MOTORLESS FLIGHT

NEWNES

PRACTICAL MECHANICS

AUGUST

6D.

EDITED BY F. J. CAMM

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PRACTICAL MECHANICS

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Fair Comment

By The Editor

The Conjurors' Cave In!

READERS will remember that when we commenced our series of articles on conjuring I received a number of letters from conjurors protesting against our "exposure" of their so-called "secrets." These letters were obviously from conjurors, and were sent for the purpose of "defending" conjurors' "interests." Many letters, of course, went into the wastepaper basket. One of the letters from a conjuror, written in a most illiterate style was signed, "Yours most *disgustingly*." The italics are mine.

These letters were followed by a threat of an action against the proprietors of this journal, its Editor, and the author of the articles, because it was said we had exposed the secret of a "trick" which was "copyright." Notwithstanding this threat we have courageously continued to publish articles on conjuring with the intention of pursuing our policy of providing exclusive material for our readers. I was, of course, aware that it was unlikely that any such action would ever be brought into court, for the very good reason that there is no such thing as a copyright in an idea or a method.

You can patent a particular method or a particular device, and it is significant that conjurors have for many years been speaking of their "copyright" tricks when they must have been well aware that they were endeavouring to impress people by the use of that word without the slightest legal standing.

These threats of actions against publishers for printing details of conjuring tricks have been going on for a good many years, and as I have said, an Association was formed with this express idea in view. Now I think it is quite true to say that there are very few, if any, new and original tricks performed to-day. Many of them are centuries old, and are merely dished up in a new form. Had a campaign of secrecy been instituted a century ago, there would have been no conjurors to-day. Their tricks are childishly simple, can be purchased by any schoolboy, and there is little original in them. Take away the special apparatus and there is no such thing as a conjuror. It is the patter and the showmanship which amuses. I pointed out when commenting on this matter once before that if every industry adopted the attitude that no one must publish details of how things are made and done the world would collapse. The plumbers, the builders, the engineers, the draughtsmen, the weavers, the architects, the foundrymen, all those craftsmen who contribute to the existence of the world would be protected by a campaign of secrecy instead of contributing to the world's heritage of knowledge.

None of us is a self-contained individual. We specialise in a particular subject because philosophers like Pythagoras, Euclid, Galileo, Faraday, Edison and others discovered basic principles and passed the information on. Conjurors, however, seem to regard themselves in a special class. Where would they be without stage lighting, electricity, woodworkers who make their trifling boxes, tables and other impedimenta? The amusing part of it is that the worst exposers of the secrets of conjuring are conjurors themselves, for most of them have written books on conjuring. It is the function of a technical journal to "expose" the secrets of anything and everything within its editorial ambit. Certainly our readers have nothing to learn from conjurors, whereas I have no doubt conjurors learn a considerable amount from these pages which I gather most of them regularly read. Doubtless many of them are performing tricks which they have learned from our pages.

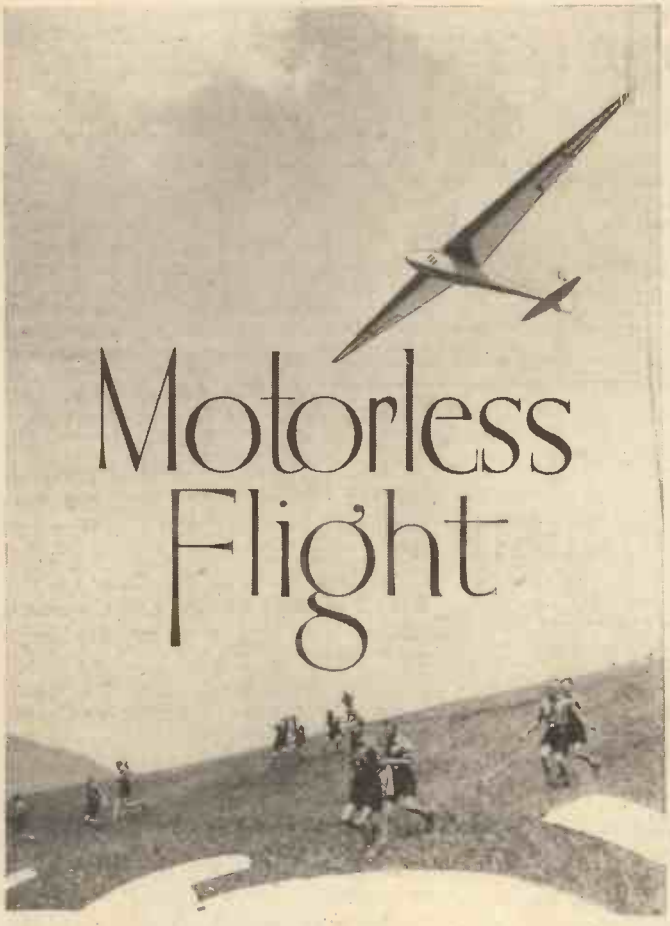
Now for the developments. The conjurors formed a fighting fund, but upon taking legal advice found that they had not a case. Apparently they punted around all of the experts on copyright, but all of them advised that they were without the shred of a case. Had such a case been brought it would have been my duty to have shown that some of the tricks which particular conjurors claim as their own invention are as old as the proverbial hills, and that they have no legal right to the exclusive use of them.

Our action in thus calling the conjurors' bluff has been of great service not only to our readers but to the publishing trade in general. It has cleared the air once and for all. What will happen to any further attempts to defend the so-called copyright in tricks is quite obvious. I merely wish to say in conclusion that we shall continue to publish such technical information as we think fit irrespective of the objections of those narrow-minded people who think that some trifling piece of information should be retained as a "trade secret."

There can be no doubt that the conjurors have put themselves in an unenviably humorous position by their attitude of speaking of the "copyright" and other legal aspects of matters which, as one writer puts it, "they know nothing about but are fond of hot gospelling on."

"Practical Mechanics" Handbook

THE final opportunity for readers to obtain a copy of this 400-page complete work on almost every subject concerned with the workshop—fitting, turning, mechanical drawing, screw-cutting, obtaining a patent, sheet metal work, hardening and tempering, electroplating, the dividing head, grinding, files and filing, etc., etc.—appears elsewhere in this issue. For 2s. and for two coupons you can obtain a copy of this work which will eventually take its place in our standard list and retail at 5s.



Motorless Flight

GLIDING has developed into a national sport, and those readers who are unable to afford £2 an hour on instruction in flying a power-driven aeroplane, but still wish to experience some of the thrills of flying, and certainly some of those which flying cannot give, should take up gliding. Apart from the fact that it is probably much safer and more silent, it is certainly much cheaper.

From the days when Wilbur and Orville Wright made their famous glide of a few minutes at Kittyhawk gliding has developed to a stage when even cross-country flying can be undertaken and glides of many hours duration successfully accomplished.

Recent Achievements

Some recent achievements are worthy of mention. In Germany there have been many instances of flights of over 300 miles in a straight line, whilst flights of over 100 miles are an almost common daily occurrence. In England some excellent flights have been recorded, although the somewhat confined area makes the coast the limit in distance gliding. In 1921 the record was 13 mins., whilst the record to-day is 2½ days. The altitude record was 300 ft., whilst to-day it is 18,000 ft.

Membership of most of the gliding clubs costs between two guineas and three guineas a year, plus a small additional charge for instruction which is payable as the instruction is given. This will vary according to the type of machine on which you glide. In the early stage of your instruction it is customary for small classes of members to be formed, the cost of the instruction which includes the use of the training glider being between 2s. and 3s. a day.

As experience is gained and your glides lengthen you pay a higher fee for the machine, and this varies from about 4s. to 8s. per flying hour, although some clubs will quote an inclusive fee for full-flying rights for the year, irrespective of the number of hours flown. This is an arrangement in operation at the London Gliding Club, who charge £5 a year for this service. Thus, it is obvious that at the most you will spend £10 a year and in return you will have had many hours' enjoyable sport and have gained experience which will be of great value to you if you wish to become a pilot of a power-driven machine.

Gliding Clubs

You should pay a visit to a gliding club, when the instructor will explain procedure. There is no charge for being an observer. You will observe the primary gliders and those of the soaring type which are used by the more accomplished pupils. You may observe a group of members take the machine out of the hangar and take it to some slope. Beginners fly solo. Elementary training consists of a large number of low hops of a few seconds' duration, thus creating a demand for launching teams, which usually consist of members awaiting their turn to fly. Each member of the team takes it in turn to occupy the pilot's seat of the glider. The instructor will tell you what to do, and how to operate the controls.

On the first few attempts you will probably not leave the ground, but gradually you will acquire the knack of so operating the controls that you are launched into the air.

London Gliding Club

Unfortunately, gliding as a sport has not made as much progress in this country as it has on the Continent. Consequently the would-be spectator is somewhat restricted in his choice when visiting a gliding ground. The principal centres here are Dunstable, which is the headquarters of the London Gliding Club; Matlock, in Derbyshire, and Sutton Bank, near Thirsk, Yorkshire.

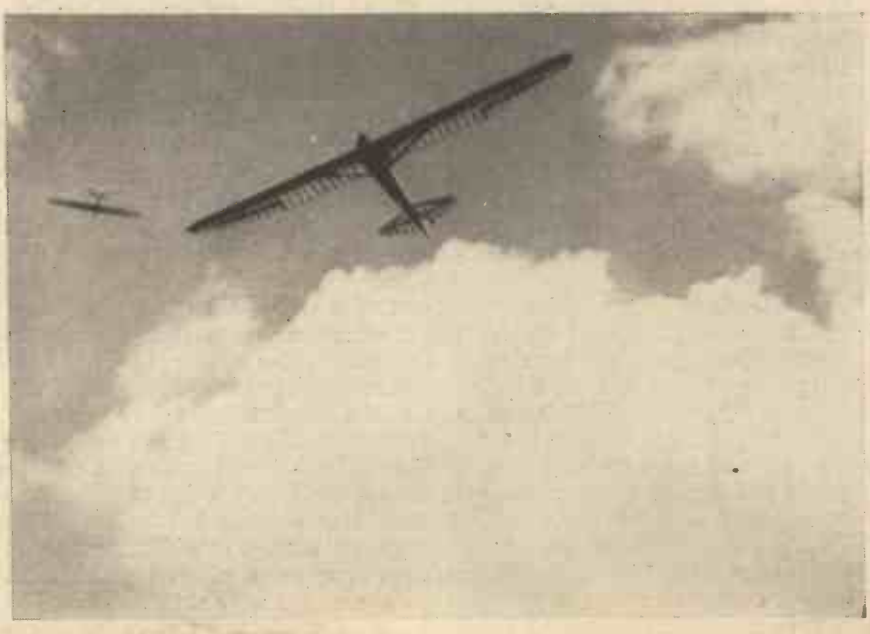
One can rely on finding the London Gliding Club in action on almost any fine week-end during the spring and summer, and it is certain that there is something distinctly fascinating in watching the graceful, bird-like machines, containing a single human being, skimming noiselessly over the heads of the watchers on the top of the ridge, swooping out over the valley and returning along the hillside, rising steadily on the up-draught until they are thousands of feet in the air, and poised almost motionless under some huge cloud, like an enormous dragonfly suspended from an invisible thread.

The construction of a glider cannot help but intrigue the practical man, too, for the workmanship in these sleek shapes is carried out with a care and precision that is a joy to behold.

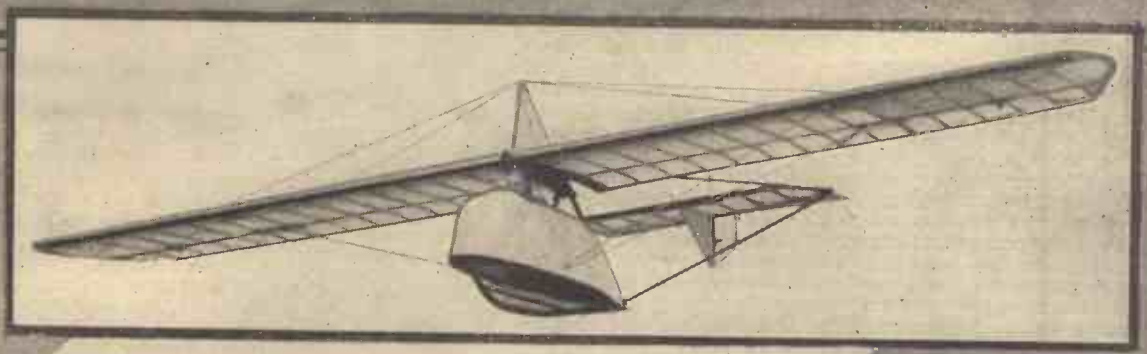
The visitor to Dunstable will see many different types of gliders, for it is a fully equipped club with qualified instructors and full training facilities. The machines range from the very early training type, known as the "primary" (on which novices are taught to take off and land correctly, and are also enabled to get the feel of the controls) to the more advanced sailplanes, which are capable of remaining in the air for hours or undertaking long cross-country flights under favourable conditions.

First "Flights"

The glider pilot begins his early training on the "primary," and the first "flights" consist as stated of "hops" across the landing



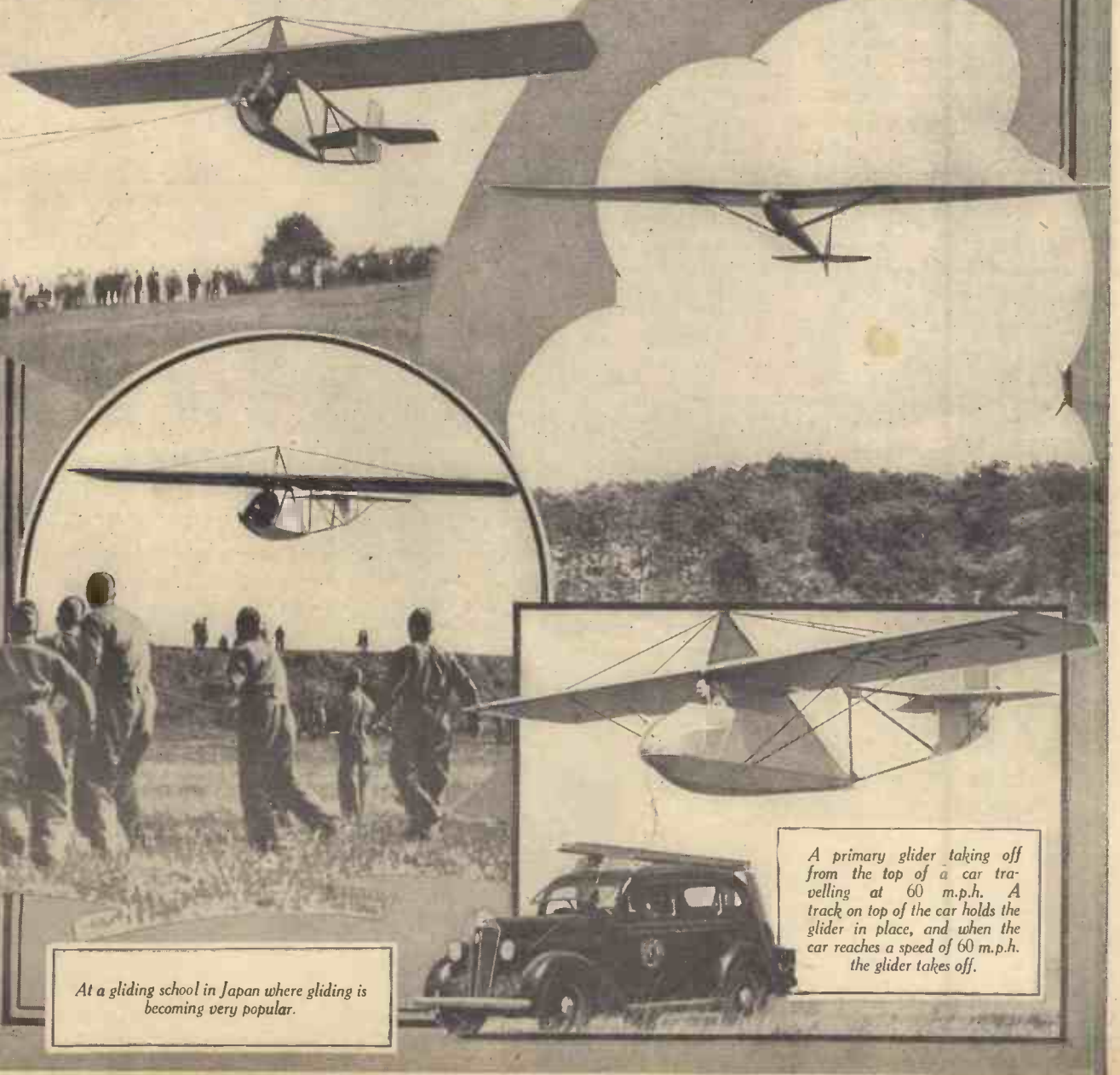
Sailplanes at Dunstable threading in and out among the clouds.



(Above) A glider soon after taking off at the Anglo-German gliding camp at Dunstable.

(Below) A glider being catapulted into the air during a gliding contest at Gatow, near Berlin.

(Below) A glider in flight above Wing Field, U.S.A., where many people are now taking lessons in the piloting of motorless craft.



At a gliding school in Japan where gliding is becoming very popular.

A primary glider taking off from the top of a car travelling at 60 m.p.h. A track on top of the car holds the glider in place, and when the car reaches a speed of 60 m.p.h. the glider takes off.

ground, during which the machine rises only a few feet from the earth. In these early stages, the launching operation is carried out by a catapult, consisting of a long rope of stranded rubber, which is hooked to the nose of the machine and stretched by ten other people—five on each side—who are under the direction of a marshal.

The First Full Flight

As the learner progresses, he is launched from points higher up the hillside until at last the day comes when he takes off from the crest of the ridge and accomplishes his first full flight. When the pilot has thus mastered the control of the "primary" he is transferred to a more advanced type of machine known as a "secondary," a machine with greater lifting capabilities than the "primary," and after completing his course in this type of machine, he is allowed to take up a full-fledged glider. Provided he has acquired the necessary skill, and the wind and weather conditions are favourable, he should now be able to remain aloft for almost as long as he chooses.

Before making his first solo flight in the real glider, however, it is usual for the learner to take some dual instruction on the club's two-seater machine, in which the pilot and the pupil or passenger sit side by side. This machine is a giant among gliders, having an enormous wing span to enable it to lift the dead weight of something like 3 cwt., in addition to its own weight.

Launched by Cable

This machine—and, indeed, most of the more advanced types of gliders and sailplanes—is launched from the landing ground by means of a winch and a steel cable. This saves the bother of towing the machines to the crest of the ridge, for once in the air, they are able to maintain and increase their altitude by using the rising currents of air near the side of the hill.

The launching method itself is rather interesting, and usually attracts a group of onlookers. The stranded steel cable is taken right across the aerodrome, and may extend for a distance of over a quarter of a mile. It is attached to the nose of the machine by a ring and bolt, the latter being controlled by the pilot, who releases it at the appropriate moment.

The Winch

The other end of the cable is attached to the winch, which is driven from the gear box of an old six-cylinder motor car engine, specially adapted for this purpose. When the pilot is ready to take off, and the slack in the cable has been taken up, a signal is given to the driver of the winch, and he opens the throttle wide. The winch screams as it winds in the cable, and the glider, after only a few yards' run on the ground, begins to climb into the air at an impossible-looking angle of something like 45 deg. When the pilot has attained the desired height, he draws the bolt releasing the cable, and the latter falls to earth. Then he banks, turns towards the hillside, and begins his flight.

It is worth noting that as the cable winds on to the drum of the winch, it passes over a special block, at the side of which stands a man with an axe. If, for any reason, the pilot is unable to release the cable when he wishes to do so, it is this man's job to sever the cable—with a single blow if possible—otherwise a nasty accident might result.

Sailplanes

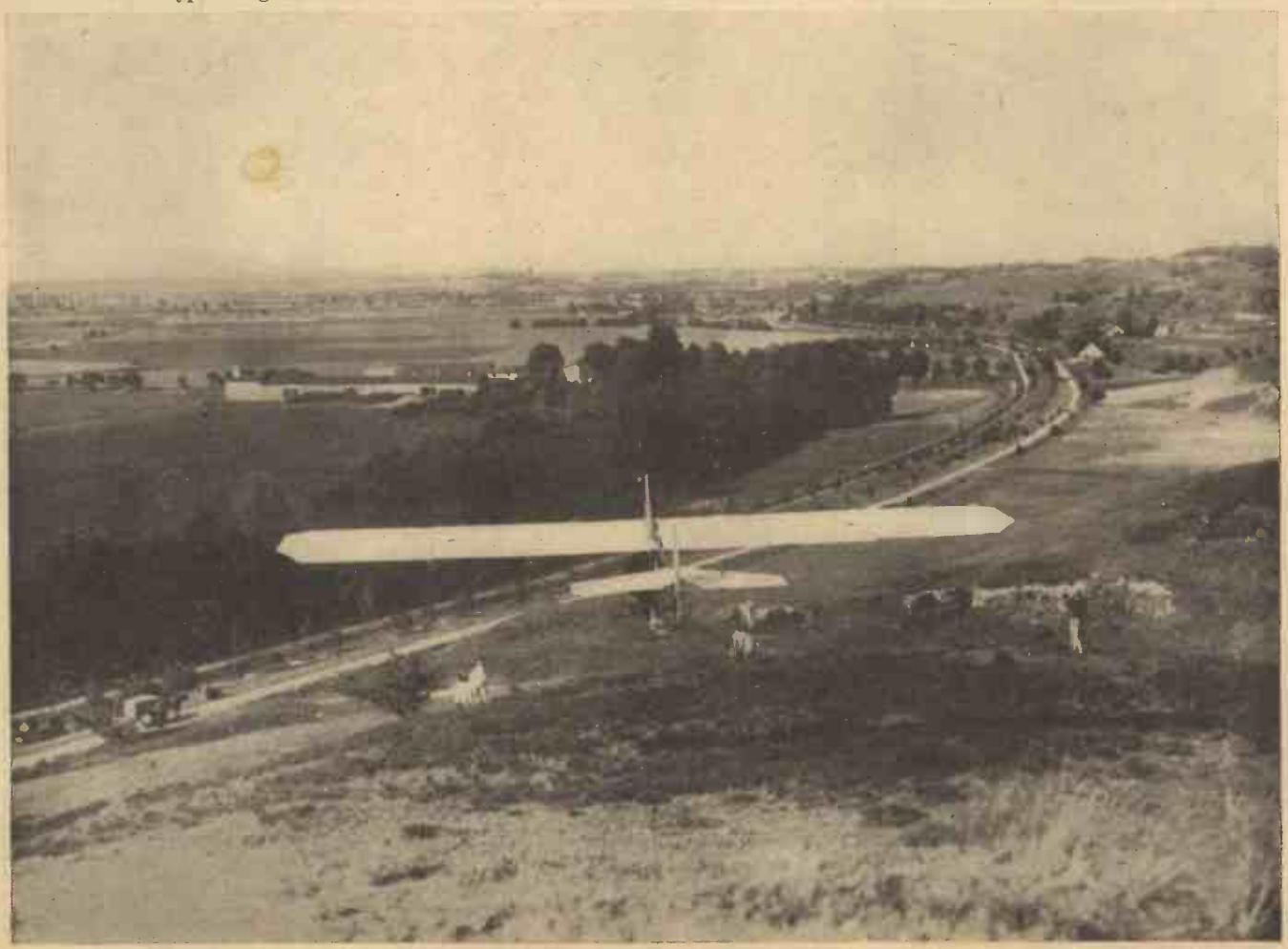
The most interesting machines to be seen at Dunstable are the sailplanes, which are based on the most advanced German designs, and are the last word in streamlining and efficiency. They are almost tailored to fit their pilots and the fully enclosed cock-pit is so tiny that the pilot really needs a shoehorn to help him in. These fragile machines are so sensitive that they can fly when there is little more than the proverbial "breath of air," and when favourable conditions prevail they can be seen threading in and out among the clouds, high above all the rest.

Clouds

The clouds are the glider pilot's greatest friends, for after he has left the friendly help of the hill from which he was launched, he depends entirely on the rising thermal currents under the piled-up banks of cumulus clouds for maintaining his altitude. Upon his skill in finding and remaining in these "lifts" depends the duration of his flight.

When the west wind is sweeping across the Central Plain, any Saturday or Sunday at Dunstable cannot fail to be of interest.

Just as we go to press we learn that Mr. W. S. Sproule and Flt. Lieut. W. B. Murray have broken the existing World's record for two-seater gliders of 21 hrs. 2 mins. by 1 hr. 11½ mins. They also broke the British Glider Endurance Record of 13 hrs. 7 mins.



A glider in the air after taking off from the hillside.

Restringing A Tennis Racket

Clear and Straightforward Direction For the Home Handyman

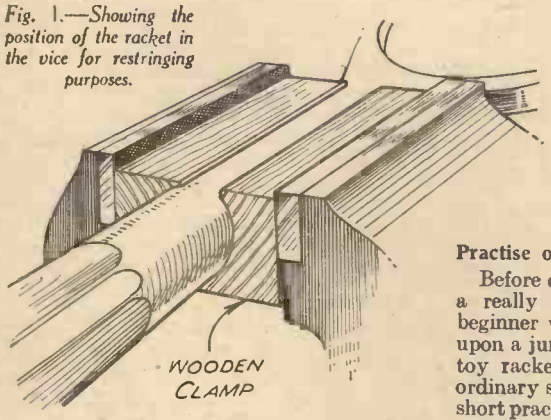


Fig. 1.—Showing the position of the racket in the vice for restringing purposes.

ALTHOUGH the restringing of a tennis racket, completely or in part, is a process which calls for the exercise of a certain amount of acquired skill, the task, once the necessary knack has been mastered, is not a difficult one. It is, indeed, an operation which is well within the practical capabilities of the average handyman, as only a minimum number of tools are required.

The amateur who takes up this interesting spare-time occupation needs merely a small work-bench fitted with an efficient vice, into which the racket under treatment can be held in the manner shown at Fig. 1. In order to obviate the risk of injury to the handle of the racket by undue pressure in the vice, it is advisable to line the jaws of the latter with hollowed-out blocks of wood exactly conforming to the curvature of the racket handle. Such "liners" for the vice will also allow of a better grip being obtained on the racket.

For the purpose of racket restringing, we require, in addition to the necessary gut, a pair of scissors, a pair of blunt-nosed pliers, and a "pricking" awl having a fine point, the latter being used for opening up the holes in the racket frame through which the gut is passed. A "setting-off" awl will also be required. This implement is merely a stout, stumpy variety of awl, having a short blade, and it can usually be made at home. Its purpose is for aiding the squaring-up of the strings of the racket during their final tensioning. Finally, one or more "stopping awls" will be required. This is merely a fine-pointed awl, whose function it is to prevent the slipping back of any tensioned string by being thrust into the hole through which the string passes.

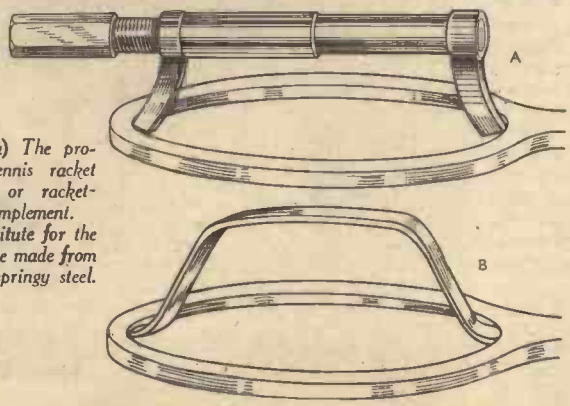


Fig. 3.—(a) The professional tennis racket "billiard," or racket-stretching implement. (b) A substitute for the above can be made from a strip of springy steel.

Practise on Cheap Rackets

Before embarking upon the restringing of a really good-quality tennis racket, the beginner would be well advised to practise upon a junior racket, or even upon a child's toy racket, and, in place of gut, to use ordinary strong string or very thin cord. A short practice along these lines, following out the instructions given in this article, will sufficiently acquaint him with the precise procedure of the restringing operation; and with this knowledge and experience will readily come the necessary confidence for tackling a full-size sports racket.

The gut for tennis rackets is obtainable in several grades and colours, the "extra high-tension" gut being the best. This quality of gut, which is expensive, is by no means necessary for average restringing work, for which purpose any average grade of gut will be quite satisfactory.

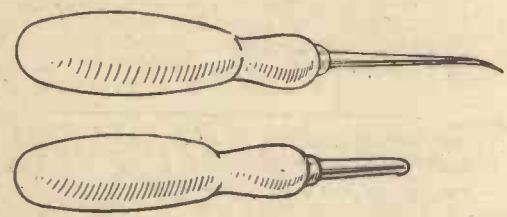


Fig 2.—Showing the types of awl required for re-stringing.

