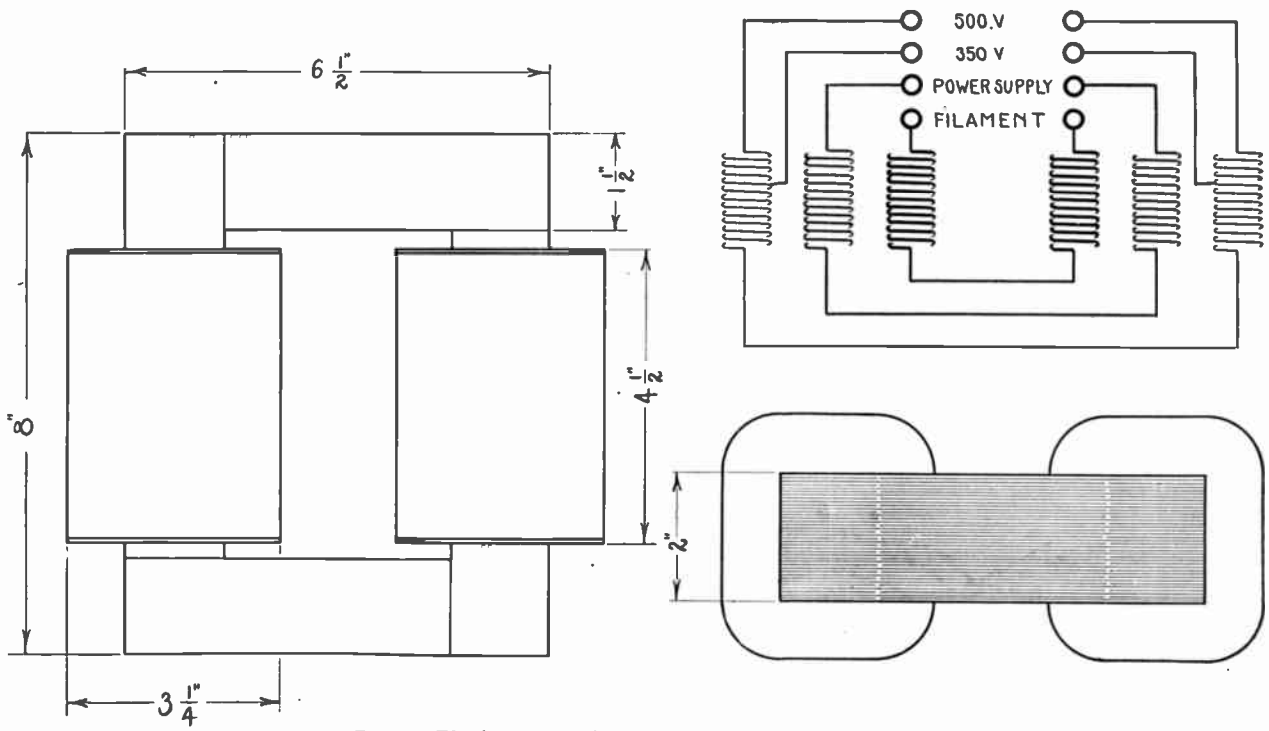


Fig. 2. The larger transformer and diagram of connections

Only one feature differs from the small transformer, namely, the filament winding. Instead of using a very heavy wire, two No. 12 wires are put on in parallel, to carry the large current drawn by the filaments.

The approximate characteristics are as follows:

Input.....110 volts, 60 cycles
No load.....15 watts, 0.15 amp.
Full load.....500 watts, 5 amps.

Plate Winding
210 watts, 350 volts, 0.6 amp.
300 watts, 500 volts, 0.6 amp.
Filament Winding
180 watts, 15 volts, 12 amps.

In the November issue Part II will give the complete design for vacuum tube transmitters operating on these two sizes of transformers.

U.S. Bureau of Standards Long-Wave Wavemeter

Experimenters Who Believe That They Can Design Apparatus for High Efficiency Will be Surprised at the Refinements in This Wavemeter

THERE are many radio men who can design instruments, and quite a number are unusually capable, but the best of us can learn a number of things from the photographs and description given here of the long-wave wavemeter, designed by the Bureau of Standards and sold by John Firth & Company. Much of the credit for the mechanical design is due to A. E. Cardwell, under whose direction this instrument is made. This is one of the finest examples of the coordination of electrical and mechanical skill among all measuring devices.

Essentially the wavemeter is made up of a variable condenser, four inductances, an inductance switch, and Weston thermogalvanometer. The range of the meter is controllable in three steps:

1,500 to 5,500 meters,
3,000 to 11,000 meters,
and 6,000 to 22,000 meters.

On the top of the panel there is a condenser dial, half of which is divided into 180 degrees, and the other half bearing three direct-reading semi-circles for the three ranges. So accurately is this meter made that the wavelength values are engraved directly on the scale. A knob to operate the inductance control switch and another to rotate the variable condenser are provided.

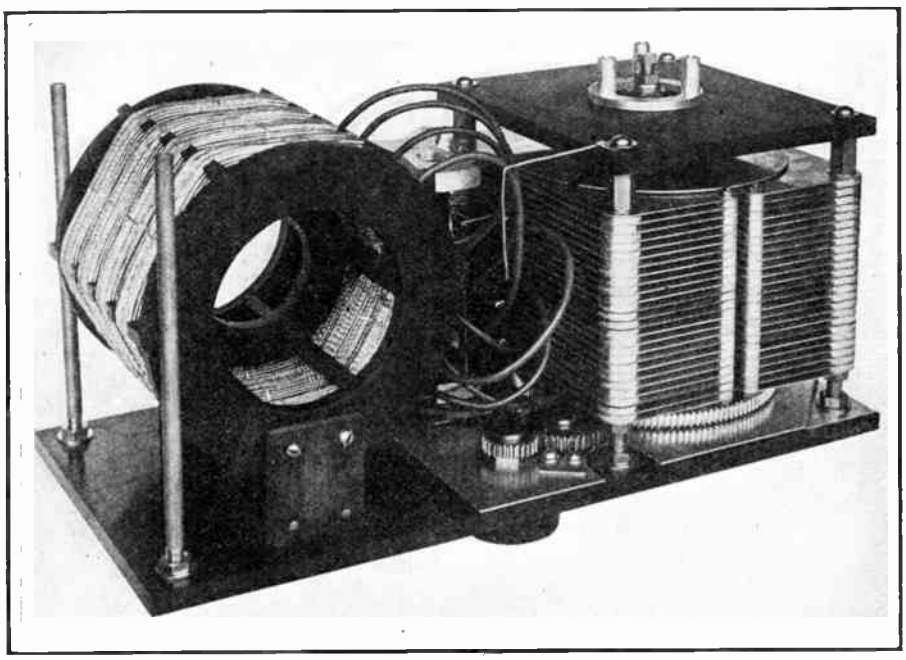


Fig. 1. A wavemeter circuit can hardly be reduced to essentials more than this one

All the parts are mounted on the panel but, contrary to the usual practice, the panel is not supported by screws into the top of the case but from the bottom. In Fig. 1 the two rods from the panel and three legs on the lower condenser plate can be seen. By these means the instrument is secured with machine screws to the bottom of the case. Thus changes due to warping of the box are eliminated. Felt packing under the panel at the top of the case allows a slight freedom to take up the effects of warping. The overall dimensions are 18½ by 8½ by 10½ inches.

The condenser is a marvel of electrical and mechanical skill. Figs. 1 and 2 show that it is of the double type, such as was described in the November-December, 1919, issue of EVERYDAY ENGINEERING. Every possible means is employed to keep down surface leakage, dielectric losses, and to localize the capacity in the condenser itself. For example, the three-legged support on the end plate, Fig. 2, is relieved so that the ring touches the bakelite only under the legs. The shield beneath the panel is bent up to keep it away from the panel save at the outer corners. A very difficult construction is used to support the moving plates so that they are insulated almost entirely by air from the main shaft, except at the top and bottom. Where, ordinarily, moving plates are kept in place by keys in the holes, these plates are recessed to take a key on the supporting rod, and the plates are forced into position.

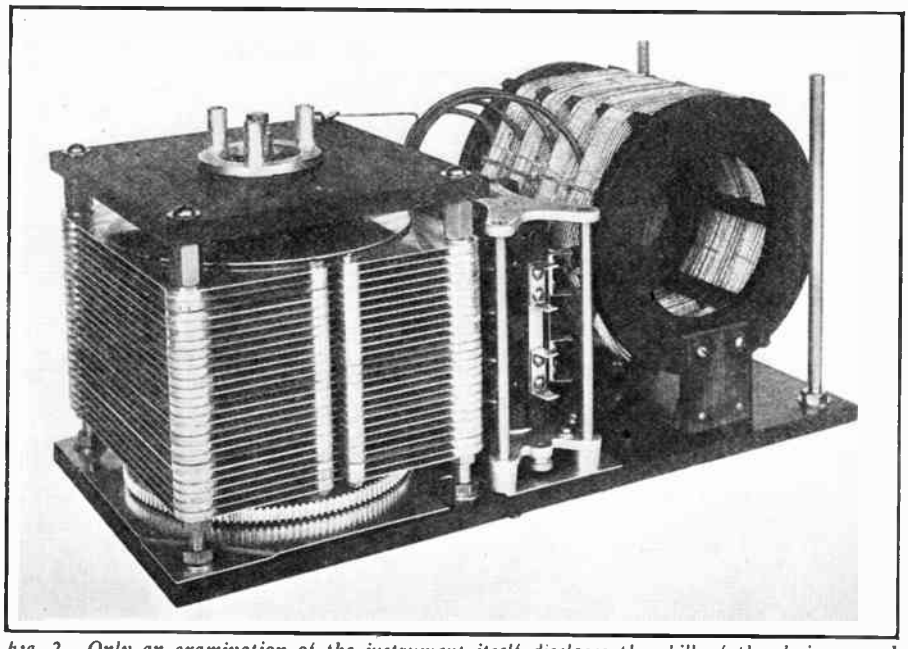


Fig. 2. Only an examination of the instrument itself discloses the skill of the designer and builder

The reducing gear to the adjusting knob can be seen in Fig. 1. So perfect are these gears, and so accurately located, that there is no perceivable play through the train.

Beside the condenser, Fig. 2, is the inductance control. Here again the path through insulating material is cleverly made very small. The contacts are mounted on strips which are, in turn, held to bakelite rings. The purpose of all these painstaking methods is to make the damping of the circuit negligible and, consequently, to procure an extremely sharp resonance curve. The switch blades are made with large contact surfaces, and the stationary leaves

(*Concluded on page* 69)

The Radio Department

A Discussion of Current Topics of Interest to Experimenters and Manufacturers

LORD KELVIN, whose fame as a scientist required no comment, said, "When you are up against a difficulty you are face to face with a discovery." To be sure things of this sort are easy to say, but, strangely enough, such sayings generally come from men whose work has expounded their own theories of working.

There is an incentive to experimenters in those words. Problems take on a new interest when approached from this angle. If it is only a small matter, a circuit that will not oscillate or key that arcs continually, the solution of the difficulty is a real discovery to the man who does the work, even tho it may be known to others. And it is by a series of these small discoveries that experience is accumulated which constitutes the knowledge by which greater problems are overcome.