Tennis racket gut is usually supplied by sports outfitters, etc., or by gut manufacturers, in 21-ft. lengths for the "mains," as the vertical strings of the racket are called in the trade, and in 18-ft. lengths for the "crossings," which is the trade name for the crosswise strings. "Mains" gut can usually be obtained in white, green, or black, whilst "crossings" guts are usually coloured red.

Good quality rackets usually have several crosswise lengths of gut put in at each end. These gut strings are professionally known as the "treblings," and their purpose is merely to fill up the space at the bottom and top of the racket which would otherwise have to be left vacant. "Treblings" gut is obtainable in 18-ft. lengths and in several colours.

Coming now to the actual task of restringing a racket. The racket is first of all firmly secured in the vice and all its old strings removed, the various holes in the racket frame being cleaned out by means of the pricking awl or some other sharp-pointed implement.

The "Mains" String

The first task, now, is to thread the "mains" strings. In order to do this, the 21-ft. length of "mains" gut is threaded through the central hole in the neck or "throat" of the racket, as shown in Fig. 4, so that exactly one half of the length of gut is made available on each side of the racket. One half of the racket is then carefully threaded, following the method indicated in the diagram, Fig. 4. In this diagram the arrow heads indicate the direction of threading the "mains" strings. Note particularly how the end of gut length is secured by being threaded through the loops of gut in the racket frame before they are pulled tight.

Having threaded the "mains" strings on one half of the racket, those on the opposite half are similarly threaded.

Now comes the highly important task of tensioning the "mains" strings.

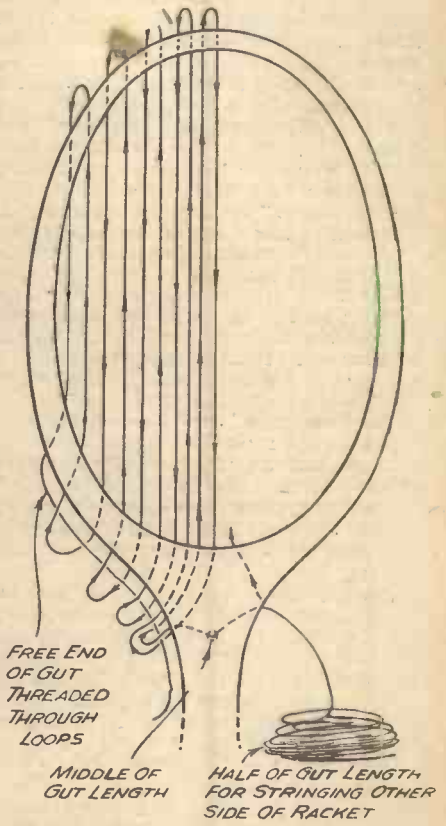


Fig. 4.—Showing the method of inserting the "mains" strings.

To effect this, we must bring into service an implement known to racket makers and repairers as a "billiard." A professional racket "billiard" is illustrated at Fig. 3. It comprises merely a metal rod, which is capable of being screwed in or out of a short metal tube. To each end of the implement curved metal pieces are fitted. When the "billiard" is inserted into the racket, its projecting pieces press against the upper and lower ends of the racket, and by screwing up the implement it is possible to put a longitudinal tension on the racket frame and thus prevent it from being distorted during the tensioning of the strings.

Whilst a properly designed "billiard" is greatly advantageous for all serious work, a good substitute for this implement can be made from a strip of springy steel inserted into the racket frame in the manner indicated at Fig. 3 (b).

Using the "Billiard"

The "billiard," or its substitute, is inserted into the racket frame, as illustrated, and the "mains" strings are each separately tensioned by pulling tightly upon them with the blunt-nosed pliers.

In tensioning these strings, begin at the centre of the racket and work outwards in the order in which the strings were first threaded. In order to get the strings adequately and equally tensioned, it will usually be found necessary to perform the tensioning operation about half a dozen times. When, however, the strings have been satisfactorily tensioned, pull the threaded ends of gut on opposite sides of the racket as tightly as possible and then cut them off short with the scissors.

If, during the tensioning of the gut, there is any tendency of the string to slip back, this can be prevented by "stopping" each string as the tensioning task proceeds. "Stopping" is a very simple operation. All it consists in is merely driving a fine-pointed awl into the hole in the racket frame through which the tensioned string passes. The pressure of the awl blade against the string in its hole will prevent the string from slipping back.

Having threaded and tensioned the "mains" strings of the racket, we have now to weave the "crossings." This is a rather easier task. The method of weaving the "crossings" is clearly shown at Fig. 5. Although in this diagram the loops of the "crossings" are shown on the outer side of the racket frame, these loops should be pulled tight as the work proceeds, any slipping back of the loops being prevented by means of a stopping awl thrust into the hole through which the gut passes.

Crossings

The "crossings" are, of course, threaded over the one "mains" string and under the next one, and so forth. For squaring up the woven pattern of the strings, the "setting" awl will be required, this being used merely to press the various strings up or down or to the right or left as circumstances may require.

Finally, the "treblings" are put in. These cross strings, which, as we have already seen, are those which occupy the extreme ends of the racket, need not be woven under tension. From the "trebling" gut, the necessary lengths required for the three or four rows of these strings at each end of the racket will have to be cut.

Note that the "trebling" gut is not merely woven in and out across the "mains" strings. It is taken right round each "mains" string, the two double "mains" strings near the centre of the racket being counted as one string for this purpose.

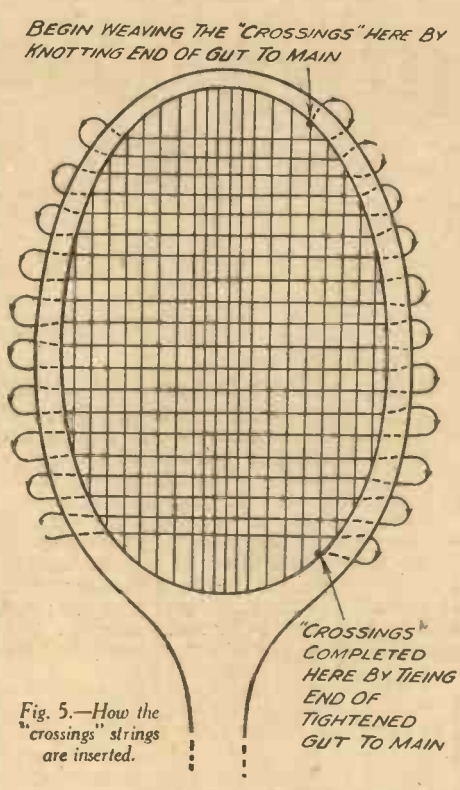


Fig. 5.—How the "crossings" strings are inserted.

Many racket repairers fill up the holes in the racket frame with a hard wax made by melting together rosin and beeswax or any other similar natural wax, this mixture tending to keep the dirt out of the holes in the frame. Ordinary sealing wax will *not* do for this purpose. It is too brittle.

A racket which has been satisfactorily restrung should have all its strings lying in the one plane, so that the entire network of strings presents a perfectly flat surface. If this requirement is not attained, the strings have been unequally tensioned.

Note particularly that after the "billiard" or stretching implement has been inserted in the racket frame for the tensioning of the "mains" strings, it should not be withdrawn until at least half of the "crossings" have been woven and tensioned.

Rackets which have merely one or two strings broken need not, of course, be completely restrung for ordinary use. A new string may readily be inserted in the following manner, no knots being utilised in the process:

Repairing Broken Strings

Remove the broken string and bring its ends to the outside of the racket frame. Now restore the tension to the strings on each side of the broken string, maintaining their tension by means of a stopping awl thrust into their holes in the racket frame. Take now a length of gut slightly longer than the length of the new string. Pass its free end through the hole in the frame next to the vacant hole, wedging it through the hole by means of an awl. Then thread the gut through the adjoining vacant hole in the racket frame, subsequently passing it through the corresponding opposite hole in the frame and, after tensioning the string, wedging it by pulling it through the adjoining hole.

In this manner a racket may have up to half a dozen new strings inserted, but if more strings than this require attention it is generally best to have the racket entirely restrung, particularly if both "mains" and "crossings" strings are affected.

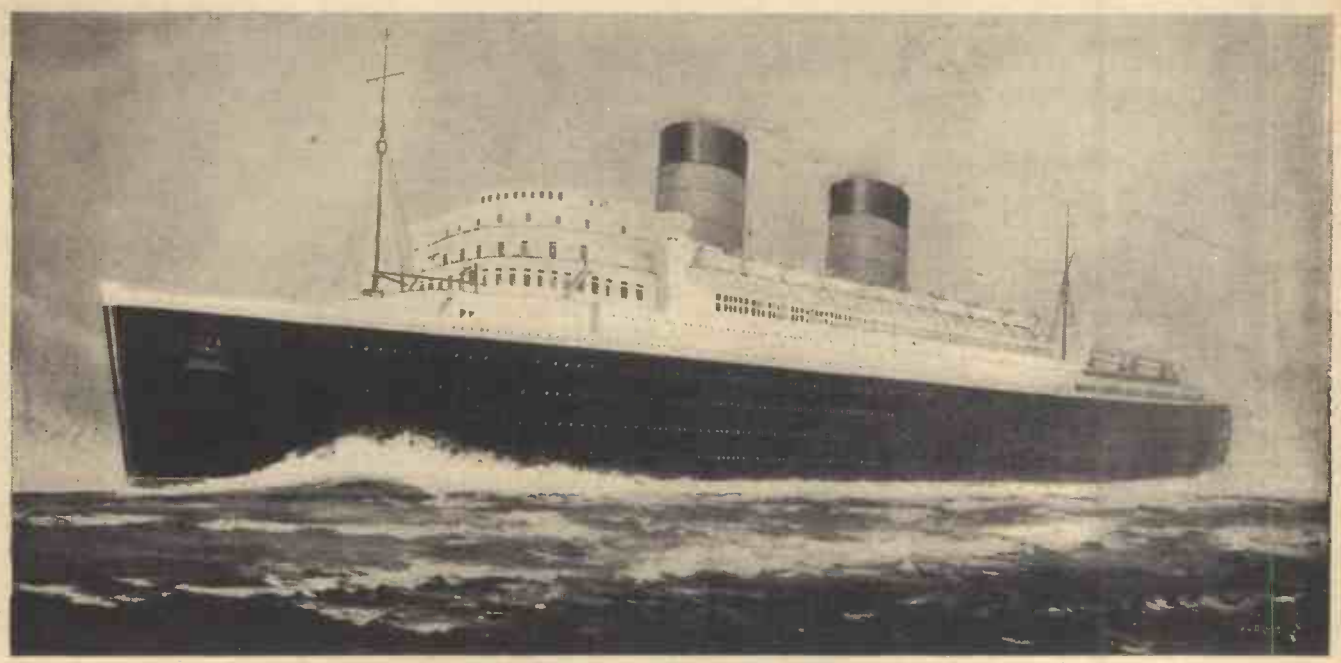
EYE MOVEMENTS RECORDED

A CAMERA developed by Guy T. Buswell, professor of educational psychology at the University of Chicago, records the positions which the eye takes as it moves along a line of printed matter. As the subject reads the printed line, the eye jumps from position to position, in which it absorbs a part of the line.

Bad Readers

Poor readers often read one word at a time, whilst good readers read the line in three or four jumps. The camera flashes the spotlight focused on the cornea of the subject's eye on a moving film at the rate of thirty flashes a second, so that every movement of the eye is recorded as it progresses along the line of reading matter. With the results of tests made with this camera, Professor Buswell has been able to improve techniques of teaching reading.

Details of the camera for recording eye movements.



An artist's impression of the new "Mauretania."

IN MEMORY OF THE MAURETANIA

At Birkenhead the Largest Passenger Ship ever to be Built in England The New "MAURETANIA" is Nearing Completion. She will be launched in the Mersey on July 28th.

SCANNING the history of ships and shipping, it is surprising, and a little sad, to find how very few vessels survive their era.

Some have been lost by shipwreck; others by fire, or the hand of war. Luckily there are a few, like the world-famous clipper *Cutty Sark*, preserved to posterity as training ships, or, like Nelson's *Victory*, retained as vessels of historic or romantic interest, but the majority, when their work is done. go to the shipbreakers, and the things, which once were inmost parts of them are auctioned and scattered in homes all over the world.

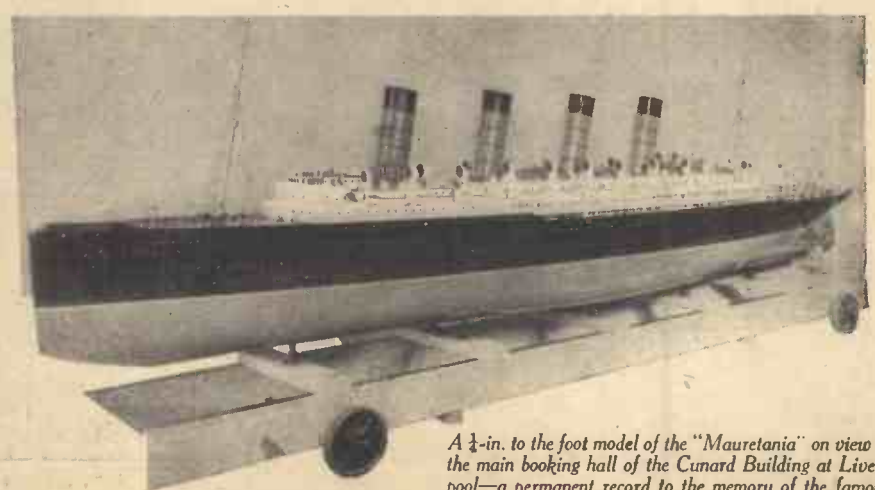
Shipping ports and harbours present a vastly different appearance to pre-war days. The British merchant ships of those days were either lost in the war or have since been laid up or broken up. The immediate post-war period was marked by the appearance of many German vessels, which had been surrendered as reparations and the tonnage of the British merchant fleet as far as big ships went was overwhelmingly foreign built. Ships like the *Berengaria, Majestic, Homeric, Empress of Australia* and *Albertic* were all German built, and the only large British ones were the *Olympic, Aquitania* and *Mauretania*, of which only one now remains.

New Ships in Service

During the past five years there has been activity on the Tyne and Clyde and new ships have come into service. The *Olympic* has gone, the *Majestic* also, and when Britain's wondership *Queen Mary* entered the merchant service, the *Mauretania's* work was over. So after holding the Blue Riband of the Atlantic for a quarter of a century, this gallant Cunarder was sent to the shipbreakers.

In 1903 with *Kronprinz Wilhelm, Kaiser Wilhelm II, Kaiser Wilhelm des Grosse* and *Kronprincessin Cecillia*, Germany possessed the four fastest and best appointed merchant ships on the Western Ocean, and this led to the placing of the order for the vessels, *Mauretania* and *Lusitania* with Messrs. Swan Hunter of Wallsend-on-Tyne and Messrs. John Brown of Clydebank, the speed stipulated being 24½ knots in moderate weather.

The leading particulars of the *Mauretania*:



A ½-in. to the foot model of the "Mauretania" on view in the main booking hall of the Cunard Building at Liverpool—a permanent record to the memory of the famous blue riband holder.

THE NEW "MAURETANIA"

Builders Messrs. Cammell Laird & Co., Ltd., Birkenhead.

Keel Laid May 24, 1937.

Launching Date July 28, 1938—naming ceremony to be performed by Lady Bates, wife of the chairman of the Cunard White Star, Ltd.

Maiden Voyage Spring, 1939—the year of the great New York World's Fair.

Dimensions The new *Mauretania* will be 33,000 tons, the largest liner ever to be built in an English shipyard. She is being built on the slipway which was the birthplace of the British battleship *Rodney* and the aircraft carrier *Ark Royal.*

It is interesting to note she will be a "keep fit" ship, with two gymnasiums, a swimming pool, and Turkish and electric-ray baths.

Propelling Machinery A twin screw vessel driven by Parson's single reduction geared turbines. Steam supplied from high pressure water tube boilers.

Other Points This new ship will embody in her design all the newest ideas in marine engineering and naval architecture.

She will have only two funnels. Time was when at least four funnels would have been required for a liner of her size, but to-day marine engineering has progressed to such an extent that to-day two funnels can easily do the work of four.

Therefore it has been possible to increase the deck space for games and promenading. There will be ten decks, and three classes of passenger accommodation provided—Cabin, Tourist and Third Class

Date of launch, September 20, 1906.
Date of trials, November 3, 1907.
Date of first voyage, November 16, 1907.

Her extreme length was 785 feet, beam 88 feet and gross tonnage 31,938. Her designed shaft horsepower was 68,000 with designed speed of 25 knots.

On her trials in November, 1907, she reached over 27 knots, and that month saw her first voyage. During 1908 the average of both the *Lusitania* and *Mauretania's* voyages were creeping up and in March, 1909, the latter made a westward crossing at the record average of 25.55 knots, a clear two knots faster than the record of the *Kaiser Wilhelm II* which reached 23.68 knots in 1904.

An Extensive Refit

After the war the *Mauretania*, still "Queen of the Seas"—received an extensive refit, and by June, 1929, the German *Bremen* was ready to sail on her initial voyage, which she covered at average speeds of 27.83 and 27.91 respectively for the outward and homeward journeys. Within a week of this the 23-year-old *Mauretania* replied with a speed of 26.85 knots on the outward trip and the return speed of 27.22—a remarkable feat.

Model in Booking Hall

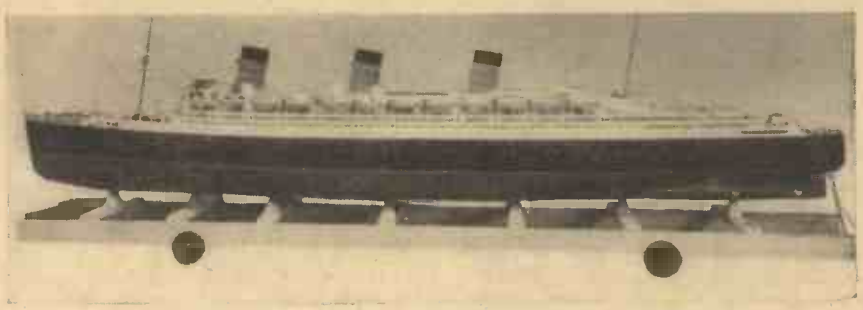
The Cunard White Star Line are justly proud of the *Mauretania* and they now have in their main booking hall of the Cunard Building at Liverpool, a ¼-inch to the foot model of the ship approximately 18 feet long and this model is the subject of the illustrations of this article.

She was sent to a model shipyard for reconditioning and also several alterations were made in her superstructure, the most important being the extension of the promenade and boat decks. Originally these were flush with the hull but now they have added 2 ft. 6 in. to each side, and the promenade deck is covered in with screens and windows about half the way along. The bridge also was brought slightly forward and entirely rebuilt, 10 new lifeboats fitted (this was necessary on the real ship to comply with the Board of Trade regulations after the *Titanic* disaster) and most of the saloon skylights completely rebuilt.

The Model Overhauled

When the model came in for overhaul, the ship modellers stripped the hull bare. All the rigging was taken down, the deckhouses, winches, funnels, portholes removed, and every spot of paint and polish scraped off. Every metal fitting was replated, each little part of the superstructure was made as new.

Ships of the *Mauretania's* day carried so much gear on deck. Tall funnels and masts with their numerous stays, decklights let into the decks, hundreds of cowl ventilators, all these were fitted—accurate to the smallest degree, on the model, which when finished lay alongside a 22 ft. *Queen Mary.* An interesting contrast—for both the *Queen Mary* and *Normandie*, the giant passenger ships of the world, have adopted the modern idea of as much clear space on the decks as possible.



The "Queen Mary" model—an interesting contrast to the "Mauretania."

Model in Winchester Cathedral

In July, 1935, a *Mauretania* model of the same size as the subject of this article—18 ft. 6 in.—was presented to Winchester Cathedral as a permanent memorial of this great ship. It was dedicated by the Bishop of Winchester to all seamen using the port of Southampton, Winchester being the nearest cathedral town

(Left) A close-up of the stern decks of the "Mauretania." (Right) An impressive view of the forward deck, and the large number of ventilators on the middle superstructure.

The first airplane to be exported from the United States equipped with the new Wright G-100 Series Cyclone engines rated at 1,100 h.p. for take-off—a Douglas 21-passenger DC-3 transport, first of a new fleet of similar ships to be placed in operation by K.L.M. between London and the Dutch East Indies.

A New Aircraft Engine

The Wright G-100 Engine which Incorporates many Refinements of Design as the Result of Research and Experimental Development

FOLLOWING more than a year's operation on airlines of the United States, the Wright G-100 Series Cyclone engine—an advanced version of the G Series Cyclones which power many leading types of military and commercial aircraft throughout the world—has been released for export sale, according to an announcement made by Myron B. Gordon, vice-president and general manager of the Wright Aeronautical Corporation, Paterson, New Jersey. Simultaneous with the release of the engine itself, approval has also been obtained, according to Mr. Gordon, to export the Wright two-speed supercharger and the Chandler Groves carburetter with which the G-100 may be equipped.

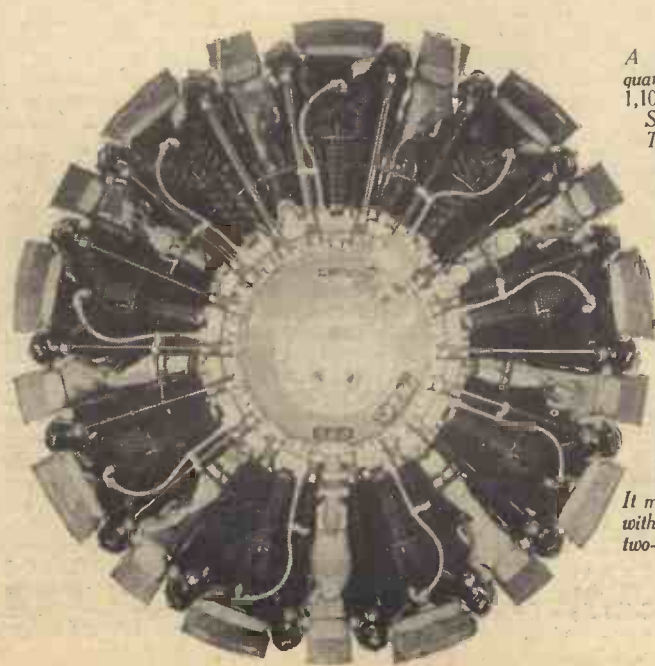
The first aeroplane to be exported powered with the new G-100 Cyclone engines was a Douglas DC-3 21-passenger transport destined for K.L.M. (Royal Dutch Airlines). This ship, the first of a new fleet of Douglases, to be powered with G-100 Cyclones, for K.L.M., will be used over the 9,000 mile airway between London, England, and Batavia in the Dutch East Indies. In addition to being the first 'plane to be exported with the new power plants, the K.L.M. Douglas is the first K.L.M. ship to be equipped with the new Curtiss Electric "Full Feathering" propeller.

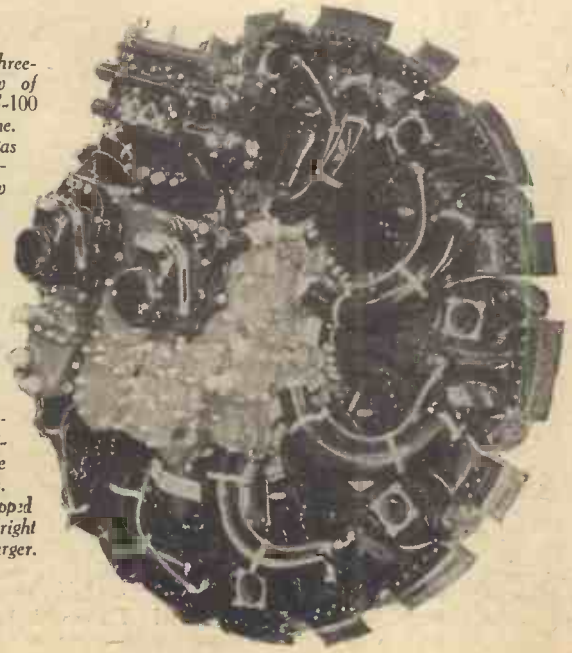
Among the most distinguishing features of the G-100 Cyclone are its 1100-h.p. take-off rating, the new Chandler Groves carburetter with which it is equipped, and its steel main crankcase section. These, coupled with other modifications, have not only increased power output and performance, but have resulted in a further reduction in fuel consumption.

Icing Effects

The steel crankcase of the G-100 Cyclone—the first steel crankcase to be employed in an American-built air-cooled radial engine manufactured on a production basis—was designed to allow for the increased horsepower resulting from refinement of the engine and at the same time provide an inherent capacity for an orderly increase in power. Although the steel crankcase has slightly increased the total weight of the engine, it has permitted an actual reduction of the specific weight by .04 pounds per horse-power.

The Chandler Groves carburetter fur-





A front and three-quarter rear view of 1,100 h.p. Wright G-100 Series Cyclone. This engine has as standard equipment the new Chandler-Groves carburetter, which automatically compensates for variations in operating altitude, eliminating the necessity for complicated mixture control devices. It may also be equipped with the new Wright two-speed supercharger.

nished as standard equipment with the G-100 Cyclone is not only impervious to the effects of icing, but also automatically compensates for variation in operating altitude without the use of complicated automatic mixture control devices. The design of the carburetter is such that the necessity for a large air preheater to prevent ice formation has been eliminated. The new carburetter is several pounds lighter than conventional types and extremely simple in construction. In combination with various other refinements in the G-100 Cyclone, the Chandler Groves carburetter has resulted in the retention of the low fuel consumption of a .43 pounds per horse-power hour at cruising speeds.

The Wright two-speed super-charger which is optional equipment on the G-100 Cyclone makes this power plant virtually "two engines in one." This device provides engines with which it is equipped with two distinct sets of performance characteristics. Careful attention to detailed design has enabled Wright engineers to produce a unit that increases the weight of the engine to which it is applied by only 10 pounds. This slight weight increase is more than offset by the increased performance obtained.

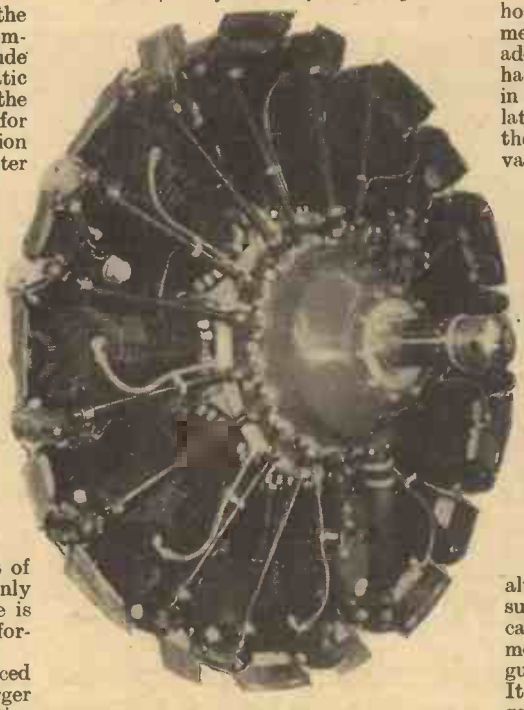
The two-engines-in-one effect is produced by provisions made in the supercharger driving gears to change the blower ratio; that is, the speed of the supercharger. During take-off under heavy load conditions or in flight near sea-level, the two-speed supercharger is fixed in the low blower ratio position which enables the pilot to obtain full take-off power. Up to a specified altitude the amount of supercharging made available by the low blower ratio provides maximum performance. After a certain height is reached, however, and power starts to fall off as the atmosphere becomes more rarefied, the engine may be switched into high blower to produce sea-level power at high altitudes. The shift from low blower to high blower is made by the simple manipulation of one control lever in the cockpit of the airplane.

Two-Speed Superchargers

The G-100 Cyclone, like previous Cyclone series, is a nine-cylinder, static radial, air-cooled engine of 1823 cubic inches displacement. It is furnished in two models, both with a 16 : 11 propeller speed reduction gearing which differ from each other only in their supercharger drive gear ratios. The first, the GR-1820-G102A, is rated at 1100 h.p. for take-off, with 900 h.p. available for normal operation from sea level to 6,000 feet. The second, the GR-1820-G103A, has a 1,000 h.p. for take-off rating, with 860 h.p. for normal operation from sea-level to 10,000 feet. Both models have been approved by the U.S. Department of Commerce and attain their rated powers with fuel of 90 octane rating.

Except for its steel crankcase, and improved spring-loaded air seal leathers on the inter-cylinder and cylinder head baffles, a casual inspection of an assembled Cyclone G-100 would not reveal many striking outward differences from the preceding G model. In reality, it is nearly an inch larger in diameter. This is to permit the use of a new type of forged aluminum alloy piston, ribbed on the underside of the head for strength and cooling and finned on the inner side walls, which has a longer skirt and uses three compression and three oil control rings. The cylinder barrel was lengthened slightly to allow for the longer piston.

A three-quarter front view of the new engine.



Efficiency

Greater volumetric efficiency of the engine has been provided by improvements in combustion chamber design and that of the intake and exhaust parts. This adds to the cooling characteristics of the Cyclone resulting from a total cooling surface on the engine equal to a flat area 17 feet long by 10 feet wide. This area has been "folded up" on an engine 55 inches in diameter by the advanced Wright foundry technique by which cylinder heads with fins 2 inches deep spaced 7/32 of an inch apart can be cast as a production operation.

Connecting rod refinements have kept pace with the development of higher horse-powers. In the G-100 Cyclone, a master rod with an "H" section rather than the earlier "I" section shank, together with improved knuckle pins allow a better equalisation of stresses between the link rods and the main crankpin bearing. All rods are hand finished with micrometric accuracy and polished to a mirror surface.

The crankshaft of the Wright G-100 Series Cyclone incorporating the dynamic damper counterweight which eliminates torsional vibration

As in previous Cyclone models, the main housing section is divided into six segments. The G-100 Cyclone, however, in addition to its steel two-piece crankcase, has a forged aluminum alloy nose section in place of the casting used on all but the later G models. This nose, which encloses the cam mechanism and incorporates the valve tappet guides, also provides for a constant speed propeller governor drive. The drive is so designed that it may be readily removed without the necessity of removing the nose section from the engine. Drilled oil passages in the forging supply the fully internal automatic valve gear lubrication featured in Wright engines. An oval nose drain provides improved scavenging.

The cast aluminum alloy mounting section, with strengthening mounting lugs for the more powerful engine, forms the front wall of the supercharger diffuser, and carries the tangential ports for the induction pipes leading to the cylinders.

Supercharger Section

The supercharger section, also of cast aluminum alloy, carries the vaned supercharger rear diffuser plate, the carburetter, the mounting pads for tachometer and fuel pump, right and left hand gun synchronisers, and the Cuno oil filter. It forms the housing for the accessory drive gears, the bearings of which are carried in an improved design of the cast magnesium accessory section. Raised starter and generator mounting pads both contain spherical oil seals at the drive outlets. Provision can be made for either a 3-jaw or a 12-jaw starter. A spur gear accessory drive, as a standard feature, furnishes power for various flight equipment or instruments.

Ignition System

The dual ignition system consists of two Scintilla magnetos operating two independent sets of spark plugs. These magnetos are provided with blast tube inlets allowing improved direct cooling of the interior of the housings. The entire ignition system is shielded to prevent radio interference.

The conventional Cyclone crankshaft, constructed of two chrome-nickel steel forgings with one bronze and one steel counterweight incorporates the steel weight, the exclusive Wright Dynamic Damper, which eliminates torsional vibration resulting from the power impulses, a condition which was present to some extent in all conventional radial aircraft engines before the original introduction of the Dynamic Damper in the F-50 Cyclones. This device, a distinctive feature of Wright aircraft engines, has been found to lengthen the life of both engine parts and components of controllable pitch propellers.

Special Features

Other features of the G-100 Cyclone are : nitrided cylinder barrels, introduced to the American aviation industry by the Wright Aeronautical Corporation, which are three times as hard as ordinary heat treated barrels ; improved drives for the constant speed propeller governor, and for the vacuum pumps which are used on modern aircraft to operate retractable landing-gear, the Sperry Gyropilot, and navigational instruments; and further development of the 11-inch supercharger impeller.

In addition to powering the new fleet of K.L.M. Douglas transports, the G-100 Cyclones will equip the new four-engined Boeing "Stratoliners" now being built at Seattle for Transcontinental & Western Air and Pan American Airways System.

HOW PLYWOOD IS MADE

The Reason why Plywood is Extensively Used by Craftsmen is because of its Great Strength in Relation to its Thickness and the Ease with which it can be Employed

Plywood in the process of manufacture.

PROBABLY no other material is used in the constructive manufactures, arts and crafts so extensively and with such variety of application as plywood, or plyboard.

Its uses are legion from door panels to complete wall panelling, from plain chair seats to most attractive radio cabinets. Similarly, in the constructive decoration work of ships' cabins and saloons, railway carriages and motor-cars, elaborate stage scenery or simple packing cases, plywood, or else simple veneer, is found almost everywhere.

The reasons for the popularity of plywood are chiefly two. Its great strength in relation to its thickness and weight compared with similar objects made from natural wood, and the ease with which it can be used or adapted by amateur craftsmen and skilled tradesmen alike. The great strength of plywood, and its freedom from warping, is due to the gluing, or cementing, of two or more layers of veneer wood together, each alternate layer being placed with its grain running across that of its neighbour. This "crossbanding," as it is called, also gives it a uniform strength in any longitudinal direction.

Remarkable Machines

The method of making plywood is not very generally known, and includes one or two remarkable machines.

Though most plywood—or at any rate the veneer sheet from which it is made—is produced abroad near to the forests where the timber is cut, and in the proximity of lakes and rivers for cheap transport of the logs, quite a lot of it is made in Britain. The most suitable woods are birch, (the best of all), alder, maple and pine.

The tree-trunks, as felled, are cut into suitable lengths corresponding to the width of the sheet to be produced, the diameter of the logs varying from 8 inches to 80 inches, according to the type of tree.

After cutting to length, the logs are barked, either by hand or in a barking machine, which removes all the bark and any projecting notches or knots, and leaves it in a more or less cylindrical shape ready for the veneer cutting machine, or "peeling" lathe. In some cases, depending on the nature of the wood used, the logs are steamed or boiled in a large concrete tank of hot water, which makes the wood more pliable for the peeling operation.

Veneer Cutting Machine

The log then goes into the veneer cutting machine. For some purposes, and when the log is unsuitable for continuous cutting, a machine with a straight shearing or guillotine action, and provided with a long straight knife, shaves off the wood in long narrow strips as in a gigantic plane.

The most wonderful machine, however, is the rotary cutting machine, the main principle of which is shown in Fig. 1, giving a part sectional view of a German machine. The log is placed in the machine, and rotated as in a lathe. Running the full length of the log is a steel cutting knife which removes the wood in a continuous long sheet of uniform thickness, which may be anything from 0.005 in. or 1/10th millimetre, up to about ½ in. thick, according to the kind of wood used and the product required. The knife is automatically fed towards the centre as the log diameter is reduced, and stops when it reaches about 4 in. to 6 in. diameter, when further cutting is not desirable.

As the sheet of wood is peeled off the log it can be wound up on a roller just like a roll of cloth or paper. In fact, the operation looks very much like unrolling a long sheet from one roller and winding it up again on another. The speed at which the wood is cut is remarkable, and in some cases reaches as much as over 300 ft. a minute. Instead of rolling up the sheet it is sometimes allowed to run over a long flat table.

Drying the Sheet

The next operation is to dry the sheet in drying chambers, where hot air is passed over the surfaces, the temperature and the moisture content being automatically controlled by thermostats.

After drying, the sheet is cut to the required sizes, graded and collected for cementing together. As ordinary fish, animal or vegetable glues are more or less

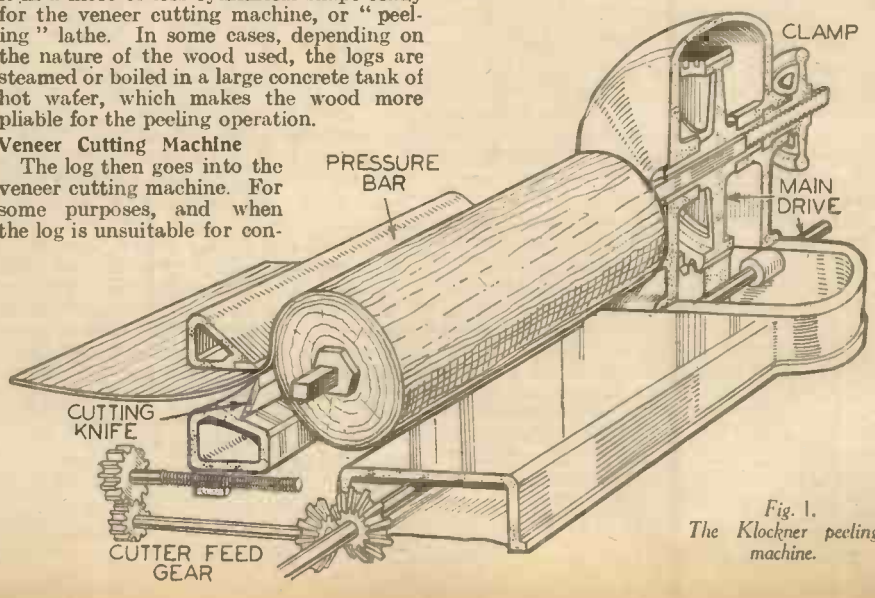


Fig. 1. The Klockner peeling machine.

affected by climatic conditions—especially moisture—the separate layers of veneer are bonded together by a cement composed of casein or albumen, or preferably a combination of both.

When the inner surfaces have been coated with cement the whole combination is placed in a powerful hydraulic press, consisting of a series of steam-heated platens, and subjected to great pressure for about three minutes, or more, according to the thickness of the board being made. In some cases, cold presses are used, but the resulting plywood is inferior to the hot presses.

After removal from the press, and cooling again, the plyboard is cut and trimmed to the correct finished sizes and shape. If a fine finish on the surface is required, the boards are then passed through a sanding machine, or a scraping machine. The former consists of a series of sandpaper covered rollers which revolve at a high speed over the surface of the board as it is fed through between the rollers and the machine table. A final drying and conditioning of the boards then completes the process.

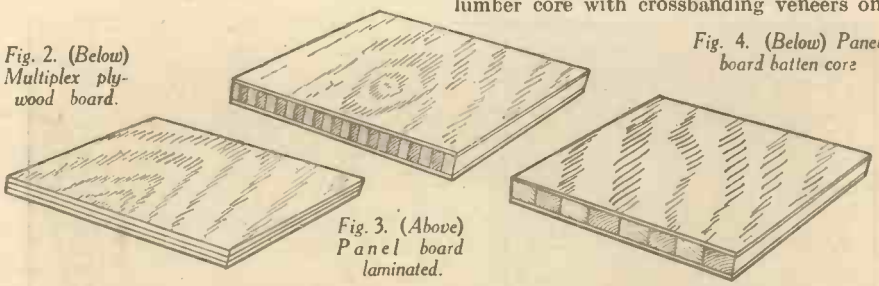


Fig. 2. (Below) Multiplex plywood board.

Fig. 3. (Above) Panel board laminated.

Fig. 4. (Below) Panel board batten core

Multiplex Plywood

Ordinary multiplex plywood boards range from, say, 1/16th in. to about 3/8th in. thick, in from 3 to 5 plys.

For thicker constructions, plywood panel boards are built up of a specially constructed lumber core with crossbanding veneers on both sides; or with a core of laminated thick veneer strips, or of sawn battens, all glued or cemented together, as shown in the Figs. 3 and 4. This enables much thicker boards to be used where wanted.

Hardening and Tempering

USEFUL HINTS FOR THE HANDYMAN

STEEL, from the point of view of the subject under consideration, may be divided into two broad classes, namely, those which will respond to a treatment consisting of heating and quenching followed in some cases by tempering, and those that require the addition of further carbon before the quenching can produce the desired result.

The Effect of Heat Treatment

Heat treatment may be necessary to restore the material to its normal condition after working at a high temperature, or in the case of certain alloy steels like nickel, nickel-chrome, and chrome-vanadium, a hardening and tempering process is carried out, after which the steel, although hardened, is still in a machinable condition. Such steel, unless required for forging, is usually supplied in a hardened and tempered condition. Steels of this description are, after treatment, relatively harder than a normalised sample, but the object in this instance is to produce in the steel the maximum mechanical properties, excluding a glass-hard surface. Where this latter property is required in addition, a case hardening nickel or nickel chrome steel is employed.

Hardening Methods

The effect of heating a piece of steel to its hardening or critical temperature is the cause of change in the micro-structure of the material. If allowed to cool slowly the structure reverts to its normal condition, but if arrested at that point by rapid cooling it becomes hardened. The temperature and degree of hardness vary with the carbon content (which is the hardening agent) of the steel. The higher the percentage of carbon present the lower is the hardening temperature, thus a cast tool steel containing 1.4 per cent. carbon will harden at a lower temperature than one having 0.5 per cent. Incidentally, both steels are used for different classes of work, and whilst the former will produce the glass hardness requisite for machine cutting tools, the lower grade is intended for such services as providing a comparatively thick, hard surface, or end, on a low-carbon steel when the two are welded together and subsequently hardened.

The means used to bring the material to the desired temperature before quenching may consist of an open fire, torch, muffle furnace, or other device specially constructed for the work. While an open fire may be suitable for hardening such articles as cold chisels, good results are not likely to follow from a general adoption of this practice.

The first essential of good hardening practice is to secure uniformity of temperature, and where a flame is impinging directly on to the work the attainment of such a condition is impossible. This is particularly so where the mass of the steel being hardened is unevenly distributed, as, for instance, in a screwing tap. Such a part is bound to receive most heat at the thinnest points, namely the threads, when the resultant hardening would be unsatisfactory. Another important point is the prevention of scale formation appearing on the work during heating. This is almost impossible where the work is open to the atmosphere during the process. Further to this, some means of temperature control is necessary, meaning that some form of chamber is required in which the heating of the part can be carried out to ensure that uniformity of hardening may be repeatedly attained with assurance.

Muffle Furnaces

Suitable furnaces may be heated by gas, oil or electricity. Briefly, they consist of a firebrick-lined chamber fitted with a door to permit the entry and removal of work, the interior of which is capable, by regulation of the heating medium, of being maintained at the desired temperature for the requisite period.

Certain forms of this class of furnace for the hardening of large quantities of small articles are arranged for continuous operation, the parts being fed on to a moving chain grating travelling at such a speed through the heated chamber that they are ready for quenching when they have passed through. On emerging from the furnace the parts fall off the end of the grating directly into the cooling bath.

Hardening Baths

Another method is to immerse the parts to be hardened in a bath of molden lead or metallic salts which is maintained at the desired hardening temperature. This method is particularly suited for the hardening of slender or intricate parts in the nature of taps, dies, and light parts. The advantage of this method is that no portion of the work can reach a temperature other than that of the bath, and therefore absolute uniformity of heating results.

Indication of Temperature

The use of a pyrometer is a necessity where hardening is an operation that is regularly carried out. Most common of these is the thermo-electric type, in which the action of the heat on the thermo-couple, housed in a tube inside the muffle or in the bath, creates a current which is registered on a meter calibrated in degrees Fahrenheit or Centigrade. Other forms are the resistance and optical type pyrometers.

Another method that can be employed where the amount of hardening does not warrant the adoption of more expensive but nevertheless reliable apparatus, is the Sentinel cone. These cones are composed of mineral salts or substances which are placed in the hardening chamber. The cones are graded by means of numbers, indicating the temperature at which they melt. Thus a cone is selected which will melt when the interior of the furnace reaches the desired temperature. When such are employed the directions for use should be carefully studied.

Judging Temperatures by Colour

The judgment of high temperatures by colour can be, by skilled persons, estimated with fairly close approximation. However, the conditions of lighting under which the viewing takes place cannot be constant, and therefore may be considered unreliable, depending as it does so much upon the skill of the operator. As an aid to such judgment a colour chart ranging from dull red (515 degrees C.) to white (1,320 degrees C.) is sometimes included in a steel manufacturer's list. A chart of this description is certainly handy, and it is intended to be used in daylight, but it naturally follows that on a dull day the colour of the heated metal may appear brighter than is really the case for purposes of comparison.

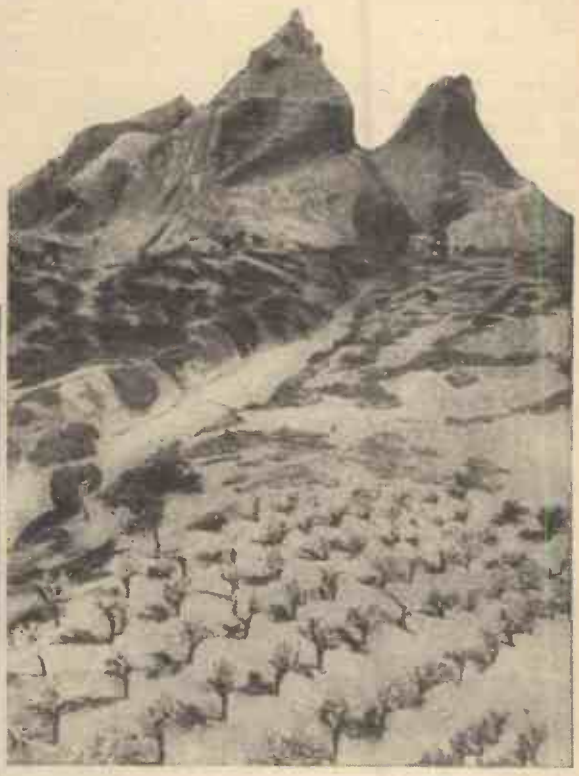
Lower temperatures are more easily judged where the steel is polished by the colour of the oxide film which appears on the heated surface. The colour ranges from pale straw (220 degrees C.) to dark blue (316 degrees C.). Here again temperature charts are available for comparison. In both cases, however, the colours are dependent on the colour printing and should be taken as a guide only, experience being gained in the light of the results obtained.

(To be continued)

MODELS SEEN AT GLASGOW

By W. J. Bassett Lowke, M.I.Loco.E.

A Panorama 40 ft. x 20 ft. of Africa from Johannesburg to Cape Town, a Model of H.M.S. Hood and a Giant Hammerhead Crane are a few of the many Outstanding Models on View at the Glasgow Exhibition.



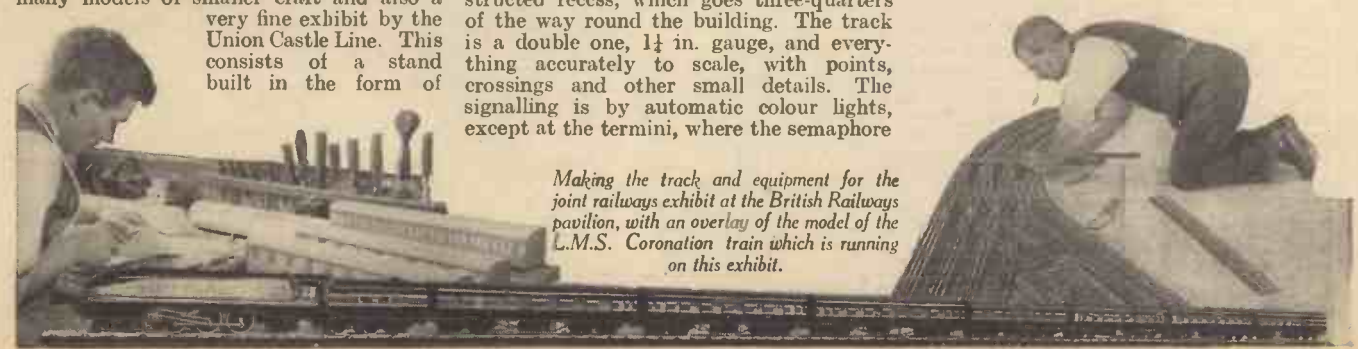
(Left) A scenic model of a South African beach with its dead white sand, palm trees and attractive natural surroundings. (Above) A mountain scene, with a South African fruit farm in the foreground

TWICE since May I have paid flying visits to the British Empire Exhibition at Bellahouston Park, and though I cannot claim to have seen the half of this immense Scottish enterprise (to view it thoroughly would take the best part of a week), I took a more than passing interest in the models on show at the various pavilions I toured.

The ingenuity of many of the working models is quite amazing. In the Travel and Transport Pavilion is a marvellous model of the Port of Liverpool. The "Old Dock," first to be opened in the port, dates back to 1715. The working model is of the Gladstone Dock portion, which, completed in July, 1927, and opened by His late Majesty King George V, is equipped with all the latest mechanical and electrical equipment. The working of this model is quite fascinating. The ships are worked in real water by electro-magnetic control in and out the dock system. In this building also there is a model of the famous Cunard White Star liner *Aquitania*, the only four-funnel ship left in the British service, many models of smaller craft and also a very fine exhibit by the Union Castle Line. This consists of a stand built in the form of ships' plating, a ¼ in. to the foot model of the *Capetown Castle*, their latest motor ship, and in the centre of the stand a model promenade deck of one of their modern motor ships showing the lounge and other public rooms. I was very taken with a model on the other end of the stand. It was of the side of the ship painted on wood in which you could open doors and see inside various cabins fully modelled with their furniture, beds, etc., automatically lighting up as the door was opened.

Realistic Model Railway

It has been said of the Joint Railways exhibit that it is the most compact and comprehensive model railway ever constructed. That may or may not be so, but certainly it is one of the most realistic I have seen for some years. Entering the left-hand side of the British Railways Pavilion—a modern design by Joseph Emberton, F.R.I.B.A.—the model railway confronts you in the form of a panorama on a raised platform in a specially constructed recess, which goes three-quarters of the way round the building. The track is a double one, 1¼ in. gauge, and everything accurately to scale, with points, crossings and other small details. The signalling is by automatic colour lights, except at the termini, where the semaphore type is used. The trains are the L.M.S. "Coronation Scot," the L.N.E.R. "Coronation," the G.W.R. Cornish Riviera Express and the S.R. electric "Southern Belle," and they pass through a background of scenery which is an attempt to present in one continuous tableau some of the beauty spots and holiday centres in England, Scotland and Wales. The arrangement has been most successful, and displays of these "crack" British trains running in such realistic surroundings are given at intervals stated on a clock indicator. The whole of the railway is controlled from one end, and its operation can be seen from both outside and inside the pavilion. Obviously, the operator cannot see the trains throughout their run, but he knows their exact position from the model electric train indicator. A microphone is installed to make announcements regarding the railway, and I was told by the operator in charge, Mr. G. L. Lake (son of Mr. Charles Lake, M.I.Mech.E., M.I.Loco.E., the well-known writer on railway practice and performance), that the average run of each

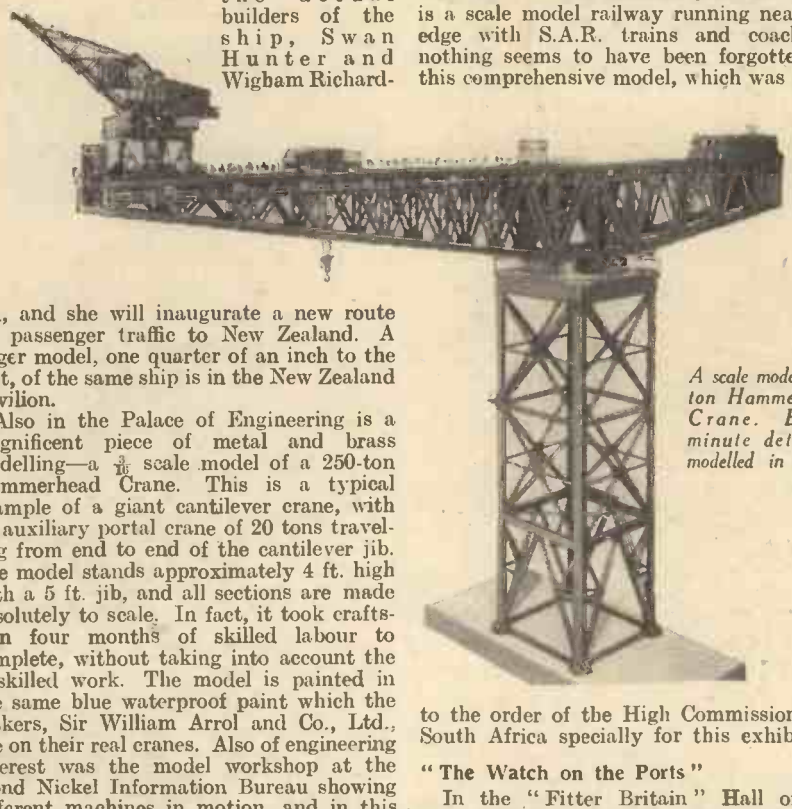


Making the track and equipment for the joint railways exhibit at the British Railways pavilion, with an overlay of the model of the L.M.S. Coronation train which is running on this exhibit.

train per week is fifty actual miles, representing 2,500 scale miles! Quite an innovation is shown by a "night effect" scene, with each train automatically lighting up as it passes by.

Engineering Models

The Palace of Engineering is full of interesting engineering models. Those of ships include the ⅛-inch glass-case model of the new Shaw Savill passenger liner, *Dominion Monarch*, due to make her maiden voyage in February, 1939. This model is on the stand of the actual builders of the ship, Swan Hunter and Wigham Richardson, and she will inaugurate a new route for passenger traffic to New Zealand. A larger model, one quarter of an inch to the foot, of the same ship is in the New Zealand Pavilion.



A scale model 250-ton Hammerhead Crane. Every minute detail is modelled in metal.

Also in the Palace of Engineering is a magnificent piece of metal and brass modelling—a $\frac{3}{16}$ scale model of a 250-ton Hammerhead Crane. This is a typical example of a giant cantilever crane, with an auxiliary portal crane of 20 tons travelling from end to end of the cantilever jib. The model stands approximately 4 ft. high with a 5 ft. jib, and all sections are made absolutely to scale. In fact, it took craftsmen four months of skilled labour to complete, without taking into account the unskilled work. The model is painted in the same blue waterproof paint which the makers, Sir William Arrol and Co., Ltd., use on their real cranes. Also of engineering interest was the model workshop at the Mond Nickel Information Bureau showing different machines in motion, and in this same building is a magnificent model of H.M.S. *Hood* close alongside a model of the new Cunard White Star liner *Queen Elizabeth*.

"Mount Neverest"

Quite a number of ships were to be seen in model form—some in the Shipbuilding Hall of the United Kingdom Government Pavilion, others in the various Dominion pavilions. An ingenious diagrammatic model entitled "Mount Neverest" demonstrated the progress of steamship propulsion, with fascinating little flags and dates on a miniature mountain.

Among scenic models no one could omit the most prominent exhibit in the South African Pavilion—a panorama 40 ft. by 20 ft. of typical Africa from Johannesburg to Cape Town. The model transports you from the white sandy bathing beaches of Natal to a Johannesburg gold mine, an ostrich farm in the Transvaal, a native village of kraals in Cape Province, or a game reserve like the Kruger National Park. The model is made to a scale of ½ in. to the foot around the edge, diminishing towards the centre where mountains tower, reminiscent of the Drakensburgs. The detail work in this model, I found, was very good. All the typical African plants had been carefully designed to scale—the banana, the paw paw trees, pineapple, tobacco plants and orange groves—all could be quickly recognised by experts. And the blossoming trees and plants peculiar to Africa, the blue jacaranda and scarlet flambuoyant—the orange kaffir bloom—were modelled with remarkable realism. The figures of settlers and natives of all sizes and in all postures were, I discovered, carved by experts, and in the game reserve the springboks, lions, rhinoceroses, giraffes were looking most lifelike, with the hippopotomi disporting themselves in the mountain river. The model had to be specially stressed under the three river beds so that the model makers might walk on it to add the final touches. There is a scale model railway running near the edge with S.A.R. trains and coaches—nothing seems to have been forgotten on this comprehensive model, which was made to the order of the High Commissioner of South Africa specially for this exhibition.

"The Watch on the Ports"

In the "Fitter Britain" Hall of the United Kingdom Pavilion is a small but rather intriguing model entitled "The Watch on the Ports." This is exhibited by the Ministry of Health and demonstrates port health work by means of a model ship which traverses a river estuary stopping at certain positions, when a sentence is automatically lit up on the back display, telling you what is taking place.

Last but not least on my tour I visited the Coal Hall of the United Kingdom Pavilion and mingled with the large and cheerful crowd examining the Model Coal Mine, exhibited by the Mining Association of Great Britain. This model gives a general idea of the layout and workings of a completely electrified modern colliery, employing 1,500 men and producing 2,500 tons of coal per day.