The true experimenter, the one whose work is of value to himself and others, has Lord Kelvin's attitude.

RADIO and aeronautical men in particular and the public in general should know more about the Airplane Mail Service. A special feature of this Service is outstanding, almost unknown to those not intimately concerned with this part of Governmental activity, namely the treatment of those who suffer personal or property injury thru accidents to the mail planes.

When a pilot, mechanic or radio operator goes into the Postal Service, he must sign a waiver of claims against the Department. This means that, if the man is killed or injured, no claims can be filed against the Government. If a machine lands in a wheat field, or knocks in the roof of a house, the owner can be reimbursed only by an act of Congress. In other words, the man must send a legal counsel to Washington, and go to such expense and delay that those who do suffer such damages charge them to profit and loss and forget it.

Our legislators have passed the Workman's Compensation Act for the protection of the employees of privately owned companies, and provides pensions for the men in other Governmental Branches, but the Airplane Mail men must assume their own losses.

Steps should be taken to protect the employees of the Airplane Mail Service, and to provide a means for paying losses to those whose property is damaged by Post Office Machines.

AT the first fall meeting of the Institute of Radio Engineers, Dr. Goldsmith read a paper by Dr. Engen Nesper of Vienna, Austria, on "Recent Progress in Radio Communication in Germany and Austria." The instruments described in this paper are: two vacuum tube transmitters and receivers, an amplifier, a loop receiver, oscillator, and measuring instruments.

Unfortunately, the description of the apparatus and its operation left much to the imagination. One of the sets discussed was built to operate on 50 to 100 meters, yet no account was given of the method employed to receive signals on such short wavelengths. While the apparatus was beautifully made, apparently, the impression was that considerable efficiency must have been sacrificed for elaborate circuits and crowding of the instruments.

In the introduction, mention was made of the use of vacuum tube equipment by the Central Powers during the War. Mr. Armstrong, in the discussion, stated that such equipment was not used by those countries for work at the front, and all the information in the hands of the Allied Armies confirms his statement.

However, the paper in spite of its questionable points, was of interest because it indicated the progress abroad, compared to which our own work is very gratifying.

THE Radio Engineering Society of Pittsburgh, probably the third largest radio society in this country, has incorporated in its activities ideas which offer valuable suggestions to other clubs. Not only do they hold the interest of their members, but they keep the Society before the eyes of the public.

Their convention, held at Pittsburgh a short time ago, was a distinct and surprising success. Instead of celebrating the occasion with the usual formal banquet at which a man can only talk to his neighbor and has to keep quiet most of the time anyway, they held the convention out in the woods, several miles from the city. Members who owned cars carried out those who did not.

Early in the forenoon the men assembled in a beautiful valley, aptly chosen, for a brook ran thru it, and there was a spring nearby. When the writer reached the place, several antennas had been run from automobiles to the trees on the hillside, and ground wires buried in the brook. A telephone set, run from a motor-generator operated on an automobile storage battery, was set up. At the far end of the valley, a Magnarox was reproducing music from a phonograph.

Shortly the Magnarox was changed over to a hand microphone by which Mr. Urban, Secretary of the Society, called the men together, and announced the first of a series of contests. A portable transmitter was carried away out of sight by two operators. Shortly the entrants to the contest listened in on a radio compass for the hidden set. Having determined the direction, they dashed away to find it, the first to reach the hiding place being the winner.

Jamming tests, and other contests were carried out. Radio companies in Pittsburgh offered generous prizes to the winners. A lunch was served at noon, and another at the close of the day.

But best of all was the opportunity for men from far and near to get together to exchange ideas and experiences. There was no feeling of restraint or formality. Probably there was more of a discussion of radio in that one day than at any other convention of wireless men ever held.

Largely due to the efforts of Mr. Urban, the City of Pittsburgh has given the Society club rooms in one of the public buildings. To keep their work before the people, Mr. Urban conducts a radio department in one of the newspapers.

Surely there are some ideas here for other radio clubs which aspire to the success of the Pittsburgh Radio Engineering Society.

TRANSATLANTIC SENDING TESTS

(*Continued from page 63*)

A	B	C
14	50	30
33.332	16.666	50
47.332	66.666	80

An examination of these scores shows that A's station was not at all dependable in operation. Perhaps, overloaded at the start, it broke down.

B's equipment was good, but its owner, with months to prepare, was not ready at the right time.

On the other hand, C got thru every time, and deservedly, had the highest score, for the object of the contest is not simply to transmit across the Atlantic, but to test the designing and operating skill of the contestants.

Under the circumstances, the likelyhood of a tie score is negligible. In that event, it would be necessary to repeat the tests.

NORTH BORNEO WIRELESS STATION

AT the half yearly meeting of the British North Borneo (Chartered) Co., held in London recently, it was said that the wireless system was working most efficiently. Uninterrupted communication was maintained throughout the year 1919, except for a day and a half, which the Sandakan station was closed. The inauguration of a wireless service between Jesselton and Sarawak had been followed by the establishment of a regular wireless service between North Borneo and the Philippine Islands.

Standardizing Radio Nomenclature

The Increasing Complexity of Radio Equipment Makes Necessary Clear Marking of the Parts and Connections. An Intelligible System is Given in this Article

THERE is a certain amount of misunderstanding due to the various terms which different manufacturers and individuals apply to the same instrument, but still more confusing are the abbreviations engraved on apparatus. Such a simple thing as the primary tuning inductance switch is marked in the following ways by six manufacturers:

PRIMARY INDUCTANCE,
PRI SWITCH,
PRIMARY,
P S,
PRI,
P

An examination of several sets showed the following markings for the plate terminal of a vacuum tube:

ANODE,
PLATE,
WING,
W,
P

In fact, there are from three to six different names or abbreviations given to almost all the parts which are marked by name-plates or engraving.

A system of standardized nomenclature must assure its intelligibility so that the uninformed will not be puzzled by it, yet it must call for as few letters as possible to make it applicable to instruments whose cost does not warrant expensive engraving. The abbreviations cannot be chosen arbitrarily then, but they must be either letters which, in familiar formulas, are used to represent certain factors, or else they must suggest phonetically the words for which they stand. That is, L is the natural mark for inductance, as is R for resistance. Other markings which we all know are G, P, F, and AC, for grid, plate, filament, and alternating current.

On the other hand, REO, MIC, OM, and GND, if pronounced, suggest immediately rheostat, microphone, ohm, and ground. Experimenters who, by the home-made method, engrave their panels, will find that this system minimizes their work.

An alphabetical list is given of the abbreviations and of the words for which they stand. The list covers practically everything used for receiving sets and vacuum-tube transmitters, as well as individual instruments.

Standardized Radio Nomenclature

A amperes
A, B, C, D secondary inductance large steps, or loading coil
a, b, c, d secondary inductance, or small steps
AC alternating current
AF audio frequency
AM amplifier
ANT antenna
AP aperiodic

BZ buzzer
BAT battery
BFD bilateral direction finder
BRG bridging

C condenser
CM centimeter
CPG coupling
CR crystal
CY cycles

D damped
DC direct current
DET detector
DMY dummy

E potential

F filament
FD farad
FX fixed

G grid
GEN generator
GND ground

H henry
HDN heterodyne

I current
IN in, inside
INC increase
IPT input

JK jack
JPR jumper

K per cent coupling
KY key

L inductance
LDG loading
LK leak
LP loop
LS large steps
LSCPR loose coupler

M meters
MFD microfarad
MH millihenry
MIC microphone
MOD modulator

OFF off
OM ohms
ON on
OPT output
OSC oscillator, oscillations
OUT out, outside

P plate
PAR parallel
POT potentiometer
PRI primary

R resistance
RCT rectifier
REC receive
REO rheostat
REMCON remote control
REST receiving set
RF radio frequency

SBY standby
SEC secondary
SH shunt
SM smoothing
SND send
SS small steps
STD standard
STG stopping
STP step, stage
SW switch

TEL telephone receivers
TGR telegraphy
TIC tickler
TLP telephony
TR transformer
TRST transmitting set
TRT transmit
TUN tune

U undamped
UDF unilateral direction finder

VT vacuum tube
V volts
VAR variable
VMR variometer
W watts
WV waves

X reactance

Z impedance

λ wavelength

1, 2, 3, 4 primary inductance, or small steps
I, II, III primary loading inductance, or large steps

Index to Standardized Radio Nomenclature

alternating current....AC
amperes....A
amplifier....AM
antenna....ANT
aperiodic....AP
audio frequency....AF
battery....BAT
bilateral direction finder....BDF
bridging....BRG
buzzer....BZ
centimeter....CM
condenser....C
control, remote....REMCON
coupling....CPG
coupling, per cent....K
crystal....CR
current....I
current, alternating....AC
current, direct....DC
cycles....CY
damped....D
detector....DET
direction finder, bilateral....BDF
direction finder, unilateral....UDF
dummy....DMY
farad....FD
filament....F
fixed....FX
frequency, audio....AF
frequency, radio....RF
grid....G
ground....GND
henry....H
heterodyne....HDN
impedance....Z
in....IN
increase....INC
inductance....L
inductance, primary, or small steps....1, 2, 3, 4
inductance, primary loading, or large steps....I, II, III
inductance, secondary, or small steps....a, b, c, d
inductance, secondary loading, or large steps....A, B, C, D
input....IPT
inside....IN
jumper....JPR
key....KY
large steps....LS

leak	LK
loading	LDG
loop	LP
meters	M
microfarad	MFD
microphone	MIC
millihenry	MH
modulator	MOD
off	OFF
ohm	OM
on	ON
oscillations	OSC
oscillator	OSC
out	OUT
output	OPT
outside	OUT
parallel	PAR
plate	P
potential	E
potentiometer	POT
primary inductance, or small steps	1, 2, 3, 4
primary loading inductance, or large steps	I, II, III
radio frequency	RF
reactance	X
receive	REC
receivers, telephone	TEL
receiving set	REST
rectifier	RCT
remote control	REMCON
resistance	R
rheostat	REO
secondary	SEC
secondary inductance or small steps	a, b, c, d
secondary loading inductance, or large steps	A, B, C, D
send	SND
set, receiving	REST
set, transmitting	TRST
shunt	SH
small steps	SS
smoothing	SM
stage	STP
standard	STD
standby	SBY
step	STP
stopping	STG
switch	SW
telegraphy	TGR
telephone receivers	TEL
telephony	TLP
tickler	TIC
transformer	TR
transmit	TRT
transmitting set	TRST
tune	TUN
undamped	U
variable	VAR
variometer	VMR
volts	V
watts	W
wavelength	T
wavemeter	WM
waves	WV

Oftentimes several abbreviations are used together. For example, if separate plate batteries are used for an amplifier, the connections might be marked

AF AM P BAT
22.5 V,

meaning "audio frequency plate battery 22.5 volts." Thirteen letters are used in the abbreviation, and thirty-nine in the full spelling. Again,

PRI L SS,

indicates "primary inductance, small steps," requiring less than one-fourth the number of letters.