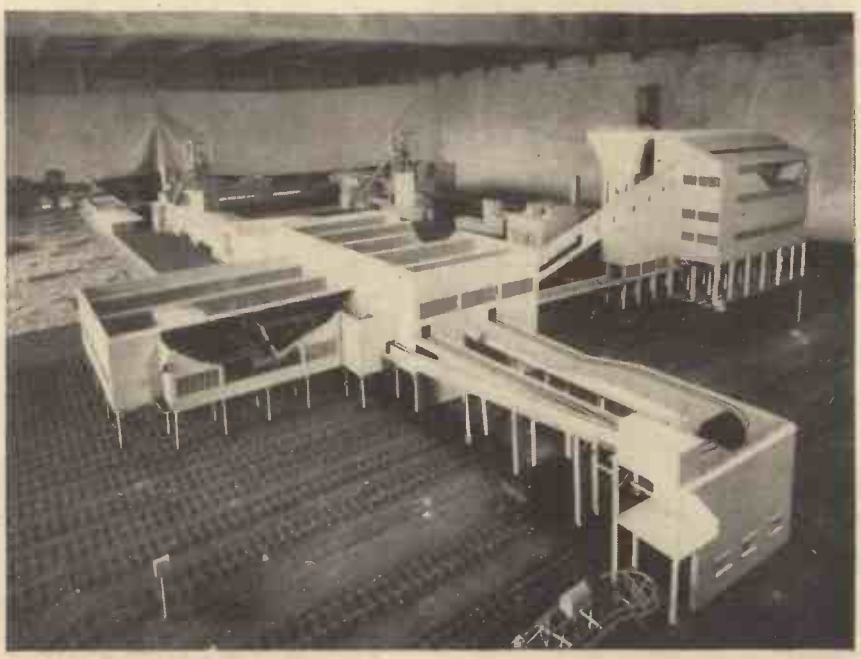
Modern Colliery Layout

It is like a rectangle in shape, 19 ft. long by 11 ft. wide by 15 ft. high, and represented a block of earth 700 ft. deep, with insets round the sides giving sectional views of the mine workings. Mounting the steps to the gallery above, you look at the top surface area, a modern colliery layout with industrial buildings, pit headgears, offices and gardens—and certainly quite a pleasant place, not dull and unattractive as the general conception of mining colliery is.

The wall insets show a conveyor face, board and pillar workings, a long wall face, the mothergate—or main—belt, the haulage rod and haulage engine, the underground pony stables, electrical sub-station, pumps, and the coal-drawing shaft, and in a very short space the onlooker can gain a valuable insight into the workings of a modern mine.

Other interesting models worth inspecting are the six-wheeled cross-country tractor, which is constructed down to the minutest technical detail, and the model of the Victoria Falls in the Southern Rhodesian Pavilion.

To the student of modern progress in electricity, engineering, mechanics and chemistry this exhibition is instructive and profoundly interesting, and its outstanding feature is the United Kingdom Government Pavilion, the "summit" of a well-planned and enterprising exhibition.



A surface view of a model coal mine. All the buildings are lit up at night, giving a very realistic and busy appearance to the model.

MODEL AERO TOPICS

Two enthusiasts winding up their model during a competition held at Fairey's Aerodrome.

CURRENT NEWS FROM THE WORLD OF MODEL AVIATION

BY F. J. C.

Northern Heights Gala Day

I ATTENDED the Northern Heights Model Flying Club Sixth Annual Gala Day at Fairey's Great West Aerodrome. The meeting was well organised, well attended and notwithstanding a brisk wind there was a continuous exhibition of model flying. It does great credit to the organisers and to Mr. C. R. Rippon. Apart from the various contests, the results of which I give later, there were many non-contestants' flying models to add to the entertainment of the visitors. There can be no doubt that this gala day will be a regular annual event. I cannot help comparing this gala day with pre-War meetings of a similar character organised by the Kite and Model Aeroplane Association. It is true that these pre-War meetings were well attended for flying was then new, but the models did not, of course, fly anything like so well as they do now, even when they did fly.

Now, I think it is within the province of the S.M.A.E. to organise its own annual gala day in just the same way as the Royal Aeronautical Society does. After all, the National Body has a duty to foster the social side on a national basis, and if one constituent club can organise so successful a meeting as the Northern Heights Gala Day, the S.M.A.E. ought to be able to do something even better than that.

Insurance of Petrol Models

IN the June issue I referred to the third party insurance policy for petrol-driven models issued by Mr. Dudley Ship of National Provincial Bank Chambers, 44 Holdenhurst Road, Bournemouth. This paragraph did not make the point quite clear, which was that another policy which has been designed specially for S.M.A.E. clubs differed from Mr. Dudley Ship's policy in that his is open to all members of the public who may fly power-driven model aircraft.

Bassett-Lowke to Stock Model Petrol Engines and Kits

MR. W. J. BASSETT-LOWKE tells me that he is now listing model petrol engines for model aeroplanes, and his present range, which may shortly be enlarged to include other makes, comprises the Spitfire, the Brown Junior and the Ohlsson. He is also supplying kits of parts for petrol-operated model aeroplanes, as well as engine parts such as coils, condensers, propellers, engine mountings, etc. These may be inspected at his London Depot, High Holborn.

Unusual Fuselage Construction

MR. J. F. DUNWORTH, of Huddersfield, sends me the photograph which I reproduce herewith of a skeleton fuselage which he has made from $\frac{1}{16}$ in. square balsa sticks and $\frac{1}{32}$ in. thick sections of "Tufnol" (a laminated resin) tube. It weighs just under $\frac{1}{4}$ ounce. The length is $14\frac{3}{4}$ in. and internal dia. 1 in. He says: "These dimensions could be considerably increased but the principles of construction will, I think, be clear from the photograph. A cigar-shaped body could be constructed with equal ease, but it would be more difficult to cover and at model speeds I contend that streamlining is almost useless.

"The design, so far as I know, is novel, and I think the ratio of all-round strength to weight must be near a maximum—which is, after all, what we are aiming at. Eight balsa sticks are employed, four being twisted throughout their length in one direction round the fuselage, and four in the opposite direction. There are no longerons in the usual sense of the word. The structure has absolute torsional rigidity in either direction, independent of any covering, and thus combines the strength of the monocoque with the lightness of the four-sided braced structure. Stress is evenly distributed and the entirely triangulated construction is sound engineering practice. Though the sticks in this particular case enclose a parallel-sided tube, they are in effect subject to a convex bend, as are the longerons in the more orthodox streamlined model."

Our £20 Model Hawker Hurricane Contest

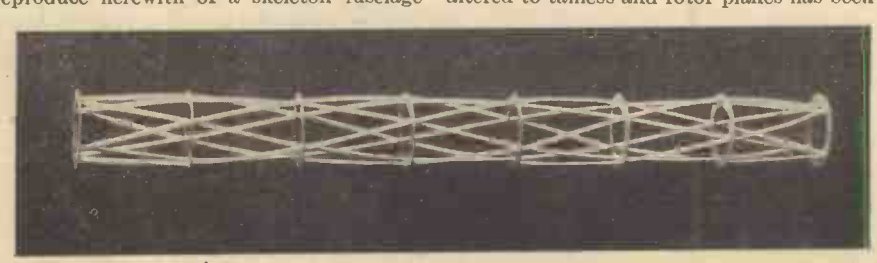
WILL competitors please note that this contest will be held at Brooklands Aerodrome, Weybridge (Byfleet entrance), at 3 p.m. on Saturday, August 6th. Owing to the large entry, it is particularly important that competitors should be ready at the appointed time. Every competitor has received the rules and details.

Hallam Engines

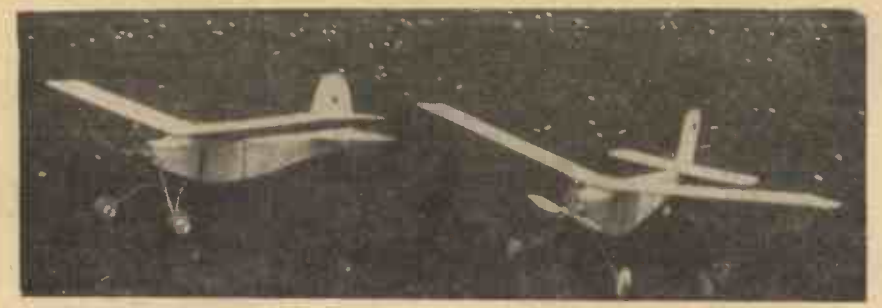
MR. J. F. HALLAM, of Upton, Poole, Dorset, has sent me the photograph (reproduced) of a model fitted with his 1 c.c. engine. He tells me that his experience has been that flight with a 1 c.c. engine has been quite possible provided that the model is kept very light and the weight under 1 lb. He has had successful flights off cement or macadam, but not off grass. He promises to send me details of his 10 c.c. engine very shortly.

S.M.A.E. Notes

A SUGGESTION that the terms "Pterodactyl" and "Autogiro" should be altered to tailless and rotor planes has been



This novel method of fuselage construction combines the strength of the monocoque with the lightness of the four-sided braced structure. It has been designed by Mr. J. F. Dunworth.



Models fitted with a 1 c.c. engine and 2.5 c.c. engine respectively which have made a number of successful flights off cement and macadam. They were made by Mr. J. F. Hallam.

agreed to. The following claims to British records were then passed :—

Howard Boys, hand-launched tailless, 2 m. 7.75 s.

H. W. Bexley, R.O.G. Fuselage, 13 m. 23.5 s.

A. H. Lee, Biplane-Seaplane, 6 m. 54 s.

R.O. Open Water.

Norman Lees, Seaplane R.O. Open Water, 3 m. 7.1 s.

W. Worden, Seaplane R.O. Tank, 3 m. 42 s.

A. Tindall, Seaplane R.O. Tank, 4 m. 13 s.

J. Wright, Seaplane R.O. Open Water, 5 m. 22.7 s.

A. H. Lee, Seaplane R.O. Open Water, 6 m. 54 s.

G. Suggett, Flying Boat R.O. Open Water, 9.8 secs.

Mr. Lee's model was given both the Biplane and Seaplane records with the same flight.

* * *

Owing to bad weather, the speed contest which was to have been held at Hurlingham Polo Ground was postponed and, with the Council's sanction, will be held on Sept. 25th.

* * *

The Council agrees that there have been too many rallies during the season. These are often held on the same day, and in the same part of the country.

* * *

Will petrol enthusiasts please note that the special registration form for these models has been prepared and may be obtained from Mr. J. C. Smith on receipt of a stamped addressed envelope. It must be noted that those persons under eighteen must have their registration forms countersigned by a parent or guardian and that in all cases the insurance policy must be sent in with the completed form, together with the two shillings registration fee. The transfers supplied by the S.M.A.E. must be affixed to the model.

* * *

Results of the Weston Cup, June 12th, 1938 :—

	Aver. of 3 secs.	Plugge Cup pts.
1. R. Copland (Northern Heights)	659.26	81
2. J. Hall (Northern Heights)	351.4	80
3. C. Gibson (North Kent)	179.6	79
4. H. Jones (Dartford) ...	175.00	78
5. L. Stott (Halifax)	171.2	77
6. R. S. Gabreath (Blackheath)	137.816	76

Results of the Women's Challenge Cup Competition :—

1, Mrs. Cosh, 81.1 s.
2, Mrs. Tindall, 53.0 s.
3, Mrs. Rushbrooke, 48.416 s.
4, Mrs. Clifford, City M.F.C. (Birmingham), 44.46 s.
5, Miss E. Wickens, 42.9 s.
6, Mrs. Bailey, 36.0 s.

The Bournemouth Model Aircraft Society Gala Day

THE Bournemouth Gala Day was held at the R.A.F. Aerodrome, Gosport, in June. It was well attended and although there was a fairly high wind some excellent flights were made. Aero modellists from Lee-on-Solent, Woking, Weybridge, Bath and Manchester, as well as a goodly number of unattached fliers, were present. A number of competitions were run off. Mr. H. Bagley of the Gosport Club won the time flight contest for the nearest to 30 secs. The second contest for duration was won by Mr. J. W. Kenworthy. The Southern Counties competition was won by Mr. G. Penhall, and the competition for petrol models by Mr. A. Brooks. The time flight contest for petrol models was won by Mr. Guy Rickard.

Northern Heights Competition Result

Popular Contests.—1st, Mr. Manning, 44.5s.; 2nd, Mrs. Houlberg, 44 s.

Lightweight.—1st, Mr. Tomes, 123.76 s., Best Flight, 237.2 s.; 2nd, Mr. H. Smith, 104.8 s.; 3rd, Mr. R. J. O'Neill, 100.93 s.

Heavyweight.—1st, Mr. J.W. Hall, 119.66 s.; 2nd, Mr. R. MacKenzie, 109.06 s.; 3rd, Mr. W. Worden, 103.16 s., Best Flight, 309.6 s., out of sight.

Concours.—Section A.—1st, Mr. Sharvell, Biplane; 2nd, Mr. E. Ross, H.W. Vega Type; 3rd, Mr. J. S. Wreford, H.W. Cabin Mono. Section B.—1st, Mr. E. W. Evans, Shoulder Wing Mono; 2nd, Mr. J. Rees, Gull Wing Glider; 3rd, Mr. F. Dewell, 6 ft. Sailplane. Section C.—1st, Mr. H. F. Towner, Phoenix; 2nd, Mr. L. Hastings, Hawker Fury; 3rd, Mr. P. Dare, Mills Falcon. Section D.—1st, Mr. E. W. Evans, Wakefield Spec. Geodetic; 2nd, Mr. H. E. White, Co-axial props. Racer; 3rd, Mr. J. W. Hall, Farman Pusher.

Seaplane Duration.—1st, Mr. R. Brown, 80.9 s., Best Flight, 132 s.; 2nd, Mr. R. W. MacKenzie, 61.2 s.; 3rd, Mr. R. Copland, 56.06 s.

Inter-Club. Six Teams entered.—1st, N.H.M.F.C., Mr. Hall, Mr. Copland, 297.5 s.; 2nd, Park Model Air League, Mr. Beckett, Mr. Hetzell, 186.9 s.; 3rd, Barnes and District M.F.C., Mr. Blackman, Mr. W. Comber, 136.15 s.

Coronation Cup.—(Postponed through bad weather. High wind.)

Pusher.—1st, Mr. J. W. Hall, 93.6 points; 2nd, Mr. R. T. Parham, 78.5 points.

N.H. Women's Challenge Cup.—1st, Mrs. Rees, 17.8 s. av.

Flying Scale.—1st, Mr. S. R. Crow, Leopard Moth, 60.5 s.; 2nd, Mr. Gillett, Leopard Moth, 47.65 s.

Aeromodeller Trophy. Mr. J. W. Hall, N.H.M.F.C. — 1st, Heavyweight; 1st, Pusher; 1st, Inter Club Team; 3rd, Concours, Section D.

Ladies' Best Performance.—Mrs. Worley, 94s.

The " Sturdy "

THE manufacturers of the Skybird solid scale models have for some time past been asked to produce a flying model. After consideration of the various types now on the market, it was decided to introduce a model of sturdy and simple construction, and at the same time one that would give a good performance in almost any weather conditions.

After three months of experimental work, the Skybird " Sturdy " Flying Model No. 1 has now been produced, and a very big demand is expected for this first Skybird Flying Model. The complete kit is good value at 6s. 6d.

The " Sturdy " has a parasol wing, span 30 in., and a diamond shape fuselage, giving a greater aerodynamical efficiency, length 21½ in., with an approximate total weight of two ounces.

Results of the Wakefield Elimination Trials

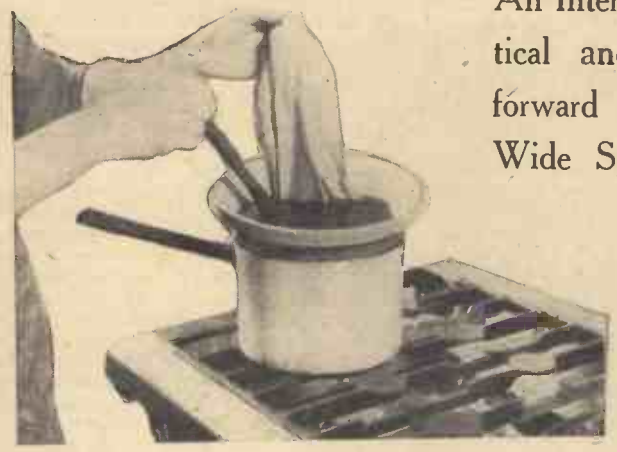
In the Elimination Trials for the Wakefield Cup, held at Fairey's Aerodrome on July 3rd, there were no less than 224 entries of which 159 flew, whilst 65 for one reason or another figure amongst the also-rans. These trials were held under difficult weather conditions, but they produced some very good flights, one of the most consistent fliers being the model flown by R. N. Bullock, of the Blackheath Club, who was second. The average time of his three flights was almost 4 m., the three flights varying by less than half a minute. His model was of the usual balsa and tissue streamlined type to Wakefield specification —span, 48 in.; mean chord, 4.3 in.; weight, 8.5 oz.; speed, 16.5 miles per hour; climb 300 ft. per minute; motor run, 125 s.; 18-in. propeller; glide, 1 in 12. I show a photograph of Mr. Bullock's model below. Appended are the times for the first ten.

Name	*Club*	*Secs.*
1. E. Chasteneuf	Blackheath	247.583
2. R. N. Bullock	Blackheath	231.2
3. F. E. J. Almond	North Kent	190.66
4. R. Smith	North Kent	184.0
5. H. White	Luton	178.76
6. L. Stott	Halifax	167.6
7. R. Copland	Northern Heights	164.6
8. J. Morris	Edgware	154.46
9. J. I. Faulkner	Blackheath	142.6
10. E. W. Evans	Luton	141.56

Mr. Bullock's Wakefield model which came 2nd in the Wakefield Elimination trials. Mr. Bullock is associated with the Warneford Model Co.

PHOTOGRAPHS ON CLOTH

An Interesting, Practical and Straightforward Photographic process which, in view of its Wide Sphere of Application, will Commend Itself to the Amateur.



(Left) The process of dyeing the cloth described below. (Below) A silhouette cut from black paper and pasted on to a sheet of glass forms an excellent positive for outline printing. (Right) A permanent print of the silhouette positive on cloth.

THIS more than usually interesting photographic process enables photographs to be obtained on a variety of fabrics, the photographs bearing a surprising amount of minute detail, provided, of course, that the texture of the cloth is sufficiently fine for the purpose.

Furthermore, although we have styled the process a photographic one, which, strictly speaking, it certainly is, it can, nevertheless, be worked in a limited manner without the aid of any camera, plate or film. The process, too, is a cheap one and it gives results which, at the least, are equally as permanent as those derived by means of ordinary photographic printing processes.

The process is based on the fact that when the dyestuff, primuline, is treated with nitrous acid, it forms a compound which is highly light-sensitive, and it is this latter compound which is utilised for printing purposes.

Peculiar Process

The process is perhaps peculiar in that a *positive* and not an ordinary negative must be used for printing, for if a negative were printed from it would yield not a positive print as it does in ordinary photographic printing, but a negative one. Hence, it is necessary to prepare a glass positive from each negative which is to be printed on cloth. This, of course, is very easily carried out by printing the negative on to a slow " process " or lantern-slide plate.

If, however, the amateur is content to print mere outlines, silhouettes, figures and lettering on his prepared cloth, the preparation of the photographic negative and positive above referred to can be eliminated completely. All, in this instance, that the amateur will require are the outlines of silhouettes of his objects cut out in black paper and pasted down firmly on a sheet of glass. Highly successful results will be obtained by this simple method, so far as the printing of outline figures, lettering and so forth is concerned and there is no doubt that many attractive applications of the method can be devised by the interested amateur.

White cotton cloth of fine texture is the best material for printing on, the correct fineness of weave of the cloth being about that of an ordinary handkerchief.

The Dyebath

Make up a dyebath containing about 3 grams of primuline (which is a primrose-yellow dyestuff) to every 150 ccs of water and to this quantity of dye liquor add approximately 5 grams of common salt or Glauber's salt in order to make the cloth " take " the dye with perfect evenness.

Have the dye liquor in a basin standing in a saucepan of water. Immerse the cloth in the dye liquor (the latter being cold), gradually heat the water in the saucepan up to boiling point, keeping the cloth on the move all the time.

It should take about a quarter of an hour for the water to arrive at boiling point and this temperature having been reached, the water should be allowed to continue gently boiling for a further five minutes.

The cloth will now be fully dyed a lemon-yellow colour. It should be removed from the dyebath, thoroughly well rinsed, dried and stored for further treatment.

In order to convert the primuline-dyed cloth into its light-sensitive condition, it must be immersed in the following bath for about one minute :

Sodium nitrite (*not* nitrate) ...	3 grams
Strong hydrochloric acid ...	7 ccs.
Cold water	500 ccs.

This process must be carried out in artificial light to which the treated cloth is not sensitive.

" Diazonium " Compound

The hydrochloric acid in the above bath acts upon the sodium nitrite, liberating free nitrous acid. This interacts with the primuline in the fibres of the cloth, converting it into what is known as its " diazo " or " diazonium " compound, which is light-sensitive. The formation of the diazo compound of primuline on the cloth will be immediately apparent, the cloth turning an orange shade of yellow.

After the primuline-dyed cloth has been " diazotised " in the above manner, it should be wrung out (not rinsed) and immediately ironed flat and dry with a warm (but not too hot) iron. Be careful, of course, to iron all the creases out of the cloth, for these would interfere greatly with the clarity and definition of the finished print.

Provided that the " diazotised " cloth is stored away in a dark, dry place, it will keep for a few days. It is always advisable, however, to use the cloth for printing as soon as possible after it has been prepared, since the " diazo " compound of primuline, like all diazo compounds, is unstable and slowly decomposes.

For the printing of the cloth we require, as already noted, not a negative, but a positive. Furthermore, this positive must be a very contrasty one. A thin positive, lantern slide or transparency will give a very unsatisfactory result When making the necessary positive, therefore, aim always at getting a heavy, contrasty image. This will give excellent detail when printed on the cloth.

An Inverted Picture

In passing, it may be pointed out that the finished picture on the cloth will be " laterally inverted." That is to say, the left side of the original photographed subject will appear on the right side of the cloth, and vice versa. For very many purposes, portraiture included, this lateral inversion of the printed picture is quite immaterial. If, however, it is necessary that the inver-

sion should not take place, the positive must be made on a film and the latter printed with its emulsion side facing the light.

Alternatively, as we have previously remarked, letters, figures, silhouettes, etc., may be cut out in black paper, pasted down on to a glass sheet and this "artificially made positive" utilised for printing. Indeed, it is a good plan to start printing with an improvised positive of this description, since the procedure will serve to acquaint the beginner with the working characteristics of the process.

In printing the positive is laid down in a printing frame, emulsion side upwards, and the diazotised cloth is placed in contact with it. With direct sunlight, printing takes about 4-5 minutes, and, of course, proportionately more in the absence of sunlight.

After the cloth has been printed, a faint image will be seen on it. The fabric is thereafter developed by immersion in a weak solution of caustic soda containing one of a number of developing agents, each of which will produce a picture of a different colour.

Some of the best of these developing agents are listed below :

Beta-naphthol produces a bright red print;
meta - phenylene - diamine produces a dull red print;
pyrogallic acid produces a brown print;
carbolic acid produces a yellow print;
hydroquinone produces a yellow print;
alpha-napthylamine produces a brown-red print;
resorcin produces an orange print.

One or other of these materials (like primuline itself) can usually be procured in small quantity through any good druggist. Beta-naphthol and meta-phenylene-diamine give, perhaps, the most satisfactory results for average purposes.

Developing Solution

In order to prepare the developing solution, take approximately 200 ccs of warm water and dissolve two or three grams of caustic soda in it. Then add to the solution a good "pinch" or a small saltspoonful of the developing agent and dissolve it completely.

The cloth, having been printed, requires but 10-20 seconds immersion in the developing solution, after which it should be rinsed in warm water, washed with soap and water, rinsed again and finally dried and ironed. It will now have a strongly coloured image on a cream background.

If the image is "washy," one of two factors have been wrong : either the cloth has been over-exposed or else the positive used for printing has not been contrasty or dense enough. With, however, the "artificial positives" of cut-out paper described above, these faults will never occur.

The final stage of this interesting process consists in removing creases from the finished cloth prints by means of a warm iron.

The developing solutions will not keep for more than a few hours. Hence they should only be made up in small quantities at a time.

It is possible by careful working to produce two- or three-coloured images on cloth by means of the primuline process. These are effected by painting on to the cloth the different developing solutions by means of a brush, care being taken, of course, to see that the solutions do not "run." Thus by painting on to the one exposed cloth solutions of beta-naphthol, resorcin, and pyrogallic acid, an image in red, orange and brown can be developed up.

Easily Worked

The primuline process is very easily worked and by means of it handkerchiefs and similar fabric articles can be readily printed with photographic or non-photographic views, portraits and designs. One factor only is necessary for success : the positive employed for printing *must* be one of great contrasts. Flat, thin positives are utterly useless. That is why the beginner would do well to start his trials of the process by printing mere outlines, silhouettes, etc., after which he may proceed to the somewhat more exacting printing of actual photographic positives.

An interesting modification of the primuline process may be worked by making up three per cent. solution of ordinary cooking gelatine and by colouring it by the addition of a suitable quantity of primuline dye. This gelatine should set solid on standing.

It is then liquified by warming and coated on to clean glass plates. After the layer of gelatine has set on the plates, the latter are transferred to a 5 per cent. solution of chrome alum or a one per cent. solution of formalin for a few minutes in order to render the gelatine insoluble. After this, the plates are set aside to dry and are subsequently "diazotised" and printed in exactly the same manner as the primuline-dyed cloth.

In this way, primuline-printed transparencies may be obtained. By coating large sheets of glass with gelatine containing primuline and by printing from cut-out positives it is possible to obtain large window-transparencies for decorative or advertising purposes.

The process is simple enough, but, naturally, for the sake of practice, it should be carried out with the smaller sizes of glass before the making of extra-large transparencies is attempted.

A FOOLPROOF AUTOGIRO

AFTER 10 years' research, and an outlay of £10,000, David Kay, a Perthshire inventor, has perfected what is claimed to be Britain's first "back garden" aeroplane. It is a single-seater autogiro fitted with a 75 h.p. engine, is wingless, and has a four-bladed "windmill" over the cockpit. Mr. Kay states that it is absolutely safe, and is the only experimental machine in the world to do four years' flying without a crash. When demonstrated, the plane was in the air and climbing steeply after only a 10-ft. run. After remaining motionless in the air, it finally drifted down to land with a gentle bump on 18 ft. of turf.

The inventor claims that the machine would remain on an even keel if the pilot, in a moment of panic, let go of the controls, and if the engine were switched off the autogiro would drop gently to earth. The autogiro refused to dive unless the nose was forced down and held there.

An Aerial Tramway

THE first aerial tramway on the North American Continent was opened in June. The cars carry 27 passengers over a course of about a mile up the side of Cannon Mountain to an elevation of 4,002 ft. in less than eight minutes. At the summit station paths have been made to enable visitors to walk around the top of the mountain.

No Flies on it

FLIES and other insect pests that descend on us during the summer months will, when sprayed with a chemical compound known as cyclohexylamine, find it very detrimental to their health. Although this substance is not a new discovery, its potency as an insecticide has just been discovered as a result of laboratory experiments. It is prepared by treating a dye with hydrogen.

Treasure Trove

YET another attempt is to be made to salve the £2,000,000 worth of gold in the wreck of the British frigate, *Lutine* which sank 138 years ago. The attempt is to be made by the Dutch dredger, *Karimata*. There were 300 on board when the *Lutine* sank and with the exception of one, who died soon afterwards, not a soul was saved. The most successful of the previous attempts was that of the British diver, Ballie, who touched a bar of gold, whilst Beckers thought he could suck up the treasure by means of a tube. This failed, as the treasure lies below piled-up stacks of cannon balls. The immensity of the task may be gathered from the fact that below the depth of water there are 40 ft. of sand and 10 ft. of solid earth to be removed before the treasure can be reached.

A Giant Tyre

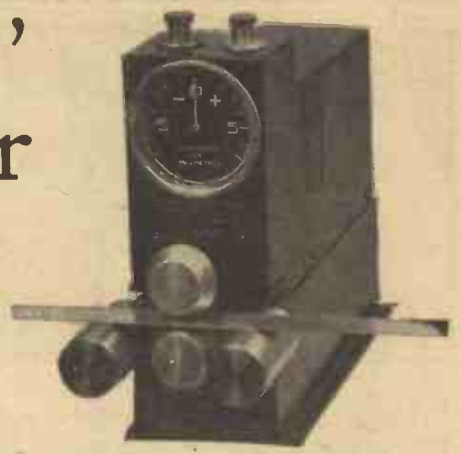
A GIANT pneumatic rubber tyre, 60 ft. long, is to be used as a fender on the dock at Southampton to prevent damage being done to Imperial Airways flying-boats by bumping.

The tyre has been designed by an expert in the company's ground service department.

Four tyres in all are under construction. Two are 60 ft. long and two 8 ft. They are about thirty inches in circumference. The outer cover consists of alternate layers of rubber and canvas, and the pneumatic inner tube is in sections each 3 ft. long. Each section has a valve by means of which air is blown in to the required pressure.

The "Oehmichen" Universal Caliper

Details of an Ingenious Measuring Device, the Special Features of which are given below



The "Oehmichen" Universal Caliper.