It is also of interest to note that some manufacturers are using the Bureau of Standards Classification for type numbers. (This classification was published in the July, 1920, issue of EVERYDAY ENGINEERING.) The type number for a loading coil might be

BI-6,

where the B indicates the modification and the I-6 classifies the instrument as an inductor. Similarly a vacuum-tube transmitter might be

DC-4,

D being the modification and C-4 the classification for electron-tube generators.

U. S. BUREAU OF STANDARDS LONG WAVE WAVEMETER

(*Continued from page 64*)

are mounted non-rigidly so as to take position freely on both sides of the blades.

When the switch handle is rotated, one of three numbers, 1, 2, or 3, appear in a hole in the panel, showing the position of the switch. At the same time, a pointer on the calibrated half of the condenser scale moves to the proper semicircle. Everyone is familiar with this pointer arrangement, as it is used on so many of the Navy receivers. On those sets, however, the switch handle can be turned between limits only, while on this wavemeter the handle can be rotated continuously. Instead of relying on a spring return for the pointer, a cam is used by means of which the pointer is moved in or out, according to the position of the switch. Therefore the possibility that the switch would turn and the pointer remain stationary is eliminated.

The four inductances are wound on a skeleton framework in order to keep down the dielectric in the field of coils. Six slotted strips are fitted into the supporting rings, with a third ring inside at the center for extra strength. At each side of the slots in which the wire is wound are semi-circular recesses into which strips of insulating material are set to act as separators between the layers of the coil. This produces an air spacing between the layers.

On the low wavelength range, all four coils are in parallel, on the intermediate range, they are in series-parallel, and on the long range, in series. This does away with absorption from unused turns and gives an overlap of wavelengths great enough that the calibration of points at one position of the switch can be checked against those on the succeeding position.

Another feature of this instrument is the galvanometer switch. Normally it is short circuited and a resistance inserted equal to that of the galvanometer. When the condenser-adjusting knob is depressed, however, the resistance is cut out and the galvanometer put in the circuit.

It is hoped that this description will give the readers an insight into the methods employed by designers and manufacturers of the finest types of equipment.

THE MONTREAL RADIO ASSOCIATION

THE Montreal Radio Association held its first annual meeting in its new quarters in June last. This association was formed about fifteen months ago, but its development during the first year of its existence was considerably retarded by the lack of a suitable clubroom. That this disability no longer exists is due to the generosity of Mr. Jas. E. Wilder who has given the use of two rooms on the tenth floor of the new Wilder Building, together with permission to string aerials on the roof. One has already been strung from a sky sign on a nearby ten-story building, making it 200 feet high at one end and 140 feet the other and 250 feet long.

The mail address is Montreal Radio Association, Wilder Building, Montreal. The Secretary is Mr. L. E. Hunton and he will be very glad if other organizations or individual amateurs will communicate with him.

RADIO SOCIETY OF SOUTH AFRICA

IT is rather surprising to learn that a radio society, giving promise of considerable influence, has been organized in South Africa.

The Society will consist of full members, associate members, and honorary members. Candidates for full membership must have attained the age of 21 years, and must have been engaged in research or experimental work in radio science for at least two years, and must also satisfy the Provincial Committee of the Society that they possess the necessary qualifications or training. Candidates who do not fulfil the foregoing conditions are eligible for associate membership.

Radio men in all parts of the world are urged to write to the Secretary for membership application blanks. The entrance fee and yearly dues, payable upon acceptance, are quite moderate. This Society deserves all possible support and encouragement. To become a member is not only of benefit to the applicant, but a helping hand extended to those who are carrying on radio work far from the conveniences which we have, under circumstances which to us would seem unsurmountable.—MR. G. L. R. LOWE, Secretary, 57 Kitchener Ave., Bezoidenhout Valley, Johannesburg. South Africa.

(*Continued from page* 51)

as the inside. The components A-B-C and P may be glued and nailed with 3 in. No. 12 to 14 wire finish nails, lock-nailing them as described in the previous issue. Dress or surface-plane the sides before adding the top shelf D which is also lock-nailed to A.

The front or lid may be of one piece, or several pieces of reversed grain strips glued together, or a flush-back panel. In the event that the latter one is desired, a frame consisting of two rails and two styles 2½ in. to 3 in. wide with the corners mortised and tenoned or half lapped jointed, is used. Figure 7 shows a section of the panel and rails. If a more elaborate panel is desired, a combination of a raised and flush panel may be used. This is made by using a thicker panel and bevelling as shown at Figure 6.

It may be hinged in several ways. Ordinary butt hinges 1½ in. x 1½ in. may be used with the plates inside, flush with the inside of the door and inside shelf, or with the pin up. They may be also set flat with the pin downward, one plate flush with the inside shelf, the other plate let in flush and in the edge of the lid, the pin lugs set in half in the door and halfway into shelf. There are several other special strap hinges that set in the edges of lid if desired.

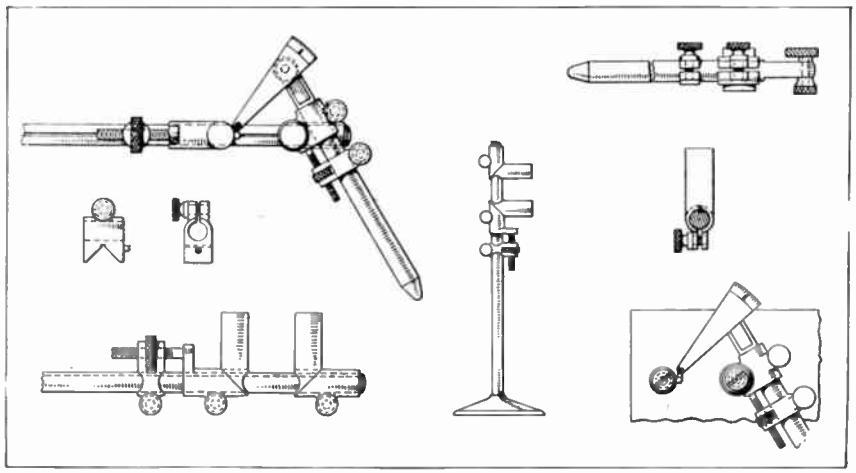
The large drawer may be constructed as per Figure 5, the sides rabbetted into the front, or dovetailed as will be described in a subsequent article. Rabbetts or grooves for the bottom ¼ in. x ¼ in. must be made in the front and the two sides before assembling, also ¼ in. x 1½ in. grooves for the drawer slides and ⅜ in. grooves crosswise for the back in the two sides. Perhaps it would be advisable to examine any drawer, as a more comprehensive idea would be gained in that manner than chapters of explanation. The pigeon holes form a unit that is assembled or nailed together so separately, then fastened in the desk by 2¾ in. No. 10 flat head wood screws through the sides O into A.

The drawer Y may be simply a tray of 3 in. x 6 in. x 8 in. outside dimensions with the side as a front This may be improved by adding another piece as the front glued or screwed on to the front of the tray. In other words, a doubled front. Of course, the screws will be through the rear of these parts.

The illustration at Figure 4 suggests two ways of relieving that harsh appearance of plain edges. This chamfering surely repays for the little extra work required. The complete secret of chamfering is to carefully thumb gauge the guide lines and to carefully plane only to the lines.

Thumb gauging is done by holding the pencil about the same way as one would do to write, using the nail of the second finger as a guide and slide the hand away from the body. This will prevent getting slivers under the finger nail which are very painful.

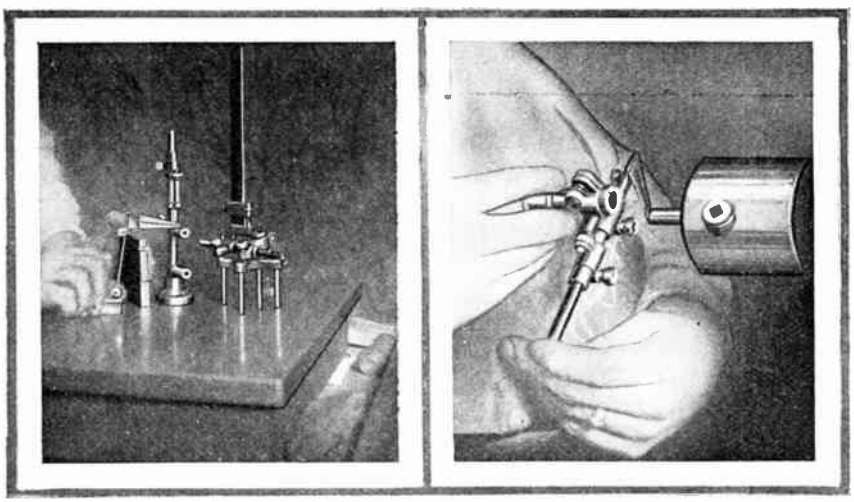
The top wall board F may be shaped as indicated or just a 2 in strip may suit your fancy. Sandpaper with the grain. Stain and finish as per directions given in the August issue of EVERYDAY ENGINEERING MAGAZINE. A panelled roll-top desk will be completely described, including all working drawings with full details in the November issue of this magazine.



Details of adjustable gauge and indicator holder

ADJUSTABLE GAUGE AND INDICATOR HOLDER

A GAUGE device has been invented by William J. Winkelman of Dayton, Ohio, for obtaining the position for holes to be bored in a given article with more accuracy than is possible with the micrometer or height gauge or vernier now commonly in use. The device comprises a main shaft, posts extending from that shaft, one of the posts being adjustable relative to the other to vary the dimensions between the posts—it is by the posts that the position of the holes to be bored is ascertained—and a transfer caliper adapted to transfer the dimensions to the jig or other article to be bored. This transfer caliper has a detachable swivel connection with one of the posts, and a calibrated member adapted to engage the other post and to indicate the dimensions between the posts. In the accompanying illustrations, Figure 1 shows the slidable gauge being set for the spread of the first two holes to be bored. After this is obtained the caliper or indicator holder, which member is shown in photograph No. 2, is placed over one of the posts and a contact made with the indicator until the dial registers zero. The caliper or holder is then ready to be transferred to the plug which has already been placed in hole No. 1. With the machine running the indicator is brought to the same reading as was made on the movable gauge. The principal object of the device is the making of measurements by the use of the well-known Johanasen block in connection with this adjustable gauge and indicator holder in less time and without requiring so high a degree of skill as with methods heretofore used.—*Lester L. Sargent.*



How the adjustable gauge and indicator is used

WHAT IS NEW IN AVIATION

(*Continued from page 37*)

Another very interesting small machine is the Austin "Whippet," made by the AustinMotor Co. This is also primarily designed for cheapness, but is designed upon conventional lines. Intended to demand the minimum of attention, it has no wire bracing whatever, the whole of the fuselage and wing bracing being of steel tube. The rest of the wing construction is of wood. The wings fold back parallel with the fuselage so that the machine could be kept in an ordinary motor garage, the folding operation taking only about one minute. The range of speed, with a 50 h. p. stationary radial Anzani engine, is from 90 to 35 mph. and it is capable of getting into the air out of a very small field. It weighs 810 pounds loaded. It is 16 feet, 3 inches long and has a span of 21 feet, 6 inches. The area is 134 sq. feet and it carries but 16 pounds to the horsepower.

The Avro "Baby" is a very efficient small biplane equipped with one 35 horsepower, Green, four-cylinder engine. It carries but one person, the pilot. It will climb 5,000 feet in 15 minutes. Its minimum speed is 35 mph. and its maximum is 80 mph. It weighs empty 615 pounds and loaded 870 pounds. It is 19 feet, three inches long, has a span of 25 feet and a height of 7 feet, 6 inches. The supporting area is 176.5 sq. feet. It carries 21.7 pounds per horsepower and the wing loading is about 5 pounds per sq. foot.

A NEW HIGH LIFT WING

THE British aeronautical trade press gives prominence to descriptions of a new aeroplane wing form about to be introduced. In a recent issue *Flight* states that this wing is the outcome of many years of experiment and research and although in its present form the wing marks a great improvement on the ordinary aerofoil for load carrying at moderate speeds, it does not, in the opinion of the inventors, represent the maximum attainable.

The accompanying sketch shows a model wing of this Alula series, from which some idea of the shape of the wing may be formed. The chief characteristics are the straight trailing edge, the negative dihedral leading edge, the deep camber, and the wash-out in chord camber and incidence toward the tip. In addition to the scale model wind tunnel tests, full scale experiments have been made for some time by the technical staff of a prominent aircraft manufacturer to determine the agreement between model and full scale work. These trials are still in progress, and very satisafctory results are being obtained.

Not only is the maximum lift coefficient corresponding to maximum L/D are also extremely good. The maximum lift coefficient is .827 and occurs at an angle of incidence of 15°. As the maximum lift coefficient of the ordinary wing is somewhere between .5 and .6 it will be seen that, for the same landing speed, the wing area can be reduced to about three-fourths that necessary with the ordinary wing. This is not the only, nor perhaps the greatest advantage of the Alula wing, as it is called by the designers. The maximum L/D (to which scale correction still has to be added) is as hight as 22.9 which compares favorably with the orthodox wing, and the lift coefficient corresponding to this maximum L/D is .566, or as high as the maximum lift coefficient of the average wing. This, it will be seen, makes for economy of flight, especially in machine carrying a high load at moderate speeds.

Designs have been produced for a cargo machine to carry four tons. This is known as the "Pelican 4 Ton Lorry." This is a colossal cantilever monoplane designed for two 460 h. p. Napier engines. Its cruising speed is 72 mph., its top speed 96 mph., and its landing speed 55 mph. Its total load is 24,100 lbs., its wing loading is 12.9 lbs. per sq. ft., its useful load is four tons, with fuel for the London-Paris journey, and the cost of operation will be about six cents per lb. of cargo for the London-Paris journey.

The machine is a non-folder, being designed to dispense with shed costs altogether. The crew consists of a pilot carried right forward and a mechanic in charge of the engine-room aft. The engines are twin Napier Lions, and the machine is designed to fly *and climb* even if one engine breaks down. Reliability of service is assured by this power to fly on one engine and by the superintendence of the engines in flight, coupled with the fact that all work is normally done at half-power.

The design has been prepared on a most conservative basis in all respects; for instance, an allowance of 7½ per cent. on all structure weight above the calculated figure has been included, and the factor of safety has been taken as 5 in the calculations, whereas 3 is nearer the ultimate mark for cargo machines; further, a 30-m.p.h. head wind is assumed in calculating the weight of fuel carried.

Specifications

Span	146 ft.
Length	84 ft.
Height	22 ft.
Chord	16 ft.
Fuselage diameter	14 ft.
Weight—	
Wings	5,100 lb.
Fuselage	2,080 lb.
Tail	850 lb.
Chassis	1,160 lb.
Structure	9,190 lb.
7½ per cent addition	690 lb.

Tanks	550 lb.
Engine and propeller mountings, radiators, silencers, etc.	970 lbs.
Engines	1,680 lb.
Crew	360 lb.
Cruising consumption	243 lb. per hr.
Other Particulars—	
Total horsepower	920
Surface	1,870 sq. ft.
Pounds per sq. ft.	12.9
Empty	13,440 lb.
Fuel (London-Paris)	1,660 lb.
Cargo (London-Paris)	9,000 lb.
Fuel (400 miles)	2,770 lb.
Cargo (400 miles)	7,890 lb.
Total	24,100 lb.
Performance—	
Landing speed	55 m. p. h.
Cruising speed	72 m. p. h.
Climb	410 ft. per min.
Climb on one engine	40 ft. per min.
Cruising revolutions	0.80 of normal
Cruising B. H. P.	0.51 of normal
Pounds per B. H. P.	26.2
Cargo space	1,700 cub. ft.
London-Paris cargo	4 tons
400 miles cargo	3½ tons
Gliding angle	1 in 15

NEW APPLICATION FOR METAL SPRAYING

THE metal-spraying process appears to have found a new application in engineering practice, according to an article in a German technical paper. It seems that the sand contained in the water jets supplying Pelton wheels may pass through the finest screens and still be sharp enough to destroy the buckets. Observation has revealed the fact that the sand-blast does not remove lead covering from iron, and it is therefore proposed that buckets for Pelton wheels should be lead covered by means of the so-called spraying pistol, in which a lead wire is fed automatically into an oxy-gas blowpipe and sprayed as a fine cloud of molten metal by the force of the gases. Lead applied in this way adheres very firmly to iron and steel as the minute particles are projected with great force and actual metallic contact is obtained, which is not the case when ordinary dipping processes are employed. Presumably the lead forms a sort of amorphous surface layer sufficiently elastic to counteract the erosive action of the sand particles.

COMPARATIVE TIRE WEIGHTS

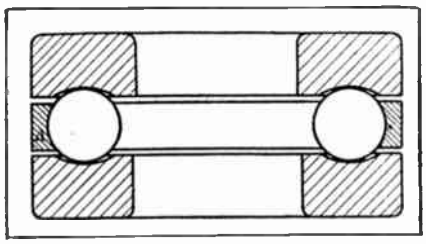
THE comparative weights of solid and pneumatic tires as fitted to a well-known make of English motor truck are very interesting. With solid tires the weight of the front wheels was 152 pounds each; back wheels, exclusive of hub and brake drum, 700½ pounds. With pneumatic tires the same wheels gave a total weight of 591 pounds, a saving of 413½ pounds in favor of the pneumatics.

EVERYDAY SCIENCE NOTES

BY T. O'CONOR SLOANE, PH.D.

BALL BEARING

IN the sectional view of the ball thrust bearing shown herewith which is intended specially for use in high speed machinery, the balls are depicted with a stay ring A



outside them. Under the effect of high speed rotation the stay ring A centers itself so as to touch neither ball race thus avoiding all friction and allowing equal distances in the space between the two ball races and the separator.

Interest is again excited by the use of liquid oxygen as an explosive. It is used by soaking cartridges containing finely divided oxidizable matter in the liquid gas, immediately placing them in the drill holes and exploding them. If lighted in the air no explosion takes place but only a very vivid combustion. The explosion is more violent as the solid which is contained in the cartridge is more finely divided. The most violent of all charges for the cartridge is powdered alumina. Because the liquid is so volatile the cartridge saturated with the gas is only good for fifteen minutes. This of course is a great element of safety. Five or ten minutes are required for the soaking. One liter of gas is equivalent in its action to a kilogram of black powder and is much cheaper. One 150-horsepower motor is sufficient to actuate the aparatus.

The production of tungsten in China has aquired some importance, In 1918, 10,365 tons of concentrates, mostly wolframite, were exported from that country. This metal is in great demand for high speed steel and for incandescent electric lamp filaments.

A rolling mill measuring 17 ft. between the housings which gives the capacity for plates of steel 16 ft. wide has recently been installed in a works in Coatesville, Pa. The working rolls are 34 inches in diameter and are backed up by 50-inch cast steel rolls. The mill is driven by a 25,000 horse power steam engine.

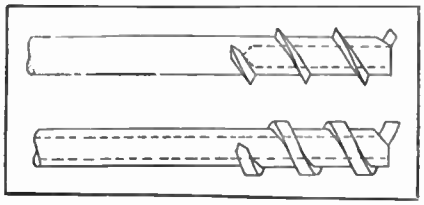
The colony of Victoria is in trouble with the varying interstate railroad gauges and proposes to solve the difficulty by laying a third rail. In this way trains of cars of two different gauges can be drawn. The writer many years rode on a train on the Erie Railroad in which train there were cars of two gauges. The third rail being laid for the standard width of track, as the old Erie Railroad was originally laid with a very wide gauge.

From Japan comes the report of very large coal deposits. It is estimated that there are over 800,000 tons not more than 2,000 feet below the drainage level, while there are nearly four times as much which may become available in the future with the development of highly efficient methods. There is a possibility of a quantity of about five billions of tons there.

EVERYDAY SCIENCE NOTES

HIGH SPEED TOOL

THIS is a tool for high speed steel bits. It is to be used on lathes or on similar machines. The holder consists of a bar of mild steel. A strip or thin bar of high speed

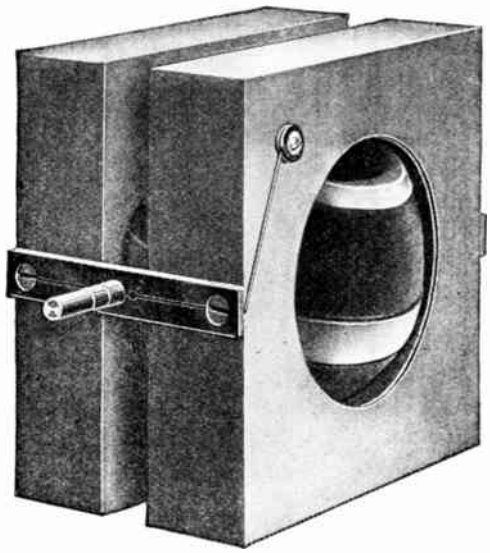


steel is wound around the holder as shown, and bar has an axial hole bored into its end. As the high speed bit wears away it has to be ground and the holder bar is ground away with greater readiness on account of the thinness of the walls outside the spiral bit.

From Canada comes the suggestion of the possibility of a power scheme for the eastern states of this country. A 250,000-volt transmission line is suggested connecting Boston and Washington via New York. The water power of the St. Lawrence River and power stations in the coal fields are suggested to be used to supply it with feeders from 150 to 250 miles long.