THE "Oehmichen" caliper is a high precision measuring device designed for the continuous automatic measurement of one dimension (thickness, width or diameter) of any drawn material (strip, film or wire) which is moving in the direction of its length. The special features of this instrument open up a wide field of industrial applications. These are probably best illustrated by a brief description of its application to the cold rolling of steel strip.

It is generally recognised that if production is to take place under the best and most economical condition, it is indispensable to know at any moment, with a high degree of precision, the thickness of the strip as it leaves the rollers. Up to the present, the apparatus employed for this purpose is either rudimentary and insufficiently accurate for practical requirements, or on the other hand, it is too complicated, delicate and expensive for general workshop use.

The "Oehmichen" Caliper functions with extreme accuracy during the manufacture or processing of the material, which may pass between the measuring members slowly, or at speeds ranging up to 500 feet per minute. It is mechanically operated, robust in construction, remarkably simple, unaffected by vibration and reasonable in cost.

Description of Instrument

The new method of measuring employed by this instrument consists in determining —by means of a micrometer screw (7) which automatically makes several measurements per second—the distance separating two heavy articulated metallic jaws (1 and 6). Fixed to these jaws are two rotating members (2 and 4) through which the band to be measured is passed.

The two metallic jaws, one fixed and the other movable, are placed horizontally and are constrained by a spring (20), which tends to bring the upper and lower rotating members into contact. The micrometer screw, perfectly centred, traverses a thread carried by the upper (movable) jaw. This screw is caused to descend in the thread by a spring (32) which tends to give it a fraction of a turn. It is also lifted periodically, i.e., turned in the opposite sense, by a cam (38), which is operated by an electric motor mounted on the upper jaw.

When the micrometer screw descends it meets a hard steel stop (9). The height of this stop in relation to the fixed jaw is regulated by the graduated control which may be seen on the top right hand of the instrument.

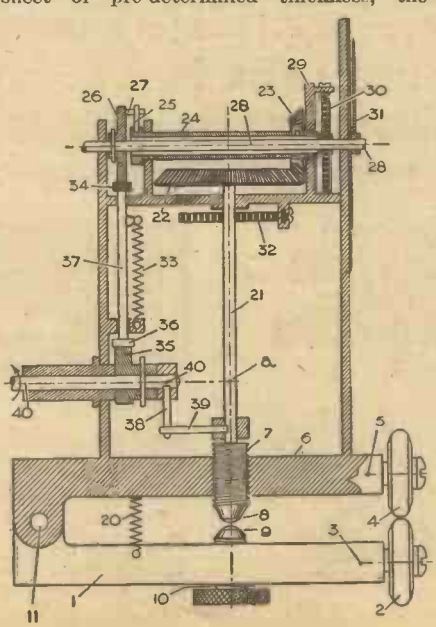
The position of the stop is so adjusted that the spherical end of the screw in its downward movement, meets the steel stop before it has quite completed its descent. The position in relation to the instrument at which this contact takes place is registered by the apparatus and indicated on the dial in the following manner. The movements of the micrometer screw are transmitted to a shaft (24), carrying at its end a dog or projection (25). This projection is constrained by a spring (30), to maintain contact with a pin (27), which is held in position during the greater part of the cycle by means of a cam-operated brake (34).

The Brake Released

When the screw has completed its descending movement, the brake is released and the pin under spring tension moves until it meets the projection (25). The brake operates immediately afterwards fixing the pin (27) in the position just taken up. This pin is secured to a plate (26), which is keyed on a shaft (28), which passes through the hollow shaft (24), and carries the indicating needle (31), moving in front of a graduated dial. So long as the thickness of the strip remains constant, the pin remains motionless since the final position of the projection (25), is unchanged.

If the thickness of the material increases or diminishes, the projection (25), stops in front of or behind its previous position and the pin (27), is accordingly displaced, towards the right or left. This movement is transmitted through the shaft (28) to the dial needle (31).

If it is required to manufacture a metal sheet of pre-determined thickness, the jaws (6 and 1) are separated and a shim of the thickness required is inserted between the rotating members (2 and 4). The jaws are then closed together until these rollers pinch the shim between them. The apparatus is started and the screw (10) is actuated to displace the stop (9) until the indicating needle (31) rests opposite zero on the graduated dial.



A sectional veiw of the instrument.

High Precision

The jaws are then separated and the metal sheet as it comes from the rolling mill is introduced between the rotating members (2 and 4), and the rolling mill is started. Although the successive measuring operations are separated by intervals of only a fraction of a second, the indications of the needle are entirely aperiodic, resembling those of an electro-magnetic apparatus. The slightest variations in the thickness of the strip—even of a thousandth of a millimetre (.00004 in.)—are immediately revealed and rendered clearly visible at a distance of several yards.

Although the "Oehmichen" Universal Caliper is an instrument of high precision, owing to its extremely strong construction and foolproof design it is capable of being put into almost any hands. Its operation requires no special knowledge.

Maintenance.

The indicating device is well protected and requires no lubrication or other maintenance. The motor, reducing gear and the main shaft require a few drops of oil every fortnight.

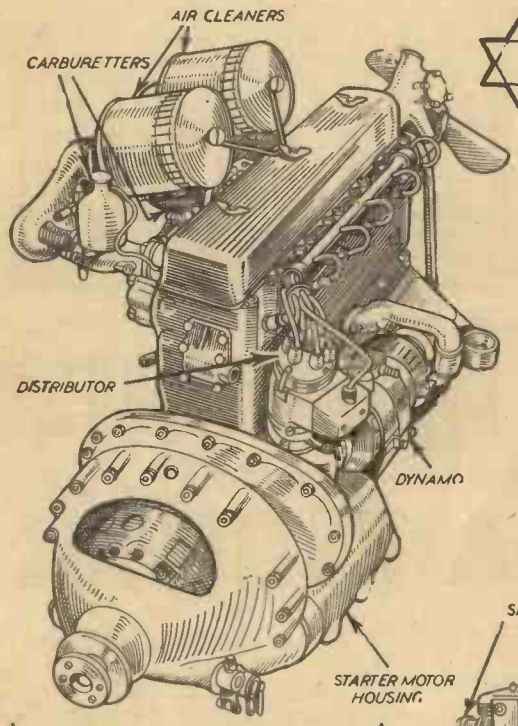
The rotating members are made of extremely hard materials and require replacement only after long intervals. Their replacement cost is small. They require no further lubrication after leaving the laboratory.

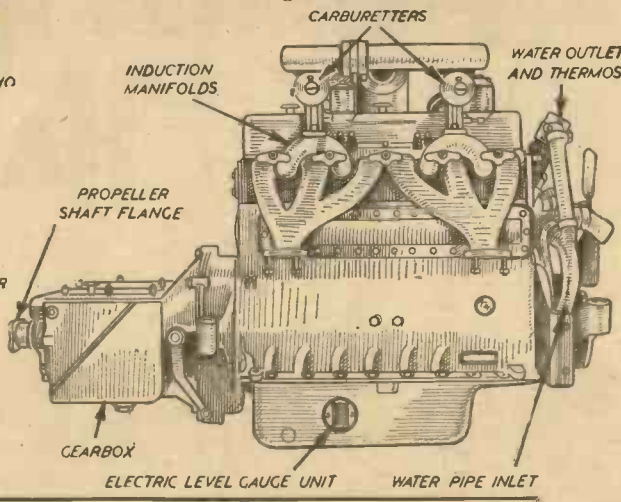
A recording device can be supplied at an extra cost. The recording mechanism is operated by the motor of the measuring device and requires no separate clockwork drive. The records are taken on paper strips about 24 inches long. These may be removed after each operation and may be used as production batch records. The weight of the instrument is about 21 lb. It occupies a small space and can be readily placed in position for operation.

UNDER the BON

A Pictorial Survey Of Modern Automobile Engine Design. By A

The modern car has reached such a state of mechanical perfection t person's indifference to what is "under the bonnet" is perha compliment which may be payed to the engine. This pictorial impression of modern design from "baby" to "giant" and, when it that the automobile industry is but the outcome of the twentie amazing strides which have been made are appreciated all th





ALVIS 4.3 litre

H.p.	31.48
Capacity	4,387 c.c.
Bore	92 m.m.
Stroke	110 m.m.

Coil ignition.
Firing order 1, 5, 3, 6, 2, 4
Overhead valves operated via push rods.
Special features : Triple S.U. Horizontal carburetters.
Single plate clutch. All constant-mesh forward gears.

M.G. 2 Litre

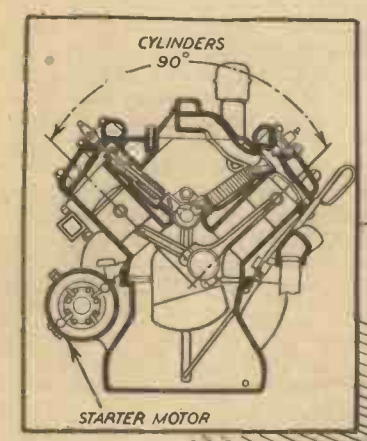
H.p.	17.97
Capacity ...	2,322 c.c.
Bore	69.5 m.m.
Stroke ...	102 m.m.

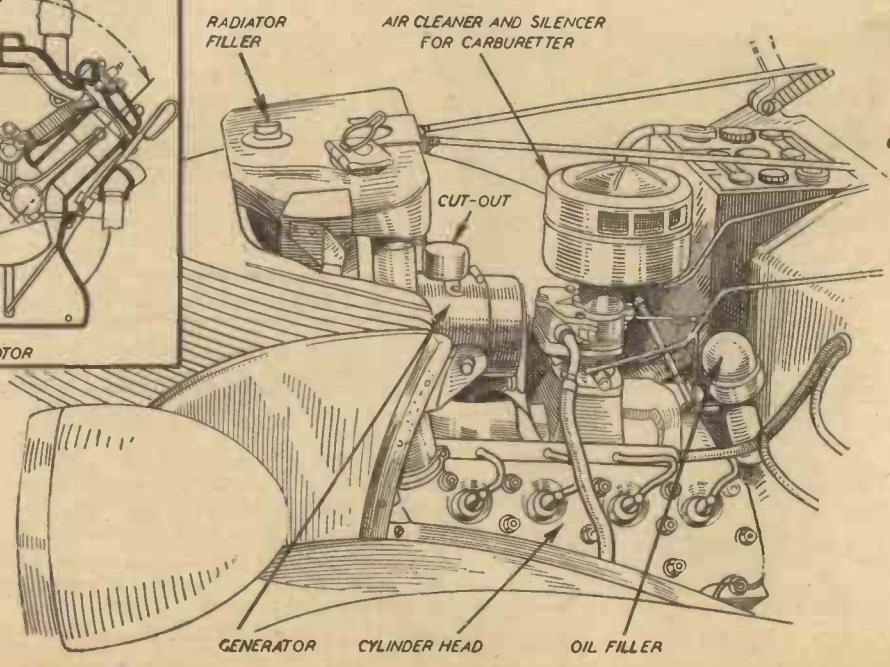
Coil ignition.
Firing order 1, 5, 3, 6, 2, 4
Overhead valves via push rods. Camshaft on side of engine.
Special features : Twin S.U. carburetters served by 2 S.U. Electric Petrol Pumps.
Thermostat control. Forced feed lubrication.

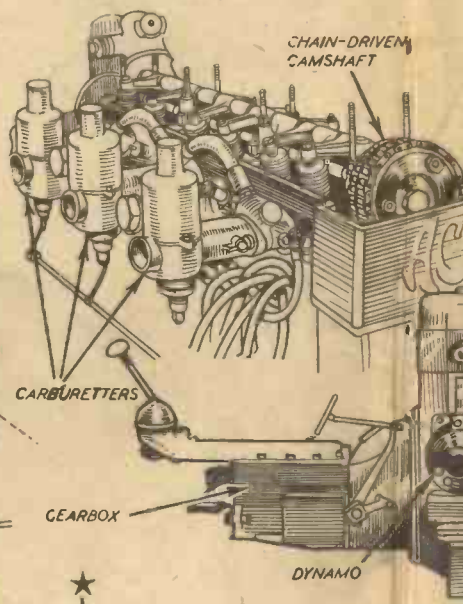
FORD V/8

H.p.	22
Capacity	2,226.9 c.c.
Bore	66.04 m.m.
Stroke	81.28 m.m.

Coil ignition.
Firing order 1, 5, 4, 8, 6, 3, 7, 2
Side valves driven by helical gear.
Special features : 8-cylinder "V" type engine. Automatic advance and retard. Dry single-plate clutch.







A.C. 16 60

H.p.	...
Capacity	..
Bore	...
Stroke	...

Coil ignition.
Firing order ... ...
Overhead valves and camshaft.
Special features : 3 S.U. carburett crankshaft with damping device silencing system.

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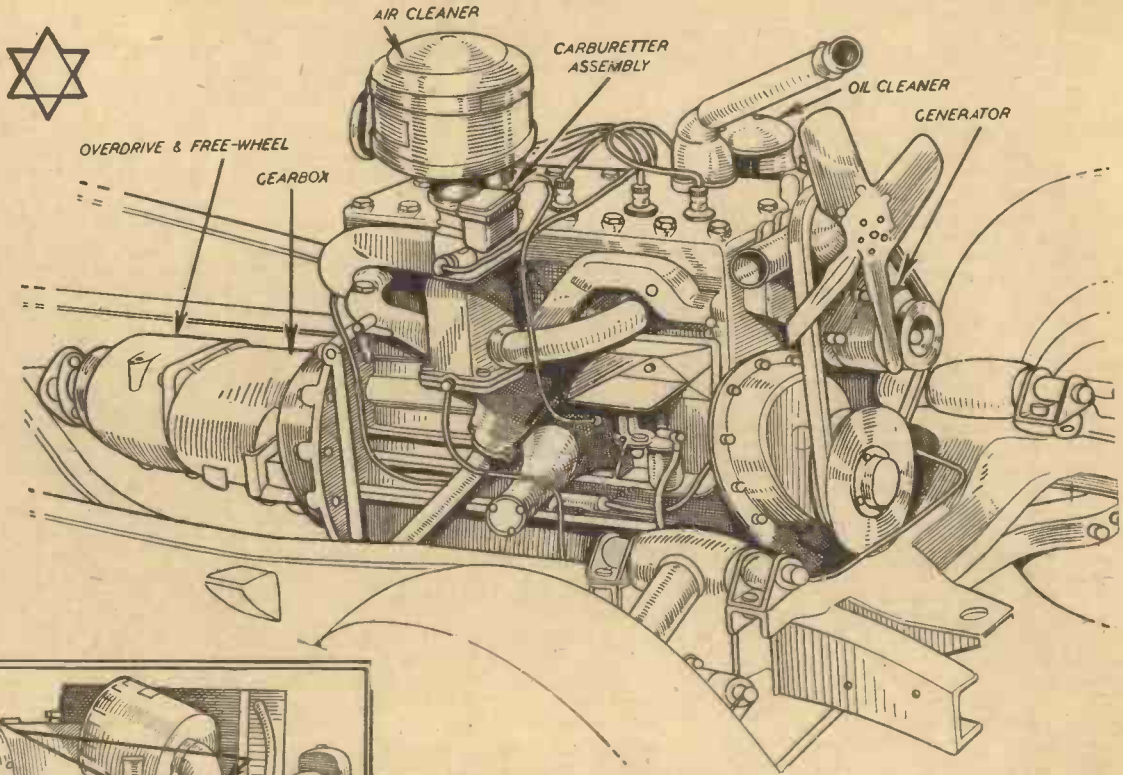
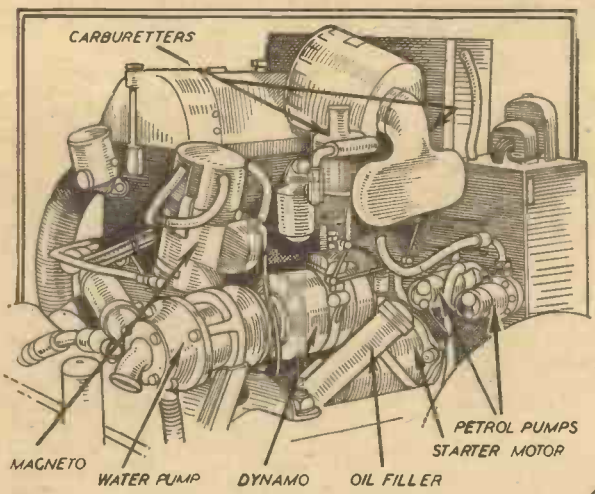


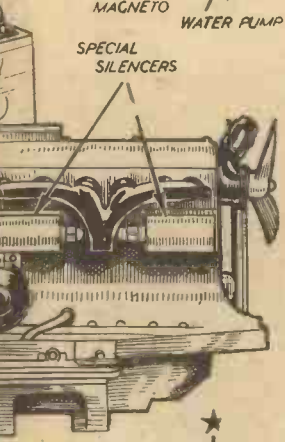


STUDEBAKER "Commander"

H.p.	26.35
Capacity	3,703 c.c.
Bore	84.1 m.m.
Stroke	111.1 m.m.
Firing order	1, 5, 3, 6, 2, 4

Coil ignition.
Side valves.

Special features : Stromberg downdraught carburetter with automatic choke and heat control. Complete water jacketing to base of cylinder walls and direct cooling to valve seats.



...	15.7
...	1,991 c.c.
...	65 m.m.
...	100 m.m.

1, 5, 3, 6, 2, 4

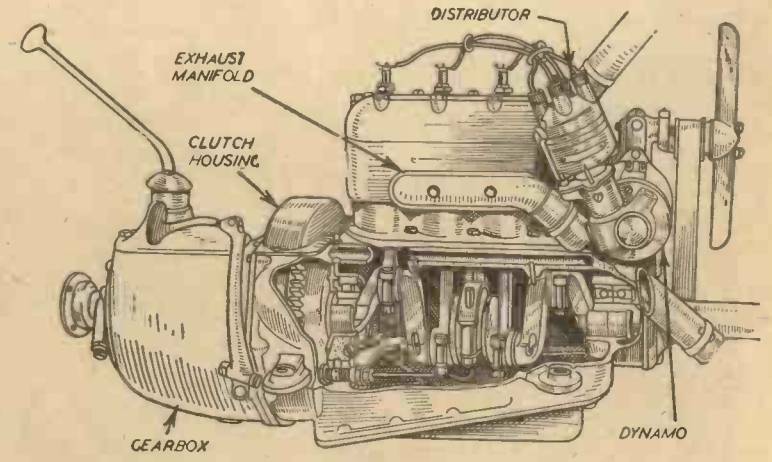
ers. Five-bearing
. Special exhaust

ASTON MARTIN 2 Litre

H.p. ...	15.09
Capacity	1,950 c.c.
Bore ...	78 m.m.
Stroke ...	102 m.m.

Magneto ignition.
Firing order 1, 3, 4, 2
Overhead valves and camshaft.

Special features : Twin S.U. Carburetters. Cooling : Cyl. block by thermo-syphon, cyl. head by large water pump.



AUSTIN "7"

H.p. ...	7.8
Capacity ...	747.5 c.c.
Bore ...	56 m.m.
Stroke ...	76 m.m.

Coil ignition.
Firing order ... 1, 3, 4, 2
Side valves.

Special features : Three-bearing crankshaft; front, ball; central, plain; rear, roller. Flexible, single-plate, spring-loaded clutch.

SCIENCE FOR THE CITIZEN.—By Lancelot Hogben. Published by George Allen and Unwin, Ltd. 1,120 pages. Fully illustrated. 12s. 6d. net.

This is a self-educator based on the social background of scientific discovery. It is very fully illustrated and includes some illustrations by J. F. Horrabin. I am not sure that I agree with Prof. Hogben when he says that had it not been for the Southern Railway which carried him to the spot where he wrote the book, it would never have been written. This is false reasoning because the book would never have been written if someone had not invented ink, and pencil and paper. It would not have been written if there were not such a process as printing and block-making. It would not have been written if there had not been such individuals as professors and others who taught Prof. Hogben science, and it would not have been written had there not been philosophers in the early ages who discovered the science about which Prof. Hogben writes.

This criticism, however, does not detract from the value of the book, which represents a *magnum opus*, and a colossal amount of work. It deals in everyday language with such subjects as the Pole Star and the Pyramids, the Calendar, the Science of Sea-faring, the Telescope, the Laws of Motion, Materialism, Inventions, and a vast number of other subjects. The book is in four parts under such provocative titles as the Conquest of Time Reckoning and Space Measurement, the Conquest of Substitutes, the Conquest of Power, the Conquest of Hunger and Disease, and the Conquest of Behaviour. This is a most entertaining and fascinating book which I am sure will be avidly read.

PATENTS, DESIGNS AND TRADE MARKS.—By Charles S. Parsons, B.Sc. Published by The Technical Press. 184 pages. 10s. 6d. net.

This useful volume deals with the British Patent System, the Patent Ability of Invention, the Evolution of Invention, Patents and Industry, Maintenance and Enforcement of Patents, Patent Rights and Exhibitions, Trade Marks, the Selection of Trade Marks, Trade Marks in relation to Advertising, the Legal Aspect, Foreign Patents, Foreign Trade Marks, the Function of the Patent Act, and concludes with a useful summary of the Patents and Design Acts from 1907 to 1932.

SAILING.—By E. F. Knight. Published by G. Bell and Sons. 156 pages. 3s. 6d. net.

The subjects treated in this book include the Theory of Sailing, Facts about Small Boats, the Rigs of Small Boats, the Cutter and Bermuda Rig, How to Sail a Yacht, Fitting Up, the Laws of the Sea, Instruments of Navigation, Finding One's Way at Sea, Weather Wisdom, Yacht Racing, Useful Glossary of Yachting Terms.

THE BOY MECHANIC BOOK.—Popular Mechanics Press. 468 pages. 2 dollars.

This book contains details and diagrams of no less than 700 things for boys to make and do, including model aeroplanes, boats, amusement novelties, toys, winter and summer sport devices, camp equipment, children's furniture, puzzles, kites, etc. The book is lavishly illustrated.

THE BOAT BOOK.—Edited by Sam Brown. Published by Popular Mechanics Press. 292 pages, plus Appendix. 3 dollars.

This book deals with full-size boats of a small type. A great feature of the work is the practical sequence of diagrams, showing how to build the boat from the cutting of the wood through the various stages. Sections include; Starting to Build, Hull Construction, Decks and Decking, Motor Installation, Building an Outboard Cruiser, a Racing Hydroplane, an Outboard Runabout, an Inboard Runabout, Canvas Canoe, Rowing Boat, etc., etc. A most practical volume.

POPULAR MECHANICS SHOP NOTES.—Popular Mechanics Press. 200 pages. 50 cents.

This is a useful work for the practical man, and deals with a great variety of gadgets and methods relating to turning, woodworking, fitting, soldering, welding, etc. Very fully illustrated.

POPULAR WOOD-TURNING.—Popular Mechanics Press. 16 pages. 25 cents.

A fully illustrated pamphlet dealing with all branches of wood-turning.

ELEMENTS OF MECHANISM.—By Schwamb, Merrill and James. Published by Chapman and Hall. 400 pages. 17s. 6d. net.

This is an authoritative work dealing with the Laws of Motion, Vectors, Velocity Analysis, Acceleration Analysis, Linkages, Transmission of Motion by Direct Contact, Rolling Contact, Gears and Gear Teeth, Wheels in Trains, Cams, the Inclined Plane, Wedge and Screw, Belts, Ropes and Cranes, and Miscellaneous Mechanisms. This book is quite a standard text-book and very authoritatively explores the whole subject of mechanism. I recommend it to everyone interested in machine design.

PHOTO ELECTRIC CELL APPLICATIONS.—By R. C. Walker, B.Sc., and T. M. C. Lance. Published by Sir Isaac Pitman and Sons. 336 pages. 12s. 6d. net.

This is a Second Edition revised and brought up to date. The chapter headings are; Characteristics of Cells, Methods of Use, Counting, Timing, and Mechanical Handling Devices, Alarms, Indicators, and Safety Devices, Advertising Devices, Sound Reproduction, Photo-Telegraphy, Television, Scientific Instruments, Miscellaneous Applications, and useful appendices and index. It is a most exhaustive book which must take its place as a standard on the subject. Everyone interested in photo electric cells should obtain a copy.

FOG MADE TO ORDER

THE G.P.O. research station at Dollis Hill, London, N.W., is the home of future developments of the G.P.O.'s communication services, which link up this country with 95 per cent. of the world's telephone subscribers. Some five hundred investigations per annum are carried out. Fifty-two of the more important investigations completed in the past few years resulted in a gain, either in the form of a new source of revenue or economies, of over £800,000 a year. Dollis Hill, in addition to being the G.P.O. research centre, is also the technical training headquarters for its engineers. Dollis Hill has achieved a world-wide reputation for research work in connection with the study of telephone apparatus, transmission, and the fundamental methods of acoustic measurement.

Features of the station include a "room of silence," where the walls are lined with cotton, and an all-steel chamber for testing radio sets, where outside disturbances and atmospherics cannot affect them. They also have a special cabinet in which fog is artificially manufactured for testing the durability of different metals used in outdoor construction work, and gramophone records of street noises and normal disturbances of business offices for testing the sensitivity of telephones.

Teleprinter transmission contacts undergoing micro-examination at Dollis Hill.

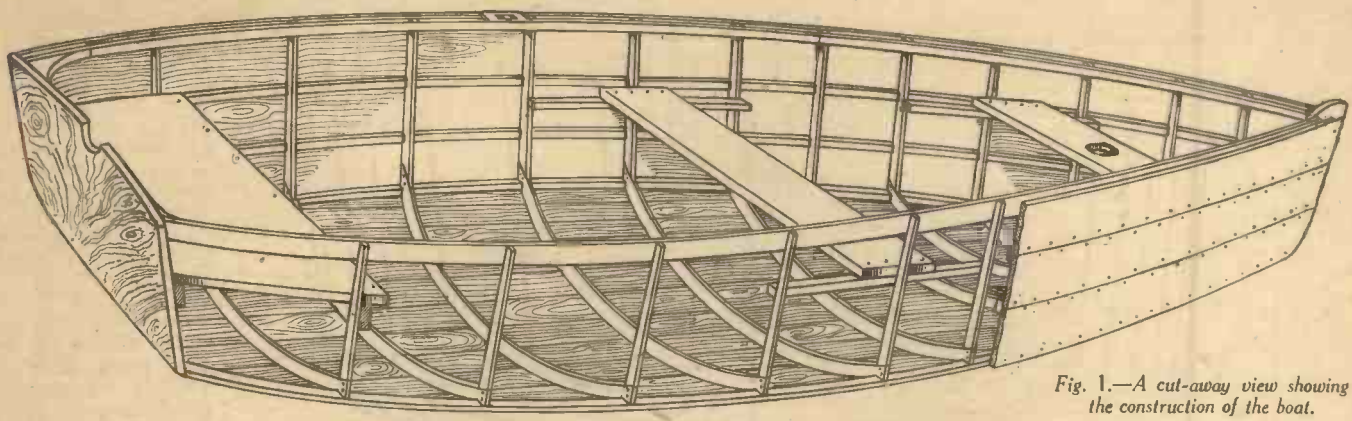


Fig. 1.—A cut-away view showing the construction of the boat.

Building an All-round Utility Boat

By C. T. Lewis

The Construction of a Boat which admits of either Rowing, Sailing or Motor Power Propulsion

THE best all-round utility boat to construct is the common dinghy, with her full, round bilge, transom stern and straight stem; but, unfortunately, the hull is one of the most difficult to build. Her planks, which appear to the eye to be all of simple, elongated crescent form, are half of them swan-necked in actuality, and not merely bent, but sharply twisted into position. Only after practice or with skilled help can an amateur woodworker make a successful job of such a difficult piece of construction.

Forewarned of these difficulties, most amateurs for a first boat-building venture tackle a "hard-chine," that is to say—angular-sectioned hull, with either a flat or a V-sectioned bottom.

The construction of these is much more straightforward, but on the other hand no angular boat has the all-round utility of the round-bilged hull, being neither so strong, nor able to carry a heavy load without sacrificing the other desirable qualities when so loaded, namely manœuvrability and seaworthiness. She has other disadvantages, too, but those mentioned are enough to make one wish to obviate them if possible.