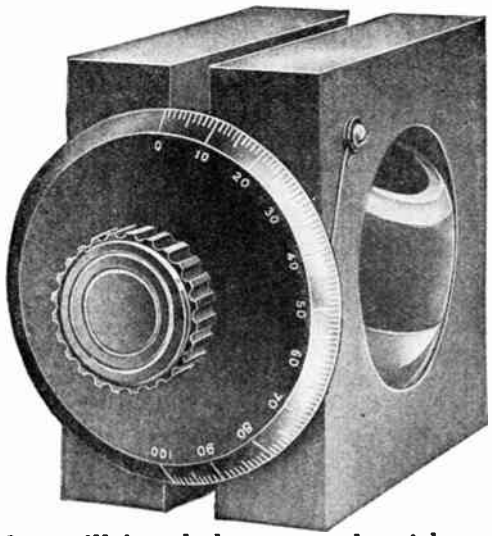
Some interesting figures on the necessary shutter speed for photographing moving objects are given in one of our French contemporaries. A shutter speed of one-twentieth of a second will answer for the length of the lens. If the exposure is brought down to one-fiftieth of a second such objects as a walking man also at a distance of 150 times the focal length can be taken. This will give a very small image on the plate, the man being less than half an inch high. For the shutter speed of one-hundredth of the second galloping horses at a distance of 250 times the focus can be taken if their motion is directly towards the instrument. One, three-hundredth of a second, will do for all ordinary street scenes, including bicyclers at moderate speed and horses galloping obliquely across the field at a distance of one hundred times the focus. For real rapid work such as race horses in action, automobiles and moving trains, birds and aeroplanes, the shutter speed should be from one five-hundredth to one-thousandth of a second.

Acetylene gas buoys are familiar objects along our coasts. They are charged with acetylene under pressure and in solution and can contain enough gas to last a number of months with a single charge. The light is never extinguished day or night under ordinary methods of working and it is made to give any desired timing of flashes automatically. Thus a navigator seeing the light flashing regularly knows that it is a gas buoy and by timing the flashes and consulting his coast pilot or bulletins can identify it in the darkest night, getting absolute certainty of his position. From an English source we are told of further improvements. A method has been devised to light and extinguish the flame by the sun's rays, using the differential expansion of a blackened brass cylinder and a group of gilded cylinders, the latter of course expanding much less when rays of light impinge upon them do the blackened one. This differential action is made to work a cock so to shut off the gas and turn it on according to the sun. Of course a pilot flame may be kept going constantly. Another advance is the use of incandescent gas mantles and an arangement by which these are replaced automatically until twelve mantles are used up.



ANTICIPATING THE DEMAND

While analyzing the wants of the Radio Man, Radisco discovered the value of anticipating the demand for modern and efficient apparatus; knowing that the Radio Man would be quick to realize and appreciate such service. Under this incentive Radisco engineers have produced such justly famous instruments as Radisco Coils and "B" Batteries and we now take pleasure in announcing the new



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Like all other Radisco products it has been produced to anticipate and supply the demand for a good short wave instrument, qualified to stand the acid tests of radio work, and built at a price consistent with the cost of manufacture, which has always been a Radisco characteristic.

For the radio man who desires an instrument of this character, our Variometer makes a distinct appeal. It is made in one size and of one quality, the best. The extreme dimensions are 4¾" high, 3" wide, 5" deep and the shaft is of ¼" brass, just the right size to fit the number 69 dial; forms are carefully turned from thoroughly seasoned wood and substantial brass bearings provided. The price is strictly an innovation and should appeal to the most conservative.

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Shipping weight 3 pounds

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Radio Engineering Co.,
614 No. Calvert St.

BEINVILLE, QUEBEC, CAN.
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BOSTON, MASS.
Atlantic Radio Co.,
88 Broad Street.

BROOKLYN, N. Y.
Kelly & Phillips,
312 Flatbush Ave.

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Chicago Radio Laboratories,
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The Wireless Shop,
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EVERYDAY SCIENCE NOTES

Resistance to motion of trains of cars has been recently investigated by the University of Illinois and quite elaborate tabulations have been published. Of course the condition of the roadbed would affect the result, but it may be assumed that a fair average is represented for the experiments. A thirty-ton car moving at five miles an hour required a tractive force of 7.4 pounds per ton. At seventy-five miles an hour this force ran up to 17.9 pounds. A seventey-five-ton car with the same speeds needed 4.1 pounds and 9.8 pounds force per ton, only a little over half of what it required per ton for the lighter car. A great number of intermediate figures are given in the tabulation, but the above are the extreme limits.

The effect of speed of electric cars on the wear of rails shows that the wear increases in a less ratio than the speed. It was found that at eighteen miles an hour 216,000 electric cars produced the same wear of rails that 320,000 produced at nine miles an hour. It was found that in a two-way single track the wear was sometimes less than on a double track. This is assumed to be due to the different directions of travel affecting the duration. Very expensive steel is now used for parts subject to wear. There was a famous curve in Boston, the rails of which would wear out in four days, until manganese steel rails were substituted for those of ordinary steel, when it was found to last several years.

Lord Perrie, the great authority on ocean ships, has expressed his opinion that there is no doubt whatever concerning the reliability and suitability of the internal combustion engine for marine propulsion. His firm, Harland & Wolff, have already built engines up to three thousand horsepower. Larger ones are to be built soon and the capacity of the engine shops in Belfast is to be doubled.

A long projected pipe line between Paris and Havre has to be completed in an operation within twelve months to give the minimum supply to Paris of 24,000 tons of crude petroleum per day. This does not indicate any great premonition of an immediate shortage of oil.

Commercial service by air from Brussels to New York has been discussed in Belgium commercial and engineering circles. It is believed that by using a 1,000-foot dirigible with 6,000 horsepower the ocean should be crossed in forty-eight hours and each airship could carry two hundred passengers.

It has been stated in the House of Commons, London, that the problem of the tunnel across the Channel between England and France has been examined from a military, engineering and naval point of view. It is said that conflicting opinions were reached, so the matter is still in the clouds.

The production of peat in Sweden for use on the State Railways for the year 1920 is estimated to be from 30,000 to 40,000 tons. A factory has been erected for the production of powdered peat, and it is claimed that this fuel is almost as satisfactory as coal.

In England there is complaint of difficulty of obtaining locomotives on account of the companies being behind hand in repairs. Russia is still worse off. Out of every 100 locomotives in Russia there are sixty which are out of service. Before the war 8 per cent of locomotives were repaired every month; after the October revolution of 1917 the percentages were reduced to 1 per cent and at present 2 per cent is claimed. Two hundred locomotives a month are going out of service.

TOOL STEEL DEVELOPMENT

ARCHAEOLOGISTS have shown that the crucible method of steel manufacture is by far the oldest process known, it being impossible, however, accurately to trace its origin and early developments. It would nevertheless appear certain that crucible steel was made and used thousands of years ago for cutting tools. What is regarded as proof of this may be seen in the marvellous carvings and work on the monuments of the ancients, the stone which is so intensely hard as to have withstood the erosive effects of centuries. It is difficult to conceive, then, by what means other than with steel tools such work could have been executed, and it is with wonder that one contemplates the fact that the principle of manufacture, namely by the fusion of iron and charcoal in crucibles, was in its essentials probably the same as the present-day process. The Chinese were undoubtedly makers of crucible steel long before the Christian era, whilst a celebrated steel was made in India centuries ago under the name of "wootz".

The famous Damascus steel, produced as far back as A. D. 1200, was famed among the Crusaders and for many years after for the purpose of weapons and armor. Curiously enough, this steel furnishes yet another proof of the old adage that "there is nothing new under the sun", for it has been established that Damascus steel contained certain percentages of tungsten and chromium, which elements are also incorporated in modern high-speed steels. From this it is evident that a latent high-speed steel has been in existence for at least 700 years and there only lacked a better knowledge of its proper heat-treatment to develop and bring it to its present high degree of efficiency.

It is generally accepted that the iron first used for tools was of meteoric origin, and there is sufficient evidence on record to prove that the tools used in building the great Pyramids were made of meteoric iron-nickel alloy. It can, therefore, be believed that in prehistoric times iron was to a small extent obtained from meteors, and that from such iron tools were produced. A more reliable theory, however, is that the accidental melting many centuries ago of a pure iron-oxide with charcoal caused the first discovery and usage on any scale of iron for the purpose of tools.

For a long period there was little or no development in the manufacture of tool steel, which was produced by either of two processes:

1. The welding together of bars of carbonized or cemented bar iron to produce shear steel.

2. The fusion of cemented bar iron, or a mixture of bar iron and charcoal, with the addition of oxide of manga-

nese and spiegeleisen in crucibles—the product known as cast steel.

Many of the alloys used in the present-day tool-steel were practically unknown sixty years ago, and the first great stride in the development of tool steel was made in 1857, when Robert Mushet introduced his self-hardening or tungsten steel, capable of cutting harder material at higher speeds than were possible with carbon steels. For forty years self-hardening steel was developed and used all over the world, and then, by accident or otherwise, it was found that by raising the temperature of a self-hardening tool to a yellow heat, such a tool gave greater cutting efficiency than a normal one.

THE IDEAL LOCOMOTIVE

An ideal solution of locomotive difficulties would be found if it were possible always to proportion the power of the locomotive employed to the weight and speed of each train hauled. But though it is possible, to a certain extent, to allocate special engines to special duties, the necessity for limiting the hours of service of the crews, and for working the engines back to their sheds by the first available means, make this course impracticable as a general rule. The ideal being unattainable, therefore, it is found the most economical plan to legislate for extremes by designing locomotives with a reserve of tractive power more than sufficient to meet the maximum demands made upon them in ordinary service. If in the course of their duties such engines are required to work on light trains an ample fire-grate and tubes of substantial length ensure the utilization of the maximum proportion possible of the calorific value of the fuel burnt, and the total consumption is probably but little greater than that of a locomotive better proportioned in dimensions to the performance of that particular duty.

The matter is one that might well engage the further attention of locomotive construction engineers.

TANNED SPONGES

An interesting process has recently been developed for increasing the efficiency and extending the life of sponges used for technical purposes, automobile washing, office use, etc.—in fact, for all purposes except use on the human anatomy. It consists in a modified tanning process, and it makes the sponge take the water much better and act more satisfactorily in giving it up to the work.

The annual timber consumption in France is not more than 100 board feet per capita, or less than one-third that used by Americans. Of the timber required, France imports 30 to 40 per cent, much coming from America.

SOAP FROM CLAY

SOAP from clay is the promise made by a group of British chemists who have been working on the utilization of this plentiful material for a number of years, and who have just established the commercial usefulness of their discoveries. Their work is being described in a series of articles in a technical paper by Prof. F. C. Weston, a leading British authority on colloidal chemistry who has been in touch with their experiments and which has been condensed in the *Scientific American.*

Stripped of all technical verbiage what this group has discovered is a method of making use of china clay which is found in large quantities both in Great Britain and the United States, not as an adulterant, but as an ingredient in soap-making. Soap, as most people know, is made now from fat and fat is scarce and expensive and is becoming scarcer and more expensive every year. China clay is plentiful and cheap. It can be had for the digging and the process of turning it into soap-making material is cheap and easy. It is claimed that it can be used up to fifty per cent in combination with the usual fatty acids in soap-making and that the soap thus made lathers as well, is as cleansing and as pleasant to use as soap made in the old way of all fat. What this means to industry may be realized when it is stated that fats for soap-making cost at present in England something like $200 a ton, while the refined china clay can be produced and sold at an excellent profit for something like $75 a ton.

So far, the clays used have been from the famous Cornish beds, but experiments with Georgia clays have demonstrated that they can be used equally well and no doubt there are many other clays in the United States that are equally suitable. The process by which the clay is prepared is simplicity itself. After mining it is purified by a combined washing and chemical process and the resultant finely divided clay after being run into a settling tank is dried and is ready for use. It is a soft soapy substance without a trace of grit. The purified clay has also been used in England in the manufacture of printing inks, for color striking, and a substitute for much more expensive chemicals in the vulcanization of rubber.

COAL THE MAINSTAY

IT is generally agreed that coal, by the decree of nature, must continue as our fuel mainstay; the dream of liquid fuel, cheaply produced and efficiently burned, may be but as a passing cloud over the sun. Already the demand for internal combustion engine fuels is outstripping the increase in the production of crude fuel. Coal will likely continue the popular source of energy, for economic reasons, if no other.

USE OF TITANIUM IN STEEL

IN view of the constant investigations as to the value of various metals in alloy steels, the following review of the present status of titanium as an alloying metal, published in a recent number of *Reactions,* is of interest. It is stated that while vanadium is comparatively scarce, there are large quantities of high-grade titanium ores in the United States, sufficient to last over one hundred years. A great amount of research work is now being applied to titanium, the use of which as a content in steel has hitherto been comparatively unknown. Until recently ferro-titanium was known simply as a deoxidizer.

During the war, France used a great deal of titanium, not only as a deoxidizer, but also in the production of steel having a certain content of titanium. It has also been learned that some of the other European countries, particularly Germany and Sweden, are using titanium as a content in the production of automobile and other steels, which are subjected to most severe service. Such steel has been a successful competitor of American steels of about the same composition but without titanium. American steel makers, however, have since experimented along the same lines, with the result that they are now producing a steel which is at least equal to that of their European competitors.

Research work has not stopped here, but has been extended into the tool steel industry, and the results of experiments indicate that titanium can be used to advantage in place of all or part of some other alloy materials. This is of particular interest to American manufacturers of high-grade steels, who have been unable always to obtain ferro-vanadium in sufficient quantities and have been forced to look for substitutes. Alloy steel makers who have been experimenting with titanium as a substitute report satisfactory results, and think it is only a question of time until the public is educated to the merits of such steel. An argument for the close study of the possibilities of titanium is the fact that there are unlimited supplies of high-grade titanium in this country. Also, the price of titanium ores is very low in comparison with that of ores of the other well-known alloying metals.

TIME FOR CURING

SHOULD repair jobs hang ten days after being built up? asks a northern repair man. No; there are two good reasons why repairs should not be allowed to stand or hang longer than 24 hours. Hanging without pressure will probably result first in loose spots upon which bloom will collect and, secondly, reduce the adhesion of the repaired parts when the cure is applied. The outside repair material toughens with age and will prevent a smooth repair.—*Goodyear News.*

HEAT TREATING ALLOY STEEL

(*Continued from page* 47)

be necessary simply to anneal at the lowest possible temperature; for instance at 900° F. to 1,000° F. and if the work must be maintained bright or scaleless, this anneal would be best conducted in a non-oxidizing atmosphere in closed pots in the presence of illuminating gas, charcoal or other substances. For strain anneal we do not care particularly if the micro-structure shows lamellar or globular pearlite.

For free machining or cold work, we desire a structure of considerable softness and free shearing properties. It appears that this can best be attained in steels above .40% carbon by gradually heating the steel up to Ac_1, maintaining this temperature until the steel is thoroughly heated thru and then cooling very slowly without the presence of drafts. The micro-structure will show globular cementite; that is, the hard constituent (cementite) will not then lie in layers, the ends of which catch on the tool, cause chattering and produce difficult machining, but will lie like shot in a box in such a way that the ferrite may be cut or pushed aside very readily. Where steel is subject to severe distortion in cold working, this condition is essential as it allows ferrite to flow freely into the new form without the spliting so common when laminated pearlite appears.

SUMMARY

It has been shown that the internal structure of the steel responds in definite known ways to definite heat treatments and that when applied at certain fixed temperatures, the results are sure and beneficial. These temperatures are readily determined in advance by means of cooling and heating curves and when so determined fix the possible range of control of heat treatment of that particular steel.

The changes in condition due to heat treatment follow known laws which are not mere theories, but instead are the basis governing the selection of proper grades of steel.

These laws have robbed the once doubtful and mysterious guesswork of the old time hardener of all of its witchery and luck and made the heat-treatment of steel the definite science necessary in these days of intense concentration upon the quantity production of work of unvarying high quality.

Part VII in next issue.)

FULMINATING POWDERS

There are a number of chemicals which, when heated, detonate or explode with a loud report, although not a violent concussion, making them harmless. The following mixtures have these properties:

No. 1—Niter, three parts; carbonate of potash, two parts; flowers of sulphur, one part.

No. 2—Bismuth, 120 parts; cream of tartar, sixty parts; niter, one part.

NEW GALLAUDET BIPLANE

THE machine has been carefully tested and its lifting capacity proved. Carrying a pay load of 1,000 lbs., and with its fuel tanks filled, it rose recently to an altitude of 15,000 feet. The biplane can be used either for freight or passenger carrying purposes. The front cockpit will accommodate five persons and the one in the rear is equipped for two pilots. Every arrangement has been made for the comfort of passengers. Suit cases are fitted into the compartments to carry baggage. On the cockpit dashboard are thermos bottles and an electric cooker heated by the ignition system. The main feature of the machine is the large body, which is of unusual width. The cargo hold is 6 ft. wide, 54 in. across and 54 in. deep. It is divided into four compartments. The rated speed is 115 m.p.h., and the landing speed from 40 to 50 miles. It is equipped with a 400 h.p. Liberty motor.

Specifications

Wing curve	A. F. 15
Wing area	48 sq. ft.
Useful load	1,800 lbs.
Weight, loaded	3,800 lbs.
Loading, per h.p.	11.1 lbs.
Wing loading	8.5 lbs. per sq. ft.
Cruising radius	500 miles
Ceiling	18,000 ft.
Maximum speed	125 m.p.h.
Loading speed	40 to 45 m.p.h.
Wing span	44 ft.
Length overall	29 ft. 5 ins.
Chord	7 ft.
Gap	6 ft.
Stagger	8 ins.
Height	10 ft. 3 ins.
Dihedral	1½°
Angle of incidence	2°

WET RUBBER CUTS EASILY

WET rubber cuts much more easily than dry rubber and this suggests the need of extra careful driving of the motor truck during the spring months when the roads are in bad condition. Sharp stones, car tracks or stray bits of glass or metal will cause cuts in wet rubber, yet they might not damage the same tire if it were dry. A careful driver will avoid car tracks at all times, but will be particularly careful in wet weather as a sharp frog may gash a tire very badly, especially if the rails are wet.

More oranges, lemons, peaches, bananas, melons, etc., are being handled by motor trucks, not alone because of the time saved, but of the saving affected in protecting the fruit from bruising. The difficulty in securing an adequate amount of farm labor will undoubtedly tend to increase the demand for motor trucks, for a man on a motor truck can in many instances replace three men and a team.

BRITISH TIDAL-POWER PLANS

IT is understood that a bill will be introduced into Parliament for the purpose of obtaining authority for harnessing a number of Scottish streams, investigations having revealed that the aggregate of available power is larger than had been anticipated, says a writer in *Scientific American*. With respect to the harnessing of the tides, it is reported that "work is about to begin both on the Dee and Severn, where power can be produced—according to estimates of a group of engineers—at two-thirds the cost of electric power generated by coal. More than this, a number of estuaries on the west coast of England have been surveyed, where the cost of installation would be considerably lower."

The basic principle underlying most of the inventions for harnessing the tides is the working of a turbine by tidal ebb and flow. The tide makes the power at both its inflow and its outflow, only ceasing for a comparatively short time during the period of half tide. In one Cheshire and Lancashire district the great variation in the hour of the tide at neighboring estuaries makes possible, through an ingenious discovery, the production of maximum energy during an almost continuous period.

The plan for harnessing the tides devised by Lewis Woodhead, of Worcestershire, calls for the building of a cheap and efficient wall out in the sea or tidal river, in which turbines are placed. Mr. Woodhead claims that 10-foot turbines would be most economical where suitable, each of which would generate over 300 horsepower with a 5-foot head. Thus a mile of sea wall would be capable of generating 120,000 horsepower. The position of such a wall would be 4 to 6 miles from shore.

EASILY LOCATED CARBURETOR TROUBLES

WHEN an automobile engine, after starting, runs for a minute or two and stops, the first place to look for the trouble is the gasoline feed line. A partial stoppage in the fuel supply pipe will lessen the flow of fuel so that the float chamber fills slowly. On being started, the engine will quickly consume the gasoline in the chamber and stop. Another possible cause for the fault is the float sticking, and if the float sticks in the high position the flow of fuel will be greatly lessened or may be stopped entirely. Water in the gasoline is also troublesome, as a drop may get into the feed pipe or the spray nozzle and interfere with prompt starting or reliable feed of fuel. Lint or other foreign matter around the filter screen in the feed line is also responsible for restricting the fuel flow, especially in cars using the gravity feed system.

LIGHT AND SAFETY

SOMEONE has said that light is a tool which adds to the efficiency of every other tool. The modern industrial manager, goes a step farther, for he realizes that adequate lighting, both artificial and natural, is indispensable not only to efficiency but also to safety. He knows that the dark plant is the dangerous plant. One of the large insurance companies made a careful study of the reports of 91,000 accidents and discovered that ten per cent—9,100 accidents—were caused directly by the absence of proper lighting and that in 13.8 per cent—more than 12,000 accidents—inadequate lighting was a contributing cause.

The British Government, in an extensive investigation of accidents, found that stumbling and falling are the most frequent causes of accidents resulting from the absence of light, and the report of the United States Census Bureau for 1918 says: "The greatest number of deaths charged to any one accidental cause, 10,330, is shown for falls." The investigation of the British Government also revealed that during the four winter months deaths and serious injuries resulting from falls were 39½ per cent greater than during the four summer months, thus showing the bearing of light on accidents.

In all of the industries where efficient safety work is being done and where large reductions in accidents have been made, strong emphasis is placed on good general illumination of all departments. Investigations conducted by one of the leading illuminating engineers of America in some 200 plants in which modern lighting systems were installed revealed that where rough work is being done, as in foundries and steel mills, the total output was increased 2 per cent, while in textile mills, shoe factories, machine shops and other industrial plants where fine work and close application is required, production has been increased 10 per cent by the installation of proper lighting equipment.

The economic value of good lighting becomes readily apparent when it is known that the overhead cost of adequate lighting is not more than one-half of one per cent of the pay roll. In other words, a workman who is being paid four dollars a day can be made a more efficient and a more careful workman through the expenditure of approximately two cents a day for adequate lighting. Any plant manager appreciates what a very slight increase in production is necessary to add two cents to the daily earning power of a workman.

Industrial managers are coming to realize that light not only increases out-

put and decreases accidents, but also plays a most important part in making the plant a cheerful and pleasant place in which to work. In these days, when management is giving the most serious attention to the attitude of men towards their work and to questions of contentment and loyalty, a plant that is light, cheerful and attractive no doubt has a great advantage over the dark, cheerless and unattractive plant.