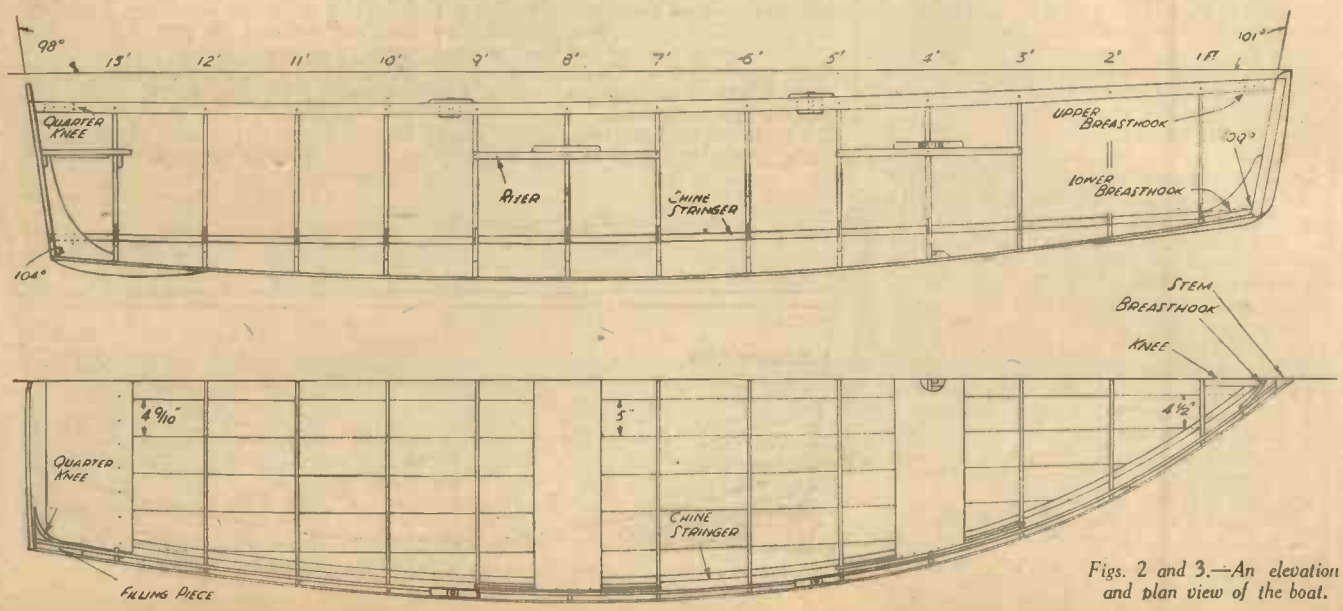
This, fortunately, can be achieved to a very great extent, and without constructive difficulties, by rounding the bottom of a hull that is in essentials of the hard-chine type. Figs. 2, 3, and 4, show respectively the elevation, plan, and body-plan of a hull of this compromise type, 14 ft. long with a breadth of 4 ft. 10 in.

Wide Utility

This particular size admits of either rowing, sailing, or motor-power propulsion. She has reasonable room for four people, yet is light enough to be handled by only two. A boat, in fact, of very wide utility.

As regards cost, sufficient timber of reasonably good quality need not cost more than £4, nails, screws and paint £1, oars and rowlocks £1, sailing gear £3, and a power unit, if second-hand or adapted, £10. There is no part of the work that cannot be carried out single-handed, though a helper, not necessarily skilled, is of considerable advantage. For a building shop any roofed space 16 ft. by 10 ft. will serve, so long as it has a boarded floor and good lighting.

Reverting to the drawings, the body-plan



Figs. 2 and 3.—An elevation and plan view of the boat.

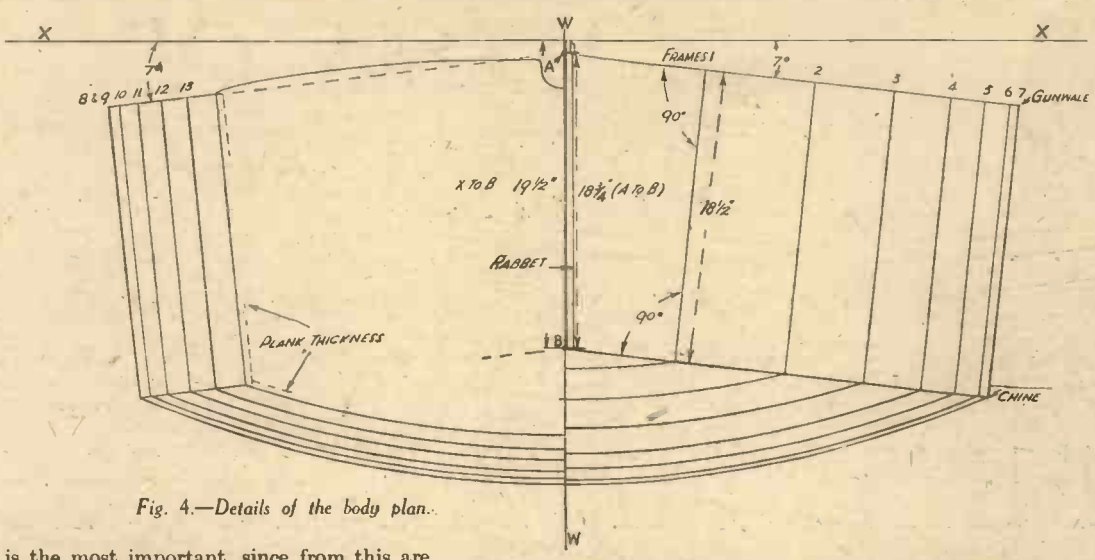


Fig. 4.—Details of the body plan.

is the most important, since from this are taken the greater part of the measurements.

The hull has thirteen frames set one foot apart, centre to centre, at the " stations " No. 1 to No. 13, and these stations are shown as half cross-sections of the hull, including the plank thicknesses, Nos. 1 to 7 to the right of the centre line X, and the remainder and the transom, or stern board, to the left.

At an early stage in all boat-building the body plan has to be reproduced as a full-scale drawing, and as this takes up floor space, probably required for the building stocks, the enlargement is preferably made at the outset of operations.

On a sheet of stout paper 5 ft. by 3 ft. draw the cross-lines W and X at an absolute right angle, right across the paper, with X within an inch of one of the long edges.

¾ in. below the junction of W and X dot in the point A, and from there run out two lines to the short edges, each at an angle of 7 degrees from X. These lines represent the outside edges of the gunwales.

Marking Out

The half-breadths of the hull at the stations and transom now have to be marked off along the gunwale lines as follows, measuring from A. Stations 1, 9 in.; 2, 16 in. full; 3, 21¼ in.; 4, 24¾ in.; 5, 27 in.; 6, 28½ in.; 7, 29¼ in.; 8, 29 in.; 9, 29 in.; 10, 28⅜ in.; 11, 27½ in.; 12, 25¾ in.; 13, 24¼ in.; transom, 22¼ in.

Following the above, mark in the point B on line W, 18¾ in. from point A, and from there run out the chine lines, parallel to the gunwale lines, the perpendicular distance between them being 18½ in.

The stations having been marked off along the gunwale lines already, as above, let fall perpendicular lines from them to the chine lines, so marking the half-breadths of the hull along the chines.

The sections below the chines all consist of segments of concentric circles struck from a centre 3 ft. 10¾ in. beyond point A along an upward extension of the line W.

To draw these segments, pin the paper on the floor, find the required centre point, and drive in a bradawl or nail. Then, for an improvised beam compass, attach a pencil to the bradawl by a well-stretched cord 6 ft. 6 in. long, and by winding the cord round the pencil near its point bring the pencil to the chine line where the cross-sectional side line of station 7 cuts it.

You can now sweep in the half-bottom for that station. Then, twisting the cord round the pencil slightly more, sweep in the segment that meets the side line of station 8, which coincides with station 9. Station 6 comes next, then station 10, and so on, shortening the cord, and with it the radius, each time.

The drawing is completed by running in the top line of the transom with a bent lath. It has no hard-and-fast curvature, needing only to be eye-sweet. Its highest point is 1¼ in. from X. There should be a 3-in. wide by 2-in. deep sculling notch marked in, also the curved projection at the outer top corner that is to overlap the planking at the gunwale.

The drawing being complete, the building stocks can be set up. Their function is to support in accurate alignment the frames, stem, and transom during the process of " planking up," that is—bending and fastening down the planks or " strakes."

A Rigid Unit

As will be realised, the stocks and framework must form a rigid unit, or by the time the planks are on, some part will have shifted sufficiently to throw the hull out of shape, with one end or the other out of the vertical.

The main member of the stocks needs to be a stiff 15-ft. plank set up at waist height horizontally and on edge. It can be supported on trestles, or on packing cases filled with any available heavy material to steady them, and prevented from sliding by cleats nailed to the floor. It does not matter if the 15-ft. plank is rough and old; but it must be planed up on the top edge to take a pencilled centre-line marked off at 1-ft. intervals for the positions of the frames, stem and transom.

The tools required for this class of work are mostly to be found in any ordinary carpentering kit, but twist drills are wanted for drilling clean screw and nail holes, at least four G cramps for bending the planks on to the frames, a sharp-toothed wood rasp for finishing bevels, and a hollow punch with a ⅜ in. hole up the centre for riveting purposes.

Timber Required

The timber for the boat itself, while it need not be expensive should not be cheap Baltic deal, except for the floorboards, which are loose and readily renewable. Columbian pine, which is reasonably priced, free from knots, and easy to obtain, is suitable for the planking and thwarts. The stem should be of British or American oak. A variety of hardwoods—oak, elm, beech or ash—are suitable for knees to fit into the various angles of the framework; while English elm, though cheap, is as good as many a more expensive timber for the frames and transom provided that it is treated with a preservative dressing.

The following are the quantities required for the main parts of the boat. Small parts can be cut out from what would otherwise be waste when the main parts have been roughed out.

The thicknesses given are the finished dimensions, so if unplaned timber is bought a planing allowance must be added.

Altogether seventeen planks of ½-in. Columbian pine are needed, of which six are for the sides and eleven for the bottom. The side planks are 15 ft. long, and of any widths that will total 18½ in. after planing their edges true.

The bottom planks must clean up to a 5 in. width. Of the eleven five should be 13 ft. 6 in. long. Four should be 12 ft. 6 in. and the remaining two 11 ft. White deal in the same lengths and thicknesses but 3 in. wide will serve as spaced-out floorboards.

Chine Stringers

For the pair of 15-ft. chine stringers that bind the frames at the chine, 1 in. by 1 in. finished battens of any knot-free pine, straight in grain, should be selected. The thwarts call for an 8 ft. 6 in. board 10 in. wide and ¾ in. thick of Columbian pine or good red deal, and the stern seat for another board of the same timber 4 ft. 6 in.

(*Continued on page* 611)

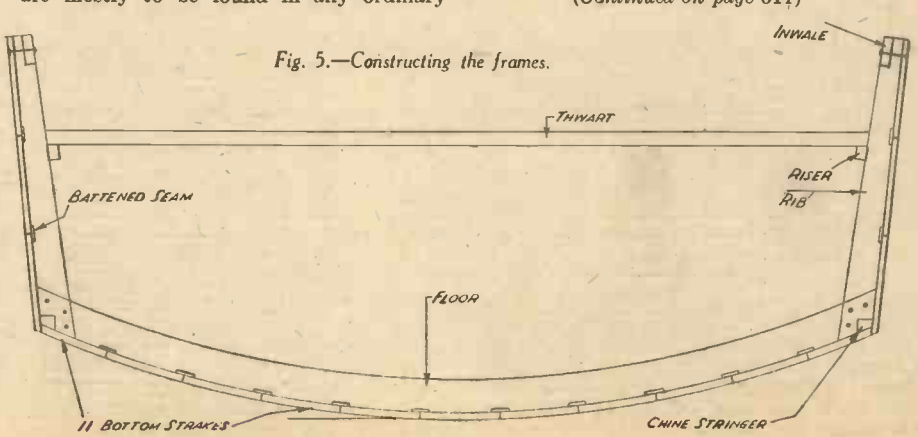


Fig. 5.—Constructing the frames.

The Rev. Edmund Cartwright, D.D., F.R.S.

MASTERS OF MECHANICS

No. 36. The Clergyman Mechanic—Some Passages from the Life of the Rev. Edmund Cartwright, D.D., Inventor of the Power Loom

MATTERS in the cotton industry of Lancashire were not going too well. True it was that the inventions of Hargreaves and Crompton, to say nothing of the schemes of the wily Arkwright, had speeded up the production of cotton yarn enormously, but, at the same time, the methods of weaving this yarn into fabrics still remained hopelessly slow.

"It is all very well," remarked one of the cotton merchants as the company sat smoking after dinner in a house on the outskirts of Matlock town in the summer of 1784, "but what will all this rapid production of yarn lead to? Putting aside the matter of the ruin of the poor spinners who will be starved because they haven't as many arms as these terrible machines, you will find that it will end in a great deal more yarn being spun than can be woven into cloth, and in large quantities of yarn being exported to the Continent, where it will be worked up by foreign weavers to the injury of our home trade. That will be the long and the short of it, mark my words!"

At this juncture, a grave-faced, somewhat portly individual interjected a remark into the conversation. He wore the dark, sombre clothes of a clergyman and it was obvious that he did not belong to the company of Manchester merchants.

"But, sir," ventured the clerical individual, "when you talk of the impossibility of weaving keeping up with spinning, you forget that machinery may yet be applied to the former as well as to the latter. Why, for instance, may there not be yet a loom contrived for working up yarn as fast as the spinning machine produces it?"

"No, no," remarked another member of the assembly, "you might as well talk about clothes growing ready-made. Weaving by machinery, my dear sir, is absolutely impossible. You must remember how much more complex a process it is than spinning, and what a variety of movements it involves. Weaving by machinery is a mere idle vision, sir, and your remarks show plainly that you know nothing whatever about the operation."

"Weaving Johnnies"

"I must certainly confess my ignorance on the subject of weaving," replied the clergyman, but surely it cannot be a more complex matter than moving the pieces in a game of chess? Now, there is on view in London a mechanical figure which plays chess, making during the game the most intricate movements, just as if it were actually alive. If such a feat of mechanism can be devised, I, for one, see no reason why a mechanical weaving loom should not be invented. Indeed, I am quite certain that before many more years have gone by, the country will have its 'weaving Johnnies' as well as its 'spinning Jennies'!"

The clerical speaker who thus astonished and amused the hard-headed Manchester men with his remarks was the Rev. Edmund Cartwright, a country clergyman of literary tastes, a classical scholar and one who had made a name for himself as a minor poet and connoisseur of the arts. Mr. Cartwright held the living of Goadby Marwood, a village in Leicestershire. He had been born at Marnham, Nottinghamshire, on the 24th of April, 1743, and thus at the time of the above-related incident he had turned forty years of age.

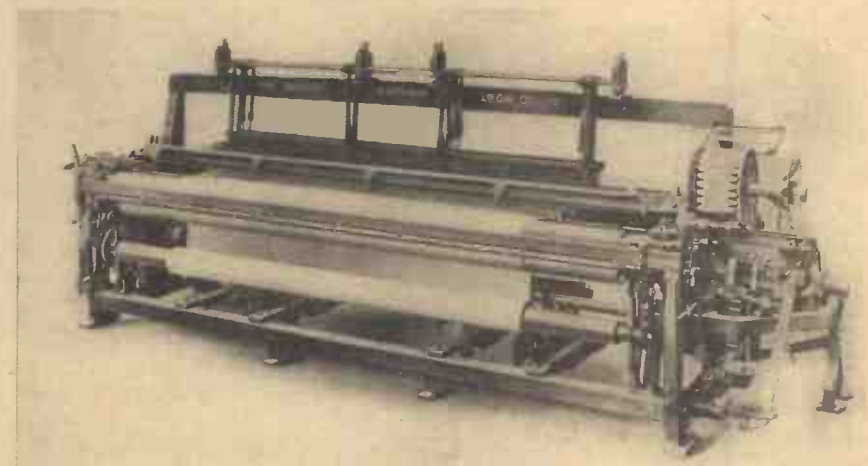
No Knowledge of Mechanics

Educated upon entirely classical and clerical lines, Cartwright had utterly no knowledge of mechanics or even of science, unless, in the latter instance, we except the small study of medicine which he made in his younger days and the few agricultural experiments which he seems to have conducted during his incumbency of Goadby Marwood. Day in and day out, Cartwright had led the life of the gentle, rural parson to whom even the simplest of mechanical principles was as Greek was to the ordinary person of his day.

It is astonishing, therefore, that almost in a single day this parson-poet, who had never even seen a spinning machine or a weaving loom, should more or less forgo all his former activities and devote himself practically entirely to constructional mechanics. A conversion such as Saul's on the road to Damascus was hardly more sudden than the conversion of the Rev. Mr. Cartwright to a career of mechanics and invention which took place on the occasion of that memorable gathering of cotton merchants near Matlock in the summer of 1784.

Cartwright returned from the assembly with his mind flooded with mechanical ideas. For days, for weeks, he brooded over mechanical principles and was often to be seen walking up and down in his vicarage garden, his arms moving from side to side in imitation of the act of a hand-loom weaver throwing the shuttle from one side of his loom to the other.

The village of Goadby Marwood soon got to know about their vicar's remarkable fits of abstraction. It was altogether inexplicable. And the mystery of it all deepened still more when Mr. Cartwright suddenly engaged the part-time services of the village smith and the local carpenter and set them the task of constructing a number of different machines which he said were intended to weave cloth quickly.



The modern version of the power loom. An up-to-date, extra-wide, high-speed, electrically-driven automatic loom for weaving cotton-goods.

Six months afterwards, an actual working loom emerged from the combined activities of Mr. Cartwright, his smith and his carpenter. It was a mechanical loom, which, although hand-operated, would turn out cloth at a rate far exceeding that of the conventional hand loom.

A "Power Loom"

Cartwright called the device a "power loom," and, having plainly demonstrated its utility, he at once set himself about the task of improving it. It was a long and arduous occupation. The surprising thing, indeed, about the whole endeavour was that it succeeded, for as we have already noted, Cartwright had utterly no knowledge of constructional or engineering

principles before he embarked upon his sudden inventive career.

In 1787, Cartwright patented his power loom and immediately afterwards set up a small weaving factory at Doncaster, utilising a number of his looms therein. At first the power necessary to operate the looms was derived from an ox which was tethered to a long wooden arm and which slowly walked round a circuitous track. In the following year, a steam engine was set up at Cartwright's Doncaster factory and for the first time in history, weaving looms were operated purely by mechanical power.

Cartwright, after the three or four years which he had spent in constructional endeavour and after the success of his power loom (or " Doncaster loom," as he sometimes called it) had been demonstrated to all and sundry, confidently expected that his efforts would receive due appreciation from the community at large. He was soon disillusioned, however, and, like Crompton and Hargreaves before him, was almost immediately subjected to a persecution which greatly added to the many anxieties of his newly-adopted career.

Opposition Raised

There is the old tale to relate. The workpeople of Doncaster and the surrounding districts as well as of localities farther distant rose up in opposition against Cartwright and his power looms. Coupled with this open rebellion, Cartwright's entire lack of experience in factory organisation brought a continual succession of troubles which, at times, threatened to overwhelm him. To make matters worse, other factory owners, from motives of narrow-minded jealousy, moved against him. Petty means of obstructing the output of his goods were practised, many of his best-woven yarns were mysteriously found to have been ruined or, at least, to have been rendered unsaleable and, in order to protect himself against open infringement of his patents, the gentle inventor and clergyman had to undertake one expensive lawsuit after another.

Matters brightened somewhat for Cartwright when, in 1790, a Manchester firm placed an order for five hundred power looms and built a factory specially for their utilisation. But the mill had hardly been erected and a few dozen looms put to work in it when the building was mysteriously burnt down. The result was that the contract for power looms was cancelled and Cartwright was left with much unwanted material on his hands.

At this time, Cartwright's private fortune of £30,000, which he had spent upon the development of the power loom and the founding of his Doncaster business, had well nigh petered out. Disappointed, shattered in mind and feeling himself a complete failure, he turned his back on his mills and, with his family, migrated to London in which city he attempted during the ensuing months to gain a living by his pen.

Further Inventions

But having once tasted the joys (no less than the sorrows) of mechanical invention, Cartwright found that it was impossible for him to settle down to a literary life. He, therefore, devoted much of his time to further inventions of which a wool-combing machine and one or two steam engines and boilers were the products of his activities. These inventions, however, came to little, for their creator had not the wherewithal to develop them.

In passing, however, it is interesting to note that during his residence in London, Cartwright was visited by the American, Fulton, who was, at that time, full of his notions for devising a steam-power ocean-going vessel. Cartwright was greatly attracted by the notion and he even went so far as to design and actually to construct a mechanically-propelled model of a ship. Cartwright's model, however, was not steam-powered; it was operated by a clockwork motor of his own construction.

In 1808, Cartwright, through the instrumentality of a few influential friends, was awarded a Government grant of £10,000 as the result of a petition which had been presented to Parliament urging the need for some such reward in view of the lowly state of the inventor of the power loom and the disappointments and losses which he had suffered. There is little doubt that such disappointments must have been many. Up in Lancashire, Cartwright's invention was pirated in a wholesale manner. Power looms were erected in factory after factory and, as a direct result, scores of already wealthy cotton manufacturers and mill owners amassed additional fortunes exceeding their wildest anticipations.

His Remaining Days

But Cartwright, although he invariably pressed his claims as the inventor of the power loom which had brought so much wealth to the country, had had enough of the toil and turmoil of industry. With a portion of the £10,000 awarded to him by the British Government, and now being sixty-five years of age, he purchased for himself a small farm at Hollanden, a village near Sevenoaks in Kent. Here he spent his remaining days, devoting himself mainly to poetry, literature, mechanics and experiments in agricultural chemistry. Cartwright, at this concluding stage of his career appears to have successfully led the life of a country gentleman. He had applied for, and been awarded, the degree of Doctor of Divinity and, although not actually in charge of any parish, he assisted the neighbouring clergy in their ministrations. As a local magistrate he is recorded to have been popular and " enlightened," and once again poems and literary essays proceeded from his gentle and facile pen.

For all that, however, the mind of Edmund Cartwright still teemed with inventive notions and ideas. Scientific experiments were given the first place in his world. As he himself put it in one of his poems :

I cleave to earth, to earth-born cares confined,
A worm of science of the humblest kind.
With mind unwearied still I will engage,
In spite of failing vigour and of age;
Nor quit the conflict till I quit the stage.

From this time onwards no more practical inventions came from the mind of Cartwright. Notions for the more efficient utilisation of steam power interested him greatly and the rising science of mechanical traction roused him to the height of enthusiasm.

The " Centaur Carriage "

At the age of 80 he had constructed to his own designs a mechanical carriage which he called a " centaur carriage." This was operated by man-power by means of a system of treadles and levers. So far as it is possible to ascertain, Cartwright's " centaur " carriage was actually successful in its own limited way.

The very last of the aged doctor's inventions is one which entitles him to be regarded as one of the earliest pioneers of the internal-combustion engine. It was an engine worked by gunpowder, the powder being automatically fed in small amounts into a combustion chamber above a piston cylinder and therein ignited.

Until recently, this building could be seen in Manchester. It was one of the earliest cotton-weaving mills in the country. In such mills, Cartwright's first looms were employed.

It is possible that some working model of this primitive engine may have been made, although, if such was the case, all traces of the model must have long since disappeared. Certain it is that the gunpowder internal-combustion engine was never patented.

But Dr. Cartwright had now attained an age when he had little need of patents, good, bad or indifferent. Still toying with his gunpowder engine, he removed to Hastings for the betterment of his health and there he died on 30th October, 1823, his remains being interred in the seaside church at Battle, Sussex.

Cartwright's claim to inventive status is undoubtedly his conception and creation of the power loom whereby the process of weaving was enormously speeded up. To that one remarkable invention, which, for him, resulted in complete economic failure, all the other incidents of his lifetime are subservient in the record of science and mechanics.

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TRICKS WITH BILLIARD BALLS

Billiard Balls Form the Basis of Many Tricks and below We Describe Some of The Most Interesting

Fig. 1.—Various trick balls and devices for ball tricks. (Left to right) A ball holder. Ball in holder. Hollow golf ball for changing a handkerchief to a ball. Billiard ball on same principle. The same with spring actuated roller to swallow silk. Halved hollow ball. Ball and half shell.

By Norman Hunter
(The Well-known Conjurer of "Maskelyne's Mysteries")

Further Articles on the Secrets of Conjuring will appear Regularly and Exclusively in this Journal

IN Fig. 1 are illustrated a number of the special devices used in tricks with balls. On the extreme left is a ball holder by means of which a small billiard ball, golf ball or even an egg, may be carried in an easily get-at-able position without fear of it being dropped. The holder consists of two loops of wire attached by a weak spring so as to grip the ball, as shown in the second item in Fig. 1. A small loop enables the holder to be pinned under the performer's coat or elsewhere. When a number of balls are required to be held ready for production each is placed in a holder and all the holders are threaded on a piece of tape which is then tied round the waist, under the edge of the waistcoat so that the load hangs at the back, out of sight but easily reached when wanted. The balls may be secured one at a time without disturbing the remainder.

Imitation Golf Ball

Third from the left is shown a hollow imitation golf ball with a hole in it and next again a small billiard ball made on the same principle. The purpose of this type of ball is to cause the magical transformation of a silk handkerchief into a ball. To perform this feat the hollow ball is disposed either in one of the clips already mentioned or in a convenient pocket. A handkerchief is shown and the ball secured. The handkerchief is then thrown over the closed fist which contains, unknown to the audience the hollow ball. One corner of the silk is tucked into the ball and the hands are then moved up and down with a waving motion, causing the silk to flutter about and under cover of this the fingers of the hand farthest from the audience gradually tuck the silk into the hollow ball. Fig. 2 will explain this quite clearly.

Another Development

A further development of the same idea is illustrated next in Fig. 1. This hollow ball is fitted with a small spring roller which can be wound up by means of a key inserted in a point on the outside of the ball. The end of the spring roller has a small projection which can be slipped into a hole in the ball to prevent the roller from unwinding. This detail is shown in Fig. 3. The method of performing the trick is the same as that used for the plain ball, but the tucking of the silk into the ball is not necessary. The silk is spread over the ball and the centre pushed in, to catch on a sharp pointed hook soldered to the roller. See Fig. 4. The presence of the ball is not of course permitted to become known to the audience. At the right moment pressure on the ball between thumb and fingers at the ends of the roller releases the spring, the roller draws the silk so rapidly into the ball that the change from handkerchief to ball seems to take place in a flash.

To reverse the trick and change a billiard ball into a handkerchief it would of course be possible to use the same simple hollow ball with a silk inside, withdrawing the handkerchief and concealing the ball in the hand. In practice, however, this is not always satisfactory unless the conjurer has a fair amount of skill in sleight of hand. A better plan is to use a ball divided across the centre, box and lid fashion, like the one illustrated second from the right in Fig. 1. The handkerchief is concealed in this and at the required time the two halves of the ball are separated. concealed behind the fingers and the silk allowed to expand.

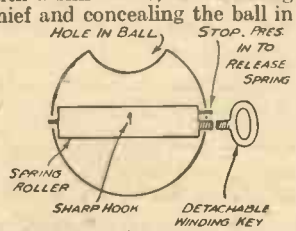


Fig. 3.—Section of a hollow ball with a spring roller.

The ball shown also has a small hole in the side so that it may be used for either form of the transformation.

Handkerchief and Ball

A still further improvement consists of attaching the halves of the hollow ball to the handkerchief, in this case as big a one as can be packed into the ball, by short lengths of thread fastened to the insides. When the ball is closed round the silk two of the corners are left projecting very slightly at the join. These are easily hidden by the fingers holding the ball and by taking one corner in each hand, the action of jerking them apart will free the silk from the ball, the halves of which hang suspended behind the handkerchief, out of sight.

The item on the extreme right of Fig. 1 is a solid ball and a half-shell fitting closely but not too tightly over it. At this stage I should mention that these conjuring billiard balls are not as a rule made of ivory, which would be too heavy for easy manipulation, but of ivorine, the shell being of the same material. Boxwood is used for cheaper sets, with shells of either ivorine or metal.

With a ball and shell and one or two additional balls of the same size, a large number of most surprising manipulations can be performed, some of which I will describe presently, but first let me explain the detailed working of a very popular billiard ball trick known as the four balls at finger-tips. The effect of this is that the conjurer holds a single ball between thumb and finger. His hand is otherwise quite empty. He gives the ball a shake and it visibly multiplies into two, both of which are shown to be solid. The multiplication is then continued until he has four solid balls between the fingers of his hand, each

Fig. 2.—Changing a handkerchief to a ball. The silk is rubbed between the hands and tucked into the hollow ball.

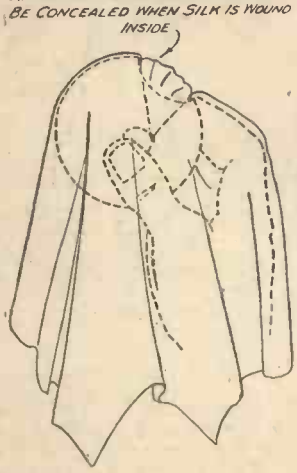


Fig. 4.—A silk handkerchief hooked by its centre to the spring roller and draped over the ball.

of which has appeared suddenly from nowhere and each of which may be examined.