Light has a positive influence in encouraging orderliness, cleanliness and efficiency. In a plant where the windows have been washed, the walls whitened with paint especially designed to reflect light and effective lighting installed, there has followed, almost invariably, a house-cleaning on the part of both foremen and workmen—all of which makes for efficiency, safety and contentment.

UNIVERSAL JOINT AN EARLY DESIGN

PERHAPS the oldest design used in the modern motor truck is that of the universal joint, which in principle is identical with the first universal developed by Cardan about 1520 A. D. For many years we called a propeller shaft and joints a Cardan shaft and even today all Europe refers to it as this type of shaft. While the original Cardan shaft, invented by Jerome Cardan, employed the exact principles of the present day standard type, the latter is to be sure quite different in detail structure and modified for automotive use. Were it not for Cardan, however, our engineers would be unable to design a shaft drive car. Like the original Cardan joint, the Spicer, for instance, is all metal and composed essentially of a metal cross or spider. To each pair of ends of this cross a yoke is attached so that one yoke can move sideways and in the opposite direction from the other yoke, since each oscillates on its own spider ends. Of course, this is covered by means of a housing to keep out dirt.

Such joints are used in all modern automobiles and motor trucks in order to allow the propeller shaft to revolve and at the same time move up and down and sideways, relative to the rear axle. The axle bounces up and down according to road conditions, but the propeller shaft must connect this bouncing part with another unit attached to the frame of the car. Unusually this is the transmission and since this does not move up and down as the rear axle does, the propeller shaft must have these universal joints. One can see that without the joints the shaft would bend and then could not transmit power.

EFFECT OF RODDING CONCRETE

RODDING concrete is accomplished by repeatedly pushing a pointed rod into the concrete. The direct effect of rodding is to expel entrapped air and excess water, and to compact the concrete; the indirect effect is a material increase in the strength of the concrete. The difference between tamping and rodding concrete is that in tamping, the upper portion of the concrete is compacted and forms a cushion which protects the lower portion of the concrete and prevents or retards the escape of entrapped air and excess water. In a paper on this subject presented to the American Society for Testing Materials, Mr. F. E. Giesecke states that rodding concrete has an important bearing on the practice as well as on the theory of concrete construction. It is important in actual construction because, when generally applied, a considerable increase in the strength of the concrete or a corresponding saving in cement will be effected. With the ordinary 1:2:4 mix and as much excess water as is generally necessary in reinforced concrete work, thorough rodding will effect an increase in strength of about 100 per cent. The cost of the additional 100 per cent produced by the rodding is very much less than the cost of the original 100 per cent, and the consequent saving is considerable.

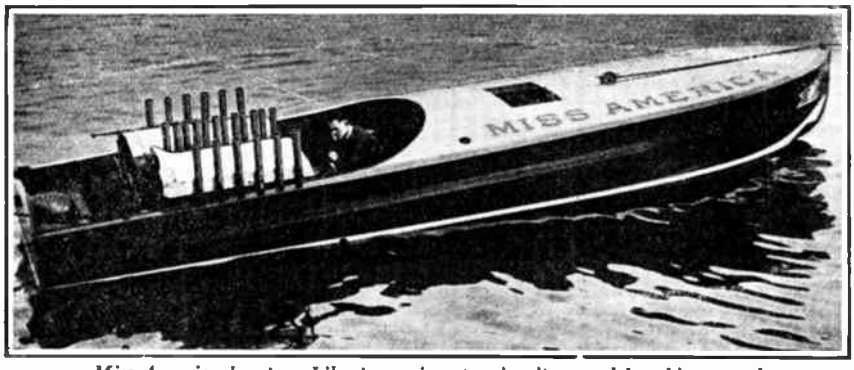
MOUNTING PICTURES SMOOTH AND FLAT

HOW many times have you pasted down a paper or mounted a print to find that when it dried it had buckled disappointingly. Ordinarily the paste is applied on the mount, the difficulty being that the exact limits to be thus covered is a matter of guesswork to meet the uncertain expansion of the print which is immersed in water before mounting; with the result that the print often exceeds the predetermined limits of the amount of the area covered with paste to receive it; on the other hand the print frequently falls within this area, leaving a margin of irremovable paste. The following method is free from such objections and difficulties: Keep the mount flat and with a small wad of cotton wetted in clean water, slightly dampen the approximate area to be covered by the print. Cover the back of the print with paste—preferably arabol—smooth and thin. Apply the print to the mount, and with aid of a paper blotter and a small roller, smooth the print from its center outward. No paste will appear outside the limits of the print; any dampness exceeding these limits will evaporate. Any paper shreds left by the blotter, etc., may be wiped clean from the print's surface with the same damp wad of cotton.—*Scientific American.*

Airplane Engines in Racing Boats

"I THINK the application of the aircraft engine to motor-boat service accounts for the great advances which have been made in the proposition of high-speed travel on the surface of the water," said Mr. Smith, the designer and builder of "Miss America," the winner of this year's race for the British International Motor-Boat Trophy. Therefore, it goes to America, where the British sportsmen expect to challenge it next year with, among others, Sir Edward Mackay Edgar's 1921 Saunders built boat, "Maple Leaf VII."

In order to appreciate the advances achieved as expressed in terms of speed we may reduce all knots or nautical miles to land miles an hour. Though these races were first run in 1903, the fast skimmer type of boat did not begin to emerge in notable fashion until after 1906, when the steel-built "Yarrow-Napier" traveled at 27.02 land miles an hour. The next big step was the Thornycroft "Miranda IV," single step, wooden hull, of 1910, when the speed went up to 33.30 land miles an hour, and the skimmer type came into its own. The following year, 1911, Sir Edward Mackay Edgar's Saunders built Consuta hull, "Maple Leaf," pushed the speed up another remarkable stage to 36.161 land miles per hour, while in the last race before the war Sir Edward Mackay Edgar's Austin-engined, Saunders-Consuta hull "Maple Leaf IV" won at 55.70 land miles an hour.



Miss America has two Liberty engines to give it record breaking speed

Up to that period the aircraft engine had not been applied to the proposition of racing motor-boats. Throughout the interval of war, the sport, while interrupted in Europe, was carried on with redoubled enthusiasm in America. As a result remarkable strides have been made in hull design, especially for smooth watercraft. Among other things this has led to dispensing with rear rudders Instead, this detail is placed amidships, in solid water where no breaking effect results. Moreover, the propeller shaft is set an appreciable distance behind the stern of the hull. Thus the stern rests also on solid water. Hence it is possible to place the power plant as far back in the hull as the designer chooses. Again, the minimum angle is achieved between the propeller shaft and the bottom of the boat. Thus the boat is all but lifted. But it is not thrust vertically; the ton and a half weight is taken only a degree out of the horizontal by the vast forward pressure. The propellers are set so near the surface of the water that on occasion there is the risk of their sucking air. The power is taken from the engines forward to multiplication gear because very small diameter propellers are employed. They run much faster than the engine.

The adaptation of aircraft engines to hulls developed in a way that has been possible through the pursuit of the sport in America without interruption for seven years, enabled the American boat to win the race this year quite easily by traveling at 61.54 land miles an hour over a 33.084 sea mile course against 55.70 land miles an hour achieved by Sir Edward Mackay Edgar's Austin-engined Saunders-built "Maple Leaf IV" when carrying the victory in 1913, which was the last race of the sort before the war. Of course, in America there have been the Gold Cup races, and so on, in the interval. The fastest lap which "Miss America" made in this year's racing in Osborne Bay was 65.17 miles an hour. But she has done a short "burst" against the clock in American waters at 80 land miles an hour. Further in the course of tuning up trials Sir Edward Mackay Edgar's Sunbeam-engined Saunders-built "Maple Leaf V" traveled on three occasions at 67.61 land miles an hour. Again in America a 22 ft. Canadian-built boat, "Miss Toronto," has traveled at 72½ land miles an hour. This vessel has one Liberty engine only.

A COMPARISON OF VARIOUS FUELS

FROM data secured as a result of hundreds of tests, Dr. W. N. Best, in an article in *The American Drop-Forger,* shows the value of liquid fuel in various forms of equipment. The following data which will furnish food for thought and which may be beneficial to manufacturers in this and in foreign countries.

In marine service, using mechanical burners, it requires 180 gallons of oil to represent a long ton (2,240 pounds) of coal having a calorific value of 14,000 B.t.u. per pound. In tugboat service, using atomizing burners, 147 gallons of oil represents a long ton of coal.

In locomotive service, using atomizing burners, it requires 180 gallons of oil to represent a long ton of coal.

In power plants, in water tube boilers, using atomizing burners, it requires 147 gallons of oil to represent a long ton of coal.

In large forging plants, it requires 82 gallons of oil to represent a long ton of coal. In small drop forging furnaces it requires 62 gallons of oil to represent a long ton of coal.

In heat-treating furnaces with high temperatures, 63 gallons of oil represent a long ton of coal. In heat-treating furnaces with low temperatures for drawing purposes, only 58 gallons of oil are required to represent a ton of coal.

In flue-welding furnaces, welding safe ends of locomotive flues, only 58 gallons of oil are required to represent a ton of coal. The reason for this is obvious. You cannot make a welding heat with a green fire. You must coke your fire and in so doing you not only lose the volatile matter from the coal, but you also lose valuable time while coking the coal.

Of course, it should be remembered that the coal referred to has always the calorific value of 14,000 B.t.u. per pound, and is figured by the long ton (2,240 pounds).

The oil referred to has a calorific value of 19,000 B.t.u. per pound and weighs 7½ pounds per gallon.

Do not try to compare the calorific values of fuels without knowing the kind of service demanded of them.

Three and one-quarter barrels of oil (42 gallons per barrel) is equivalent to 5,000 pounds hickory or 4,500 pounds white oak.

Six gallons of oil represent 1,000 cubic feet of natural gas, the gas having a calorific value of 1,000 B.t.u. per cubic foot.

Two and one-quarter gallons of oil equal 1,000 cubic feet of by-product coke oven gas having a calorific value of 440 B.t.u. per cubic foot.

Forty-two hundredths of a gallon of oil equal 1,000 cubic feet of blast fur-

nace gas of 90 B.t.u. per cubic foot. This gas is used in this country in boilers and also in large furnaces, but requires coal tar or oil to aid in the keeping up of the required horsepower of the boilers, or in furnishing the temperature required for the heating furnaces. Oil or coal tar are excellent fuels which can be readily used to operate in conjunction with the blast furnace gas in boilers or large furnace practice.

Usually 10 gallons of coal tar are made from every ton of coal coked in by-product coke ovens. This tar has a calorific value of 162,000 B.t.u. per gallon and weighs 10 pounds per gallon.

AIR CONDITIONING IMPORTANT

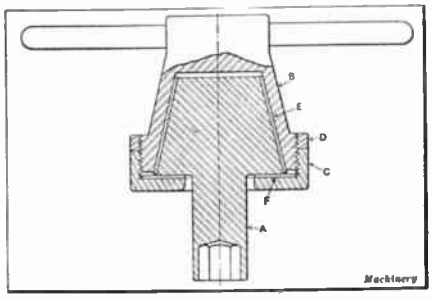
IT is only lately that the proper conditioning of air has been recognized as a subject of fundamental importance in many industries. The possibilities of overcoming unhealthful air conditions are of course extensive and a secondary consideration is the aid to manufacturing processes which satisfactory atmospheric conditions give. In the production of gelatine products, low temperatures and constant low moisture conditions must be maintained. In confectionery establishments cool, dry air becomes a requirement. In the baking industry a high humidity with proper temperature maintained constant, eliminates important variables in the raising of dough and enables the baker to standardize time. In the photographic industry the proper conditioning of air has been practised for some time, for otherwise there would be many days too hot or too damp for the production of satisfactory material. Even the printing art requires the conditioning of air, where several colors are used in the production of illustrations, for the perfect registration necessary for success cannot be expected under greatly varying atmospheric conditions. The silk industry has practised conditioning for a long time, but we have not yet been able to extend this work into the wood and cotton field. In modern textile mills, however, apparatus is being installed by means of which the condition of the air can be satisfactorily controlled.—*Scientific American.*

CRUDE RUBBER AT LOW RECORD

CRUDE rubber at from 28 cents to 30 cents a pound is selling at the lowest prices ever recorded for the commodity. Current quotations represent a gradual decline of about 20 cents a pound from price of 50 cents at which crude rubber sold about six months ago. During 1919 the price of crude rubber ranged between 44 cents and and 55 cents. In 1912 it sold for more than $1 a pound.

SLIP-FRICTION WRENCHES

THE extreme amount of care and accuracy required in the construction of airplane motors is quite well known. The production of these motors in large quantities during the war led to means being devised for obtaining an even amount of tightness in the bolts which secure the main crankshaft bearing caps in place. This point, which caused considerable trouble, would not have been noticed on the average kind of work, but since extreme accuracy must be maintained in these bearings it was found necessary, when placing the crankshaft in position, to devise a wrench which would tighten these bolts to the same degree as was obtained in the final reaming operation. A wrench of this kind, illustrated herewith was described by George C. Hanneman in *Machinery* and its development called for considerable ingenuity and experimental work.



A slip-friction wrench

Experiments were made with various forms of slip-friction devices—cylindrical, flat disk and cone, in combination with a T-socket wrench. It was found that the type of wrench shown gave the best results and that it was possible to set the friction to release within narrower limits than could be obtained by the use of any other type, and also that it would hold its adjustment longer after having been set. This wrench consists of a socket A which fits the nut and which may be made either in one place as shown, or as a two-piece construction; in either case there should be a cone at its upper end as shown in the illustration. The cone is held in the holder B by means of the retaining collar-nut C, and is locked by means of the check-nut D. Between the sides of the cone and the conical seat in the holder a liner of thin sheet fiber is interposed as at E and a fiber washer F is also employed in the retaining collar as a seat for the head of the cone. The fiber should be filed smooth before being used. By adjusting nut C, the wrench may be set to slip when the nut on the motor is tightened to a predetermined degree.

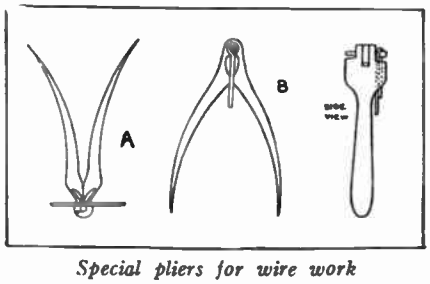
Various lubricants were tried on the fiber contact pieces, with the result that the best lubricant for increasing the length of service to which the wrench could be subjected without requiring

adjustment was found to be dry graphite. Greases and oils caused the wrench to stick when being used after lying idle for some time.

The construction of the wrench, however, did not entirely solve the problem, because it then became necessary to determine just how much stress was required and to devise the means for setting the wrenches to correspond with this known amount. This would enable quantities of wrenches to be adjusted to the same degree so that each workman could be supplied with an individual wrench, interchangable, so far as slippage was concerned, with all the others of the battery. To measure the amount of torsion required to cause the wrench to slip, a special gage was devised.

SPECIAL PLIERS FOR WIRE WORK

THE special pliers illustrated herewith were designed by an English inventor for forming loops in hard wire so widely used in aeronautic work but they can be used for making eyes in the



Special pliers for wire work

end of wires or light rods for any purpose. The construction and method of using these pliers is clearly shown at A and B. The pliers are ready to receive the wire when in the position shown at A and the loop is formed by bringing the handles around as shown at B so the extension pieces will bend the wire around the hinge pin. A side view shows that the hinge pin or former may be of different diameter at each side so eyes of two diameters may be formed with the same tool depending on which side is used in bending the wire.

RAIL-CREEP ON RAILROAD BRIDGES

EXPERIMENTS in the case of a railroad bridge in India, where the creep amounted to as much as three to four feet a year, a special cast-iron sleeper was designed to suit the 75-pound flat-footed rail with a jaw large enough to receive a lock-fast steel key. This reduced the creep to insignificance, and generally confirmed the conclusion that "creep" can only be remedied by effective anchorage.

AN UNUSUAL ACCIDENT

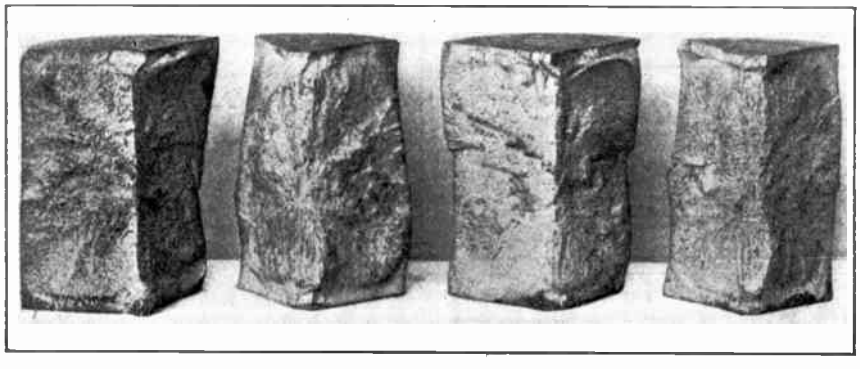
WHO ever heard of a chunk of steel exploding? None of the metallurgists in the research laboratory of the General Electric Company ever had until one day this year. On that day Herman Winkler, an employee busy hardening three slugs of ordinary Sanderson carbon steel to be used as plungers in making genelite, a new self lubricating bearing metal, drew a slug out of the electric furnace at about 750

Showing lines of fracture

degrees Centigrade, quenched it in a tank and then took it in his left hand. With a file in his right hand he was about to test the slug's hardness when someone distracted his attention. In that moment the end of his file tapped the flat end of the slug.

"It flew to pieces with a crack like a pistol shot," said Mr. Winkler. "One chunk went by my ear, another went straight up and the remaining two dropped into the sink. It was peculiar. My hand was merely bruised a little bit."

The only explanation advanced for the phenomenon is that the slug, which was about four and a half inches long and four in diameter, cooled a degree too quickly on the outside and the heat expanded core exerted a surface tension so unusual that the slightest touch at that exact moment produced the violent fracture. The other two slugs from the same bar that day got what appeared to be exactly the same treatment, as have thousands of other steel slugs in times past, and not one ever responded as this one did. The photographs show there was no flaw in the metal, but the lines of core strain are obvious. This phenomenon may be easily understood by any one who is familiar with the action of Prince Rupert's drops, small pear shaped glass beads that will fly to pieces when the small end is broken off by a sharp blow, yet will stand considerable punishment if struck on the globular portion.



How slug broke into four pieces

PORCELAIN TOKEN MONEY

THE city of Meissen and other towns have ordered porcelain coins for local use, to solve the small-change scarcity and obviate the present unclean and easily tearable paper currency. Germany is said to be about to introduce porcelain small-change coins.

OXYGEN HEATER FOR HIGH FLIERS

THE Army is conducting tests on a new apparatus for heating oxygen at high altitudes, in order to prevent a recurrence of failure such as experienced by Major Rudolph Schroeder recently in his record climb. The apparatus consists of a refined thermostatic interrupter in connection with electric resistance coils, attached to the oxygen generator. The apparatus heats the oxygen as it leaves the exhaust valve of the container, and keeps it heated until it reaches the distributor. This prevents any moisture present from freezing in the delicate distributor and it also heats the oxygen again before it enters the pilot's mask.

NEWLY DISCOVERED AUSTRALIAN PIGMENT DEPOSITS

THE discovery of an extensive deposit of ochre and sienna at no great distance from the surface and within thirty miles of Adelaide, South Australia, has attracted much local interest, particularly in view of the abnormally high price of imported paint pigments. Though regarded primarily as a mining proposition the discovery is important in a manufacturing sense. During the years of war, several new paint works were established in Australia, but the promoters were handicapped to some extent by the necessity of importing most of the requisite raw materials. This new find of ochre and sienna, therefore, extends the possibilities of the paint industry and should render it largely independent of overseas supplies of the basic pigments.

Some research work on high chromium steel, which has recently been carried out by the United States Bureau of Standards to determine the influence of various kinds of heat treatment, indicates that the maximum hardness is obtained by quenching at about 1066 deg. Cent., but that quenching from 955 deg. Cent. gives the best combination of strength and ductility. Steel quenched at temperatures above 1010 deg. Cent., shows a very low elongation and reduction of area. Such brittleness can be decreased by short-time tempering up to about 427 deg. Cent., while tempering above this heat rapidly decreases the strength and hardness. All quenching was done in oil. The material studied had the composition: C, 0.29 per cent; Mn, 0.38 per cent; Si, 0.70 per cent; Cr, 13.2 per cent.

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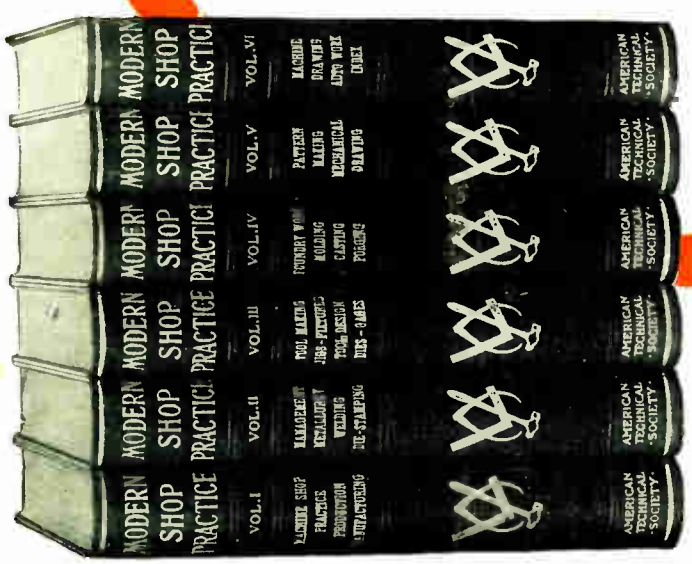

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