Sleight of Hand

This trick necessitates a small amount of sleight of hand, but it is of such a simple order that anyone can master it after a few trials. The vital secret of the trick is contained in the use of a half-shell.

Four solid balls are required and a half-shell fitting any of them closely but not tightly. At the start of the trick three balls, each in a clip, are suspended under the coat at the back of the waist. The remaining ball with the shell in position is held in the right hand. Standing with the left side to the audience, the conjurer shows the ball and shell together, holding the ball between the thumb and finger. After showing both sides of his hand he makes a slight waving movement with the hand and under cover of this movement he lifts the ball out of the shell with the second finger.

This is the key move of the whole trick and Fig. 5 explains it more clearly than words. I have shown the other balls in position to indicate that this movement can be done even when the other fingers are hampered by holding the balls as they are produced. The important thing to remember is that the ball and shell when first held are very slightly separated and the finger and thumb hold the ball at the junction of ball and shell. As the second finger comes down behind the ball, the shell being to the front and facing the audience, it is a comparatively easy matter to roll the ball upwards to its position between the first and second fingers.

While this production of two balls from one is occupying the attention of the audience the left hand is busy securing a ball from the three under the coat. This ball is concealed in the hand by curling the fingers round it. Now comes the second important move in the trick. The left hand approaches the right and the thumb and forefinger take from the right hand the ball that has just appeared, that is the ball between first and second fingers of the right hand. In doing this the ball concealed in the left hand comes almost automatically behind the shell and is slipped into it. See Fig. 6. Both balls may now be shown solid and tapped together.

Repetition of Moves

From now on the trick is more or less a repetition of these moves. But each time the balls are replaced in the right hand the ball and shell must be between finger and thumb and the other balls so placed as to leave the space between first and second fingers free to lift the ball out of the shell.

Various effective and puzzling manipulations are possible with the aid of the half-shell ball. Take one ball and shell and make it into two as described. Slip the second ball into the shell and tap the balls together as for the four ball trick. Now in replacing the ball between first and second fingers take the extra ball out of the shell again and keep it concealed in the left hand. The movement is the reverse of that shown in Fig. 6 which might equally well be an illustration of either. You apparently still have two balls in the right hand. Wave the hand and slip the ball back into the shell by rolling it down with the first finger. Then produce the ball concealed in your left hand from behind your knee. By repeatedly putting the ball back into the right hand and bringing away the one in the shell you can make the second ball vanish and appear from your elbow, behind your ear and so on.

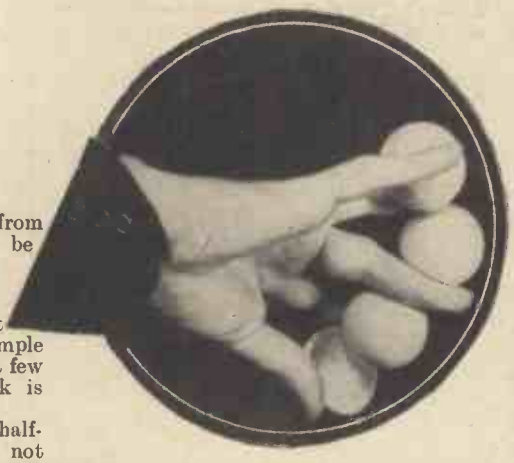


Fig. 5.—The last stage of the multiplying ball trick. Ball being rolled up out of half shell.

Fig. 6.—Loading the second solid ball into the half shell in the multiplying ball trick, in the act of taking the ball just produced to prove it solid.

Reversing the Process

The production of four balls as I have described it can also be reversed if desired and the four balls made successively into three, two and one. Here again the movements are the same as for the production but reversed, the extra ball being removed from the shell instead of being slipped into it. These extra balls may be disposed of in a bag behind the table under cover of picking up a stick to tap the remaining balls.

A simple method of vanishing a ball, without the use of apparatus or shell, is as follows. Close the right hand and place the ball on top of the fist. Now with the left hand appear to scoop the ball off the fist. As the open left hand hides the ball from the audience open the right fist slightly and allow the ball to drop down into the right hand, where it is held concealed by curling the fingers round it while the left hand is closed as if containing the ball. Allow the right hand to drop casually to the side and blow gently on the left hand, making a crumbling movement with the fingers as you open the hand. Fig. 7 will make the movements clear.

This vanish may be used with good effect in conjunction with a wooden vase for vanishing, changing or producing a ball. Although the vase is somewhat intricate in construction it may perhaps interest amateur lathe workers to try their hands at turning one out.

A section of the vase and its lid is shown in Fig. 8 from which it will be seen that the vase is so shaped that a ball of the right size placed into it occupies the vase to the exact centre of the ball, the lid accommodating the other half of the ball. A half-shell, fitting the ball loosely, but jamming fairly tightly into the lid of the vase is also required. If the shell is placed in the vase it has the appearance of a complete ball. When the lid is put on the shell wedges into the lid and comes away with it when the vase is again uncovered. If it is desired to leave the shell behind when removing the lid the small plunger on top of the lid is pressed and this dislodges the shell.

Using the Apparatus

There are various ways of using the apparatus. With the shell in the lid the vase may be shown containing the ball. The ball is removed and the lid placed on the vase. The ball is vanished as described and the plunger pressed as the lid is again lifted, revealing the ball (actually the shell) back in the vase. By reversing the procedure the ball may be made to travel from the vase to any place the performer wishes, a duplicate having been previously planted there. By having a white ball and a red shell a colour change may be worked and with two vases, one fitted with a red shell and the other a white one, plus a solid red ball and a solid white ball, the effect may be produced of causing the red and white balls in the vases to change places. At the finish of any trick with the vase, the loose shell may be got rid of in a bag behind the table or behind some convenient piece of apparatus and vase and ball handed for inspection. The small spring-actuated plunger in the lid will not

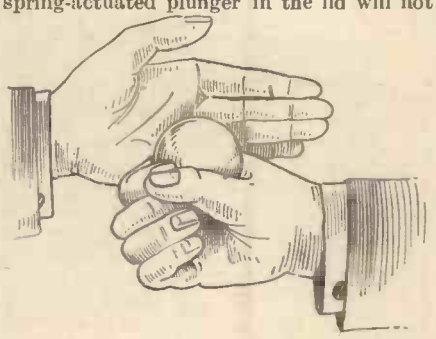


Fig. 7.—Vanishing a ball. The ball is allowed to slip down into the fist as the other hand appears to scoop it off.

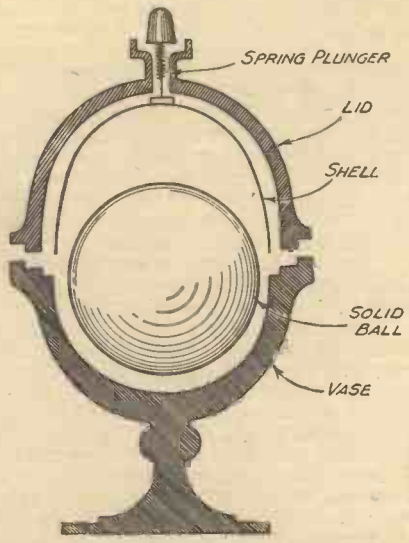


Fig. 8.—A section showing details of a mechanical vase.

give sufficient clue to the mystery to worry about.

Fig. 9 shows a stand for a quite wholesale production of billiard balls. This consists of a board pierced with any reasonable number of holes and decorated to choice. It stands upright on the table. The conjurer proceeds to catch billiard balls from the air and place them in the holes of the board until all are occupied.

Fig. 10 gives a sectional view of one of the holes in the board. As will be seen each hole is fitted with a half-shell. This shell, which should be of thin metal, is attached pivot fashion at each side by tiny screws driven through the shell into the edge of the wood surrounding the holes. A small amount of lead or solder is run along the edge of the shell which will be uppermost when the shell is reversed to show a cavity when seen from the front. The board when set up slants slightly backwards so that the shells, owing to the presence of the weight, sit firmly in their sockets whether showing their concave or convex sides to the audience.

Performing the Trick

The board being set up with all the shells turned towards the back, appears to be simply a board full of holes or cavities. The conjurer has a solid ball concealed in his hand. This he proceeds to "catch" by making a movement in the air and allowing the ball to roll to his finger-tips. The movement is similar to that described in a recent article on the money catching trick. When he apparently places the ball just caught in one of the holes of the board, he rolls it back behind his fingers and presses down the upper edge of the shell, which rotates and presents its rounded surface to the audience, giving the appearance of the ball having been placed in the hole. The moves are repeated until the board is full. The actual solid ball may be placed in the last hole, left unfurnished with a shell for the purpose. The entire board full of balls may be again vanished by turning the board upside down under cover of a cloth, when the shells will reverse themselves by virtue of their weighted edges, and retire behind the board. In this case, however, every hole must be fitted with a shell, the solid ball not being placed in the board at all.

A Combination Trick

Finally here is a combination trick with a ball and a borrowed ring.

A small ball with a hole in it and a long rod on which it may be threaded, are handed for examination while a ring is borrowed. The ball is threaded on the stick and both ends of the stick are held by members of the audience. The ring is covered with a cloth and held by a third spectator over the ball. At a word from the performer the ring appears threaded on the rod and the ball appears in his hand. Rod and ball are again examined and the ring returned to its owner.

Fig. 11 shows the mechanical part of the secret. There is a duplicate of the solid ball, made to come apart and having a groove cut for the reception of a ring. Also required is a large handkerchief with a

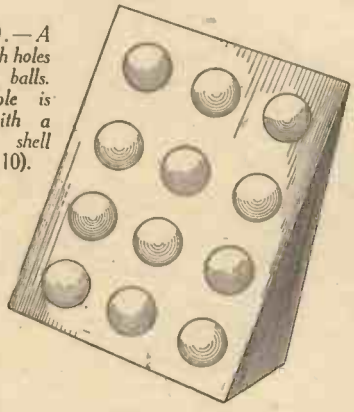


Fig. 9.—A board with holes to take balls. Each hole is fitted with a pivoted shell (see Fig. 10).

cheap signet ring sewn in one corner. The secret of the trick lies partly in the fake ball and partly in the operation of the trick.

While the solid ball and rod are being examined a signet ring is borrowed and wrapped in the prepared cloth. Actually the corner of the cloth containing the dummy ring is wrapped in the rest of the cloth and handed to a spectator, the real ring remaining in the performer's hand. The borrowed ring is now secretly placed in one half of the fake ball and the halves closed. This may be done by going behind a screen on some pretext, such as to fetch a book containing a suitable magic spell, or the operation may be carried out on the table behind some object under cover of arranging the things on the table. The fake ball is then concealed in the hand.

The Rod and Ball

Receiving back the solid ball and the rod, the fake ball is brought into view and the solid one concealed. The balls are so small that this will present no difficulty. The fake ball is then threaded on the rod

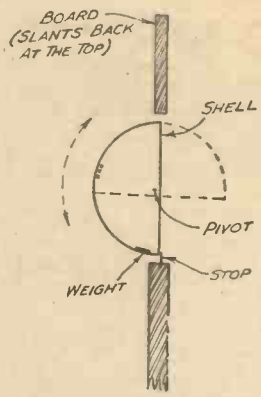


Fig. 10.—A detailed section of a half shell ball pivoted at each side to revolve a half turn and show either ball or cavity in the board.

and the solid one retained. With two people holding the ends of the rod, the folds of the cloth are arranged over the threaded ball. Under cover of doing this the conjurer opens the fake ball and conceals the two halves in his left hand, the solid ball being in his right hand. Gripping a corner of the cloth with the hand in which the halves of the ball are concealed, he flicks the cloth away, snatching it out of the hand of the person holding it. This reveals the actual borrowed ring, threaded on the rod, while the solid ball is shown in the performer's hand. The fake ball and cloth being placed aside, rod and solid ball may again be examined without giving the slightest clue to the secret of a trick that is so effective when neatly performed that it is well worth devoting a little practice to the various moves to ensure a clean and convincing presentation.

Fig. 11.—The fake ball for the ring trick and its solid counterpart.

NOTABLE RUBBER DEVELOPMENTS

Artificial Product which is Resistant to Ozone

NOTABLE developments in the treatment of rubber and the production of artificial rubber, which may in the near future have revolutionary effects on many industries, and the motoring industry in particular, but about which the public have, as yet, heard little, are recorded in the new "Britannica Book of the Year," just published.

Expansion in Germany of manufacturing facilities for a synthetic elastic, buna, which, it is claimed, is superior to natural rubber in its resistance to abrasive wear, oil, heat, and diffusion of gases, has recently been made there extensively, and the rate of production for 1938 has been set up at 20,000 metric tons.

An artificial rubber, neoprene, which is an insulator highly resistant to ozone, and also to many acids, was produced in this country on a commercial scale last year, while in the U.S.A. research proved it so successful, that over 1,500,000 lb. were produced.

A new softening process for rubber, acids produced by the oxidation of petroleum, was also introduced, and the discovery of a age resistor, hydroquinone mono benzyl ether, non-staining on exposure to light, which imparts to rubber compositions excellent flexure resistance in addition to retarding their deterioration, was also reported.

The new developments are likely to be of especial interest to the motor industry, as approximately 80 per cent. of the world's consumption of ordinary rubber is used by that industry.

EXPERIMENTS WITH POLARISED LIGHT

Spectacular Results with the Simplest of Apparatus

ALTHOUGH this article is by no means intended to be theoretical in character, it is necessary, for the sake of the newcomer to experimental science, to explain very briefly the nature of what is called polarised light.

Light, as we all know, is, in the terms of the wave theory, due to a wave motion in the ether which travels outwards from its source with the approximate speed of 186,000 miles per second. In the case of ordinary light, these waves vibrate in all conceivable directions or planes across the path in whose direction the light is being transmitted.

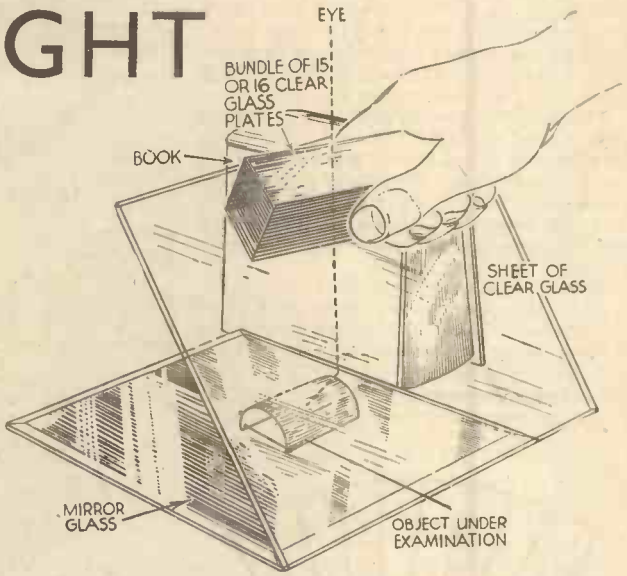
It is possible, however, by reflecting light rays in special conditions or by passing them through certain crystalline bodies, to comb out, as it were, all the light rays vibrating in different planes and to allow to pass only those rays which vibrate in one particular plane.

Such light is said to be "plane polarised," or, in short, to be "polarised," and, as such, it possesses properties some of which are quite different from those of ordinary or non-polarised light.

Colour Effects

Examined in polarised light, there are a number of materials which give rise to remarkable colour effects, many of them being decidedly spectacular. Mica is one of these materials, and, often enough, a sheet of mica or even the merest scrap of this mineral which, when viewed in ordinary light, appears merely transparent and uninteresting, will take upon itself, when submitted to polarised light examination, the most splendid and many-hued colourations.

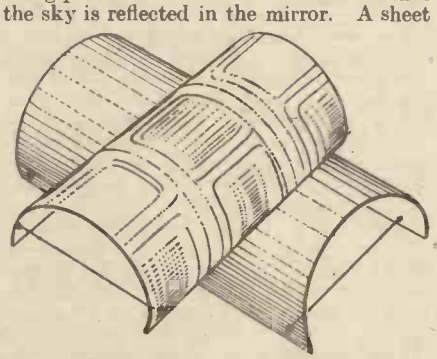
Scientific text-books have a trick of dealing with the phenomena of polarised light in a very abstruse manner and of making one believe that such phenomena can only be observed by means of complicated and expensive apparatus. As a matter of fact, however, it is the simplest thing in the world to fit up an efficient polarising apparatus and to examine quite a number of materials through it.



Showing the very simple "polariscope" or apparatus for viewing objects under polarised light.

Apparatus Necessary

The polarising apparatus necessary for observing mica, strained glass and other materials consists, as reference to the diagram will show, merely of a sheet of mirror glass laid flat on a table, the table being placed in or near to a window so that the sky is reflected in the mirror. A sheet of ordinary clear glass is allowed to lean over the sheet of mirror glass, the clear glass being retained in position by resting its edge on a book or some other convenient article.



Showing peculiar pattern created by two superimposed mica semi-cylinders when viewed under polarised light.

On the horizontal sheet of mirror glass is placed the object which it is desired to view under polarised light.

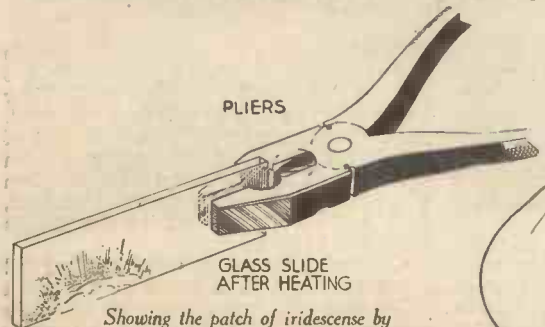
The experimenter now takes up a bundle of clear glass plates—approximately fifteen or sixteen of these constitute a suitable bundle—and, holding them a few inches above the inclined sheet of glass, looks through the bundle of glass plates on to the article which has been placed upon the horizontal mirror glass below the inclined sheet of glass.

If the object under examination is a suitable one for polarised light observation, and if the conditions of viewing are right, it will at once be seen in most resplendent colours, ranging through violet, blue, green, orange and even deep red.

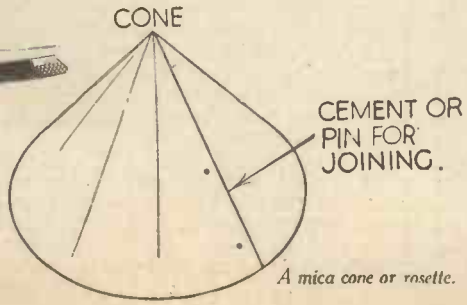
Ordinary sheet mica, a piece, for instance, taken from an old gramophone sound-box, is about the best material for polariscope viewing under these conditions, because nearly every sample of mica, particularly if it is strained in some way, shows up in wonderful colours under the polariscope.

The Glass Sheet

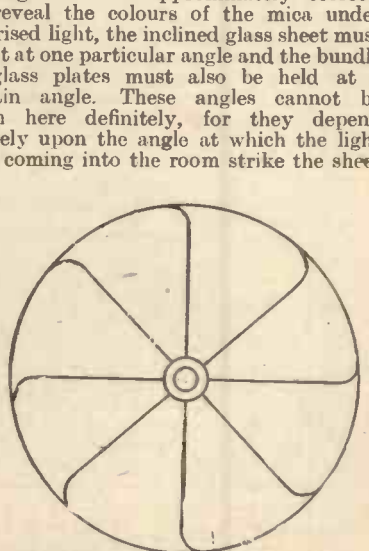
Note, however, that the conditions of viewing must be approximately correct. To reveal the colours of the mica under polarised light, the inclined glass sheet must be set at one particular angle and the bundle of glass plates must also be held at a certain angle. These angles cannot be given here definitely, for they depend entirely upon the angle at which the light rays coming into the room strike the sheet



Showing the patch of iridescense by which the polariscope reveals the strained area of a sheet of glass which has been heated.



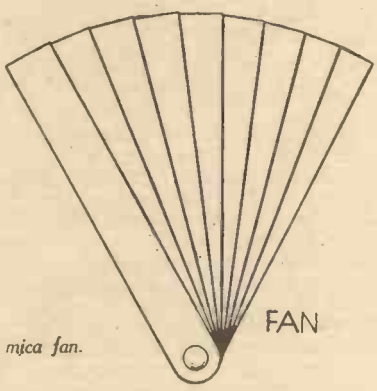
A mica cone or rosette.



of mirror glass. As a rule, however, the bundle of glass sheets should be held slantingly, and with a sideways slant, also, so that the line of sight passes very obliquely through them. The glass sheets must, of course, all be quite clean and free from grease, but they need not be very large. Indeed, ordinary plain microscope glass "slips"—2 in. by 1 in.—function very well when used for this purpose.

Most sheets of mica, particularly if they are cracked or "starred," will show up in colours well when submitted to polarised light examination. But they will usually show up still better when they are strained in some way, such as by being bent or curved into cylinders or other simple figures.

For demonstration purposes it is, indeed, a good plan to prepare a number of these mica figures. Thus, for instance, by curving a sheet of mica into semi-cylindrical form and maintaining it permanently in that condition by passing a wire through its opposite ends a very fine polariscope object



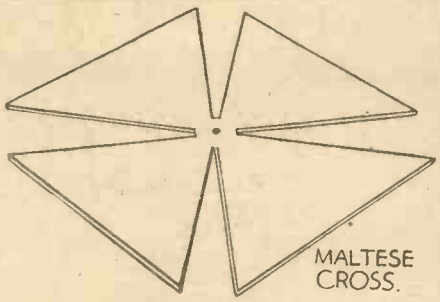
A mica fan.

can be provided, one, indeed, which will almost glow in gorgeous colours when viewed under the polarising apparatus above described.

A Striking Result

More striking still is the result obtained when two such semi-cylinders of mica are superimposed, one being laid on top of the other and at right angles to it. Under these conditions, a very definite coloured pattern, similar to the one shown in the diagram, will be obtained.

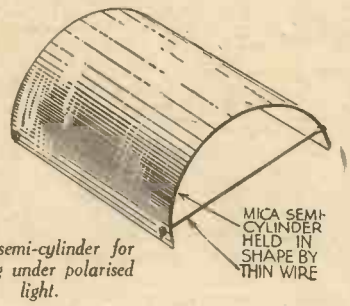
The mica star, the Maltese cross, the fan, the wheel and the cone are other examples of permanent exhibits for polariscope viewing of this transparent mineral, for, under these conditions of more or less permanent strain, the normally clear and transparent



A mica Maltese cross.

mica shows up in a variety of harmonious colourings.

These mica "forms" or figures are illustrated on this page, the mica cone, be it noted, being made by cutting a small sector out of a circle of thin mica and by



Mica semi-cylinder for viewing under polarised light.

joining the cut edges with cement or a small pin.

Properly annealed glass will not show up in colourings under the polariscope, but if there is the least internal strain present in the material the area of strain will at once be revealed by bands of colour. Thick glass articles such as cast-glass bottle stoppers, glass paper weights and so on, are usually improperly annealed and hence their internal strain reveals itself well under polarised light.

Again, if a slip of glass which does not show up in colours under the polariscope and which is, therefore, free from internal strain, is grasped between a pair of pliers and subjected to compression (short, of course, of actual breaking), the glass slip being at the same time viewed under polarised light, the development of the strain in the glass will be seen by the growing in intensity of a band of colours. As the pressure is taken off the glass slip, the colours will disappear.

A similar result is often obtained by heating a piece of ordinary sheet glass, although, in this instance, the strain due to the heating often becomes permanent.

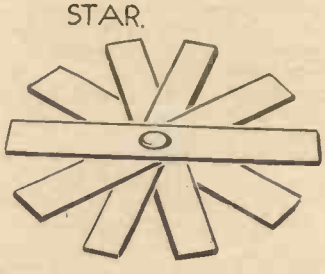
Brilliant Colourations

Some white and transparent minerals, such as calcite, certain varieties of quartz and various spars, particularly when ground into thin sections, display brilliant colourations when viewed in polarised light. So, too, do a number of very ordinary semi-transparent materials such as finger-nail parings, sections cut from horses' hooves, cows' horns, the quills of birds' feathers, glue, and jewels, such as topaz and amethyst. A spectacle lens ground from what is known as "Brazilian pebble" also makes a fine polariscope object.

There are, in addition, a number of chemical substances which, in crystal form, display wonderful colours in polarised light. Here are some of these materials :

Acetanilide, nickel sulphate, potassium bichromate, Vanillin, zinc sulphate, salicin, potassium nitrate, potassium ferrocyanide, magnesium sulphate, coumarin, copper sulphate, caffeine, ammonium oxalate, oxalic acid, tartaric acid, salicylic acid, picric acid, hippuric acid, urea, grape sugar, uranium nitrate, barium chloride, potassium chlorate.

The best way to view these materials under polarised light is to allow a moderately dilute solution of the material to crystallise itself out on a sheet of glass, so that the crystals obtained are very thin and transparent. The sheet of glass containing the crystallised material is then merely laid upon the mirror glass sheet of the polarising apparatus.



A mica star.

In a practical article such as this, it is impossible to go into the reasons why certain materials, and particularly those bearing inward strains, give rise to so many brilliant colourings in polarised light. The various phenomena are due to complex light interferences in the various materials which are only made manifest when subject to one-plane light rays or, in other words, to the action of polarised light.

Increasing Use of Aluminium

SIGNIFICANT figures on the increasing production of aluminium in comparison with other metals are contained in an analysis of metal production during 1937.

Comparing the tonnages for 1937 with corresponding figures for 1924, the analysis indicates that the production of aluminium and of nickel has increased three-fold while the production of gold has doubled. Much smaller increases are shown by other metals; copper having increased by 74 per-cent., zinc by 66½ per-cent., tin by 47 per-cent., iron by 42¼ per-cent., lead by 33 per-cent., and silver by only 6 per-cent.

Before the war, aluminium came sixth in order of production of metals by weight, but is now fifth in the list. The extreme lightness of aluminium places it fourth among metals when measured by volume, for 100 tons of aluminium are equivalent in volume to 266 tons of zinc, 270 tons of tin, 290 tons of iron, 327 tons of nickel, 330 tons of copper, 389 tons of silver, 419 tons of lead, or 714 tons of gold.

The use of aluminium has developed much more rapidly than the use of the older industrial metals. There were 825 tons of aluminium produced in 1913, 2,486 tons in 1924, and 5,236 tons in 1937 for every million tons of iron produced in each of those years. The figures for volume are even more striking, there being 2,400 cubic feet of aluminium in 1913, 7,230 cubic feet in 1924 and 15,230 cubic feet in 1937 for every million cubic feet of iron produced. In 1913 there were 230,800 cubic feet of aluminium produced for every million cubic feet of lead, but in 1937 aluminium was produced in greater volume than lead, with 1,232,000 cubic feet to the million cubic feet of lead.

Comparing the volumes of aluminium and silver produced, it is found that for each cubic foot of silver there were 39 cubic feet of aluminium in 1913, 89 cubic feet in 1924 and 251 cubic feet in 1937

STARGAZING FOR AMATEURS

A NEW SERIES

By N. de Nully

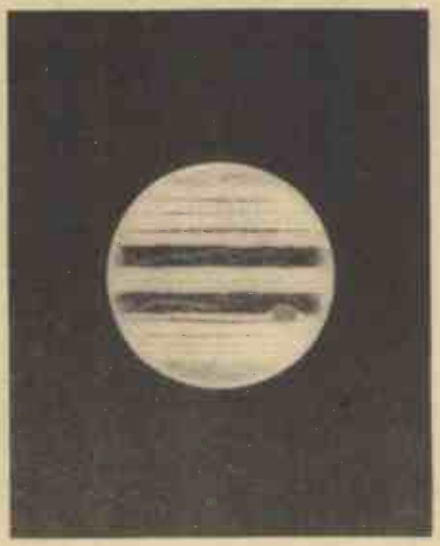
A GUIDE FOR AUGUST

BOTH Mercury and Mars are temporarily lost in the rays of the sun; but Venus may be seen for a short while in the twilight low over the western sky line. On the evening of the 28th it will be close to the crescent Moon; but the nearest approach (twice the apparent lunar diameter) will not be reached until midnight; meanwhile both will have set.

The Planet Jupiter

The planet Jupiter now rises in the east about 9 p.m. and will be above the horizon all night. It will be "in opposition"—that is, on the opposite side of the Earth to the Sun—on the 21st, when its distance from us will be reduced to 372,825,000 miles. It will then be at its closest to us this year and nearly 12,000,000 miles nearer than it approached last year. Viewed through a small astronomical telescope using a low-power eyepiece, the giant planet and its four principal "moons" afford a striking sight; especially if one of the latter happens to be passing in transit in front of the gleaming disc. Should the instrument be of sufficient aperture, both the satellite and its inky shadow will be clearly perceptible. The most conspicuous features of the Jovian disc are two broad chocolate-coloured "belts" separated by a wide lustrous equatorial zone, which is traversed its entire length by a faint central line. These north and south equatorial girdles appear to be in a continuous state of disturbance, their mottled textures diversified by dark patches and curving light streaks which alter in shade and tint in an incomprehensible manner. Even the Great Red Spot, embedded in the south equatorial belt, undergoes periodical fading, sometimes to the verge of extinction. On the polar sides of the main equatorial belts lie the bright north and south tropical zones; and beyond these, the less conspicuous narrow temperate belts. The regions surrounding the poles are delicately shaded. The diagrammatic drawing on this page indicates the position of the Jovian bands and Great Red Spot, all of which of course are not always clearly visible on the same occasions. Much depends upon telescopic aperture, the observer's vision and atmospheric conditions. It is particularly interesting to watch the "daily" rotation of the planet on its axis. This is performed in the comparatively short period of 9 hours 50 minutes, and consequently the entire surface can be viewed between twilight and dawn. The prominent stripes exhibited by Jupiter are considered by certain authorities to be merely colour effects due to the varying temperatures of the gaseous layers constituting the cloudy covering, and not to rifts in the latter exposing strips of the actual core beneath. While this theory might to a great extent account for the unequal speeds at which parts of the glistening surface rotate, it is difficult to reconcile it with the well-established permanence of the markings. For many years Jupiter was considered to be semi-polar, rendered self-luminous by its own internal heat. Although modern investigations subsequently pronounced it to be an intensely cold body, this dictum has in turn been lately challenged. One argument against self-luminosity is that were this the case, the satellite shadows would not be projected upon the globe of the planet; and, even if they were owing to the overpowering strength of flood-lighting by the Sun, they would not be so deeply black.

There are not any notable configurations of the four principal "moons" this month; though there will be an interesting eclipse of Sat. II behind the planet itself on the 9th. The disappearance at 9.59 p.m. and emergence at the opposite edge at 1.23 a.m. the following morning, may be watched by means of quite a small telescope; Jupiter will then be in the south-east. Saturn rises in the east at 10.10 p.m., and will be observable soon afterwards until daybreak. The southern faces of the rings are now being presented to us, but the system is still only partially open.



The planet Jupiter. Diagrammatic drawing showing position of the principal "belts." The margin along the rim is due to the obliterating effect of the dense enveloping atmosphere.

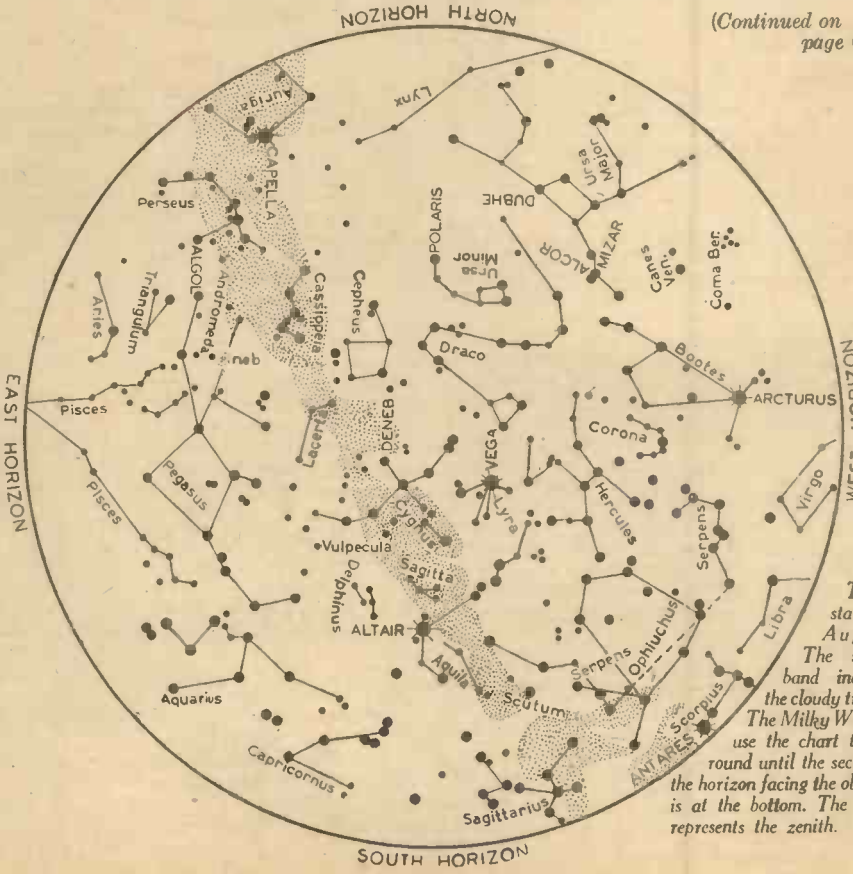
Shooting Stars

Meteors of the Perseid stream are expected to put in their usual appearance on the nights of the 10th, 11th, and 12th. Unfortunately the Moon will be at or near the full on those dates, but a number of blazing "fireballs" are sure to be perceptible as they hurtle across the sky like rockets. The circumpolar constellation Perseus, from which these meteors seem to radiate and thus obtain their designation, will be well up in the north-east by about 11 o'clock. The denser portion of the stream may, however, not be encountered by the Earth until the small hours. This particular shower has provided an annual show of celestial fireworks since ancient times, when they were given the name of "The Tears of St. Lawrence" owing to their invariable arrival on the day dedicated to that saint.

Notes

A few weeks ago the Astronomer Royal told the Board of Visitors at Greenwich Observatory that the Earth is not such an absolutely perfect timekeeper as has been supposed. Nevertheless, it is a far better one than the best terrestrial clock. While the accumulating error—resulting in a slight lengthening of the day—may assume scientific importance in remote ages to come, we need not get anxious about it yet,

(*Continued on page 611.*)



The stars in August. The shaded band indicates the cloudy track of The Milky Way. To use the chart turn it round until the section of the horizon facing the observer is at the bottom. The centre represents the zenith.

BUILDING A 1-C.C. ENGINE

Further Constructional Details of the First 1-c.c. Engine to be Described.

By W. H. Deller

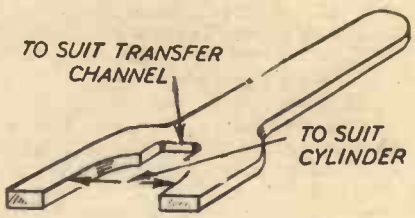
Part VII

Final Assembly

(Complete Sets of Blue Prints are now available at 5s. per Set)

THOROUGHLY wash the parts in clean petrol and wipe off dry with clean rag to make certain that the working surfaces are free from anything in the nature of grit or metallic particles.

Assemble the crankshaft into the crankcase. Pass the conn-rod with the assembled piston in position through hole in the cylinder boss in the crankcase making certain that the deflector on the piston lies towards the open side of the crankcase and also that the chamfered side of the big-end bush is likewise disposed. Push the crankshaft slightly forward and screw in the crankpin tightly with the key made for this purpose. It may be as well to mention that all working surfaces should be thoroughly oiled with a thin lubricant before assembly. This initial application of oil is important, as it ensures that the subsequent introduction of lubricant via the fuel will perform its intended purpose in an efficient manner.



The key for the cylinder.

The Cylinder Barrel

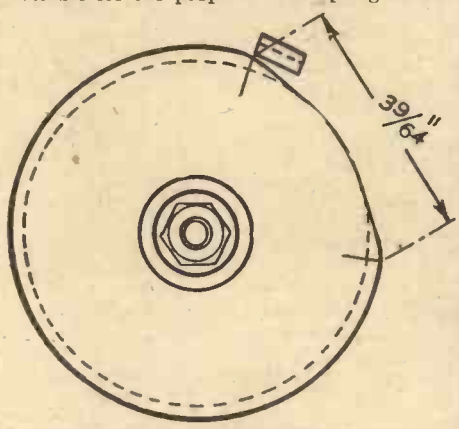
Screw the cylinder barrel in position, lightly coating the opposing faces of the joint between the cylinder and crankcase with heat and petrol-proof liquid jointing before so doing. Use may be made of a simple special spanner for finally tightening the cylinder without fear of damage. This is made from sheet metal as shown in sketch, the semi-circular portion fitting the cylinder barrel snugly and the slot fitting the sides of the transfer channel in a like manner.

As the drain plug requires to be removed occasionally, a soft washer of $\frac{1}{32}$ in. material should be interposed between the head of the plug and the bottom boss before screwing home.

Remove the carburetter from the valve body. Smear the male thread on the valve body with liquid jointing and screw into the crankcase. When finally tightened the face of the boss round the female thread should lie parallel with the under surfaces of the holding down lugs on the crankcase. Replace the carburetter body, introducing a little liquid packing to make an airtight joint. Examine the bore of the valve body to make certain the disturbance of the parts has not interfered with the free working of the valve. Should it have done so, make the necessary correction by lapping away any slight irregularities.

The Valve

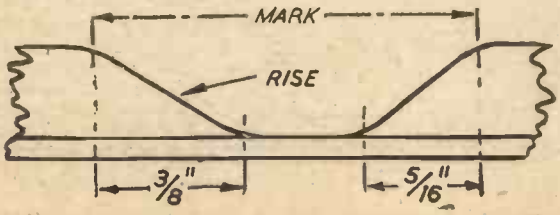
A small compression spring is required for the valve This should be of such external diameter as will permit it to slide freely in the valve; the free length is $\frac{7}{8}$ in. and the number of coils 10. The end coils should be finished flat. No. 28 s.w.g. hard phosphor bronze wire will make a spring suitable for the purpose. The spring must have sufficient strength to return the valve without any suspicion of "stickiness" if it is to follow the contour of the face cam at speed.



Details of the ignition cam.

Pass the clip of the moving contact over collar on the long boss of the crankcase and secure temporarily with the screw and nut. Spring the fixed contact clip over the insulator bush and secure in position on the extreme end of the crankcase boss. Tighten in position with the contact point uppermost and central.

After placing the small thrust washer in position secure the cam plate on to the squared end of the crankshaft with a nut. Adjust the moving contact clip to bring the point on the arm exactly over that on the fixed clip and lock up.



(*Left*) *The development of the face cam.*

Cutting the Cam Plate

Rotate the engine in a clockwise direction —viewing the engine from the propeller end—and when the piston reaches a point closely approximate to $\frac{1}{16}$ in. before top dead centre, make a mark on the front end of the cam plate opposite to the left-hand edge of the moving contact arm. From this point mark another line to the right-hand side at a chordal distance of $\frac{23}{64}$ in. away and file away the metal as shown in the diagram. It should be noted that the radius forming the lifting side of this cam should be less abrupt than the left-hand side.

Now for the valve operating cam. At $\frac{3}{32}$ in. beyond the bottom dead centre make a mark on the side of the cam plate which is to form the face cam. Continue rotating in a clockwise direction to top dead centre and make a similar mark. The edge of the cam plate is cut and filed between these points as shown in diagram. Here it should be noted that the rise is slightly less abrupt than the drop. Replace the cam and by removing the jet it will be possible to view the opening and closing positions of the valve. It may be, if the dimensions affecting the valve gear have not been rigidly adhered to, that some extra filing may be required to give the duration of opening stated. When this has been ascertained, draw file and highly polish the filed surfaces, after which the part may be hardened and tempered.

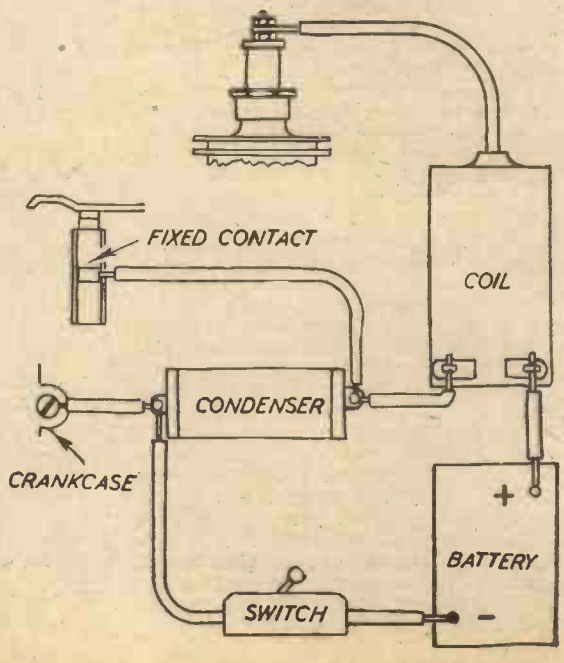
Adjusting the Contact Breaker Arm

The bent down or operating portion of the contact breaker arm will require adjusting by filing to allow the points to make a flat contact when the arm is over the filed away portion of the cam plate. To ensure that the points do contact properly there should be a clearance between the end of the arm and the cam face of from .003 to .005 in. in this position. The edges are then finished to shape and polished.

Completing the Assembly

The end cover or cap is screwed in after

(*Continued on page* 611)

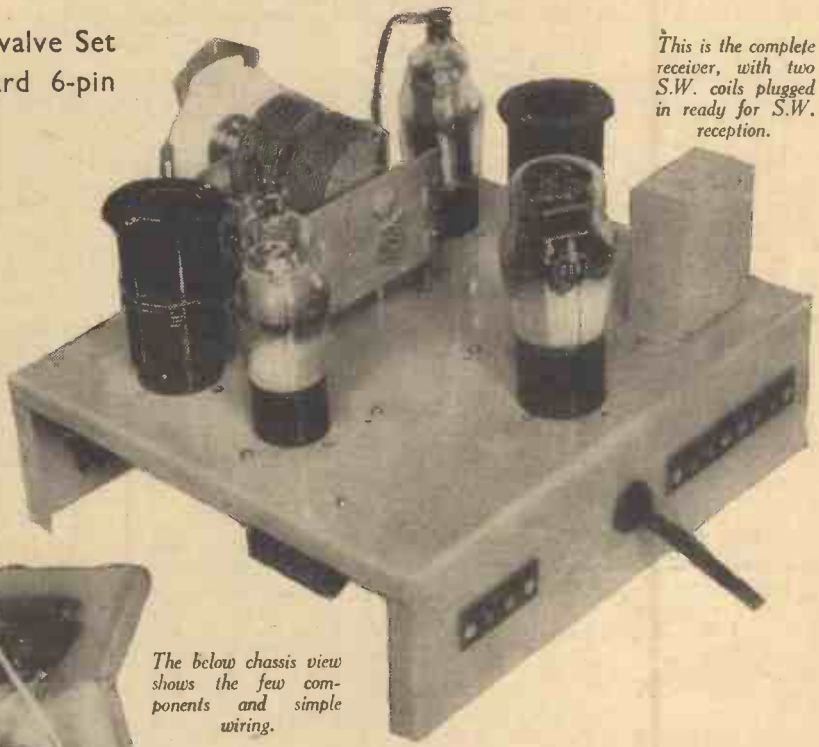


(*Right*) *Wiring plan for the coil, condenser, switch and battery.*

"PRACTICAL MECHANICS" WIRELESS EXPERIMENTER

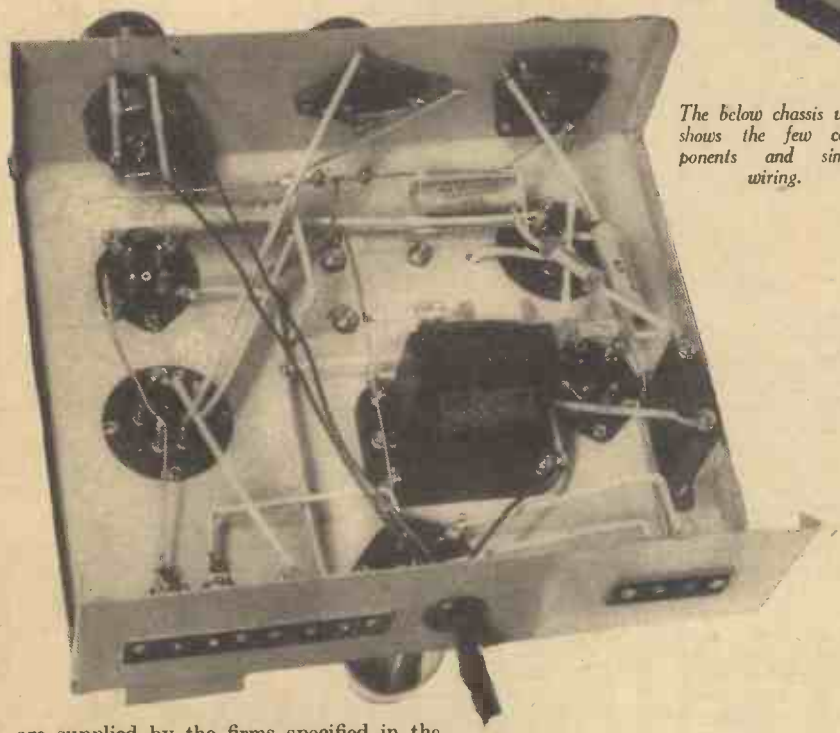
THE "MULTUM" ALL-WAVE THREE

An Economical Simple-to-Build Three-valve Set for Use on all Wavelengths. Standard 6-pin Plug-in Coils are Employed



This is the complete receiver, with two S.W. coils plugged in ready for S.W. reception.

WE have received many requests for a low-priced all-waver which could be relied upon to give good results on all wavelengths, and it is obvious that such a type of receiver could not be built around any standard all-wave tuning unit. Accordingly, the Multum has been designed round the standard type of 6-pin plug-in coil, and, as will be seen from the accompanying theoretical diagram and illustrations, two of these coils are employed in this particular set. Furthermore, in response to the demand for a low-priced receiver, we have utilised special American-type valves and other components which



The below chassis view shows the few components and simple wiring.

are supplied by the firms specified in the list of components. To simplify the constructional work and thus bring this receiver within the reach of the youngest tyro, we have also specified a special chassis which is supplied by the manufacturers with the valve and coil holders and other necessary essentials riveted into position.

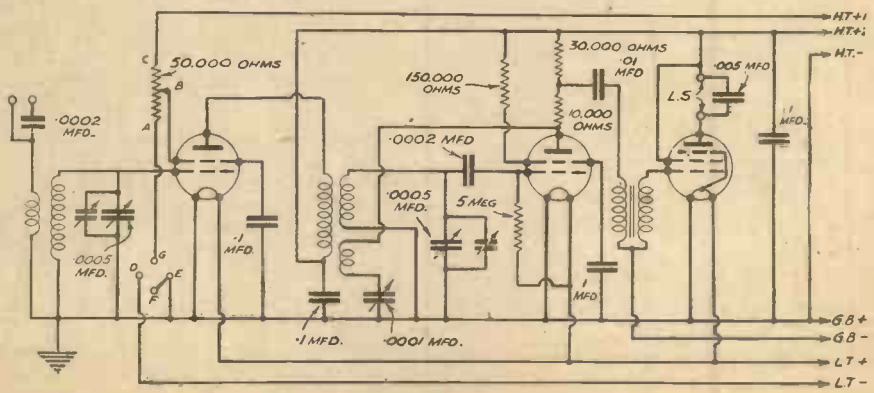
The Circuit

The circuit is of the H.F. detector and output type, but two S.G. valves are employed for the initial stages and a pentode in the output stage thus ensuring a very high output in each stage. Both the aerial circuit and the detector grid circuit are fully tuned, and therefore a two-gang condenser is employed. H.F. transformer coupling is employed in the first stage, and a parallel-fed transformer is used between the detector and output stages. A fixed tone-control condenser is included across the speaker sockets, and alternative aerial sockets are provided so that a fixed condenser may be included in series with the aerial if desired. The coils specified are of the 6-pin type with a locating plug affixed so that they may be easily inserted in the holders and wrong connections cannot be made.

By obtaining a set of these coils (they are supplied in sets of 10) it is possible to tune over the entire waveband from 9.5 metres to 2,000 metres.

Construction

The chassis can be obtained with the various holes drilled, and the valveholder coilholders and socket strips riveted into position. All that remains to be done, therefore, is to hold the transformer, condenser and tuning condenser in position, and place the two condensers and volume control on the front part of the chassis. The dial should then be attached by means



Theoretical circuit of the "Multum" receiver.

of two bolts, and the small L.F. coupling condenser should also be fitted in position near the valveholder for V2. The various resistors and fixed condensers (with two exceptions) are held in position in the wiring, and thus these should be wired into position as the circuit is completed. The two fixed condensers across the aerial and loudspeaker sockets may be placed in position when the wiring to these sockets is being carried out. It is desirable, as the receiver is employed for short-wave reception, to use a heavy gauge wire for connection, and to utilise a single length of heavy gauge bare wire for the earth return lead. The position of this may be seen from the wiring diagram on this page, and various connections may be made direct to this, using insulated sleeving over the majority of the wires to avoid any risk of damage due to short-circuits which might develop after a period of time. The flexible battery leads are attached to the transformer, common earth wire and the combined volume control and switch, and care should be taken to connect the correct leads to these points. It is preferable to cut off pieces of flex to the desired length, and as each lead is placed into position an appropriate wander plug should be attached to the other end.

Testing Out

Particular care should be paid to the connections to the grid leak and condenser for the detector stage, the leak being attached to a lead running from the L.T. positive socket on the valveholder V2, and the condenser being attached to the fixed vane connection on the gang condenser. The other ends of both of these components are then joined and connected to a short flexible lead for subsequent connection to the grid of V2. In this connection it should be remembered that these are American valves, and thus the top caps are grid connections—not anodes as in the majority of British valves.

Plug in the battery leads, connecting the positive and negative L.T. leads to the accumulator, the G.B. positive to the positive side of the G.B. battery and the negative H.T. plug to the negative side of the H.T. battery. G.B. negative should be inserted into the 4.5 volt socket for the time being, but this may be reduced to 3 volts or increased to 6 volts at a later period.

LIST OF COMPONENTS FOR THE "MULTUM" ALL-WAVE 3

One pressed steel chassis with valveholders and coilholders rivetted in position (Peto Scott).
One 2-gang condenser and distance pieces (New Times Sales).
One L.F. "Super" Transformer (Peto Scott).
One 50,000 ohm Potentiometer with 3-point switch (Erie).
Four ½-watt resistors,
10,000 ohms
30,000 ohms
150,000 ohms
5 megohms } **(Erie)**
Six Tubular Condensers:
Two .0002 mfd., Type 451
One .005 mfd., Type 451
Three .1 mfd., Type 341 } **(T.C.C.)**
One .01 Type 34 fixed condenser (T.C.C.).
One special 1 mfd. condenser (Peto Scott).
One Slow-motion dial (New Times Sales).
One .0001 mfd. Reaction condenser (B.T.S.).
One .0003 mfd. ditto (B.T.S.).
One set of three American-type valves (N.T.S.).
One set of 6-pin One-Shot Inductors (B.T.S.).
Connecting wire, battery leads, plugs, etc. (Peto Scott).
One Metal cabinet and Metal panel (Peto Scott).
One Junior 38J Loudspeaker (W.B.).
One pair of 4,000 ohm headphones (Ericcson).
One 2-volt Accumulator.
One 120-volt H.T. battery.

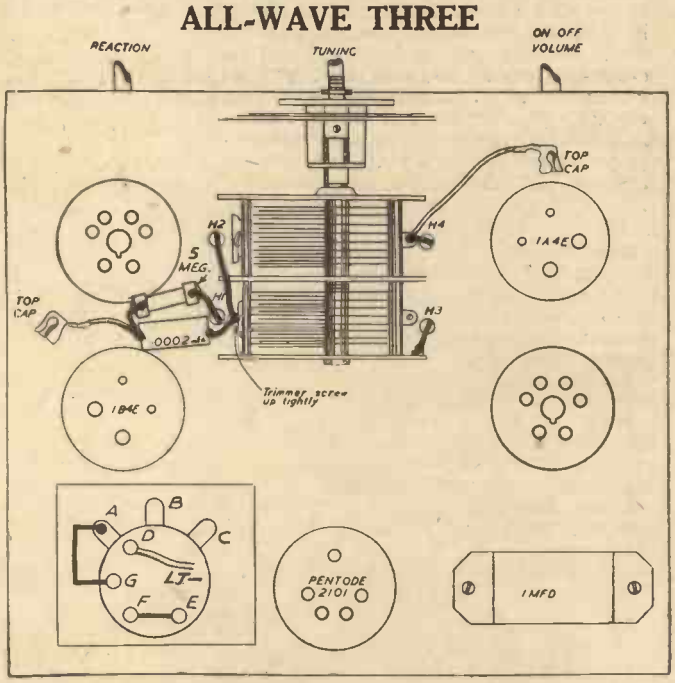
H.T. 1 should be inserted into the 72 volt socket temporarily and H.T. 2 into the 120 volt socket, when the receiver is ready for test. Connect aerial and earth, and loudspeaker, and plug in a pair of coils—preferable for the medium waves for preliminary tests. If the receiver is found to function satisfactorily the short-wave coils may be used, and if it is not desired to use this receiver for medium waves a coil such as 9/S.2—15 to 43 metres—should be used for the first tests. It will naturally be found that tuning is critical, in spite of the slow-motion condenser drive, but after a little experience it will be found quite a simple matter to use the set. The central knob in the lower row is a trimmer connected across the main condenser and should be used to complete tuning after a station has been located. During the process of tuning this should be operated in addition to the main tuning control and reaction control, and it will be found quite a simple matter to balance the three controls to get the correct tuning point. Sensitivity is controlled by the lower left-hand control which varies the voltage on the screen of the first valve, and no difficulty should be experienced in obtaining most satisfactory results with this simple set.

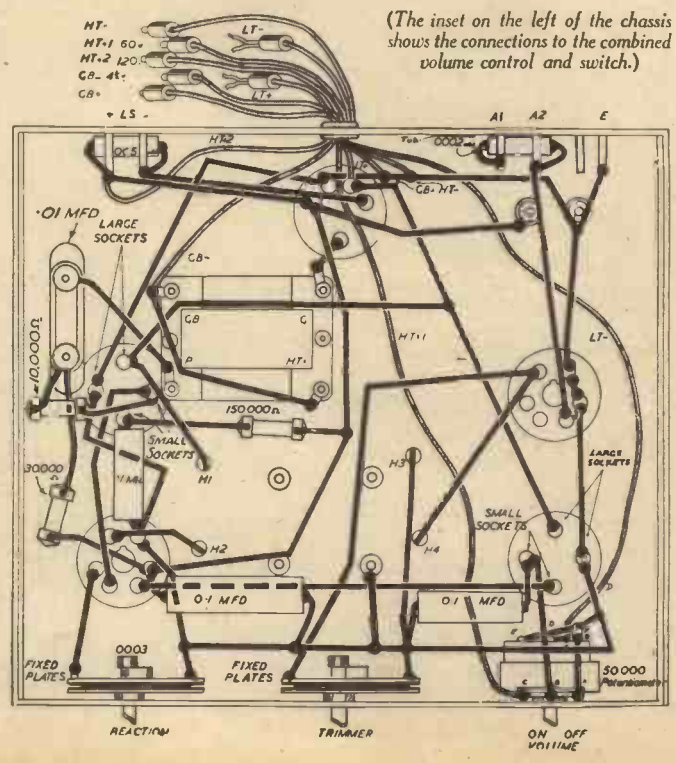
It should be housed in the metal cabinet specified and the special metal panel supplied with this cabinet should be used in order to remove difficulties due to hand-capacity effects. Although the metal or chassis will give an earth connection to the cabinet it is recommended that a short lead be attached to a screw at a convenient point in the cabinet or at the rear, and this should be attached to the earth lead or earth socket to complete the earthing of the cabinet and will prevent direct pick-up of a powerful local on the wiring of the set, and also prevent capacity effects which would otherwise upset the tuning.

Trimming

To enable the two circuits to be kept in tune a panel trimmer is provided and will be found in the centre of the lower row of knobs. This control must, therefore, be operated in conjunction with the main tuning control, and the best way to use it is to swing it backwards and forwards as the main tuning control is adjusted. On loud stations the setting will not be found critical, but on the weaker stations it will have to be adjusted in order to bring signals up to suitable strength and it must then be used in conjunction with the reaction control. Use the highest grid-bias on the output valve that can be applied without reducing volume, as this will reduce H.T. consumption and lead to more economical working.

WIRING DIAGRAM OF THE "MULTUM" ALL-WAVE THREE





(The inset on the left of the chassis shows the connections to the combined volume control and switch.)

INTRODUCING—

AN ATTRACTIVE BOAT FOLDER

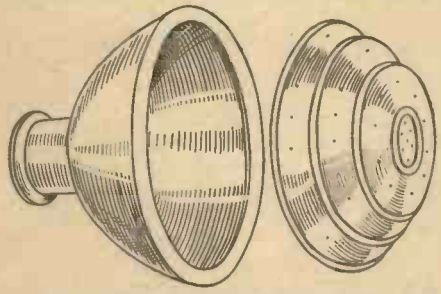
THE British Motor Boat Manufacturing Co., Ltd., Britannia House, Ampton Street, W.C.1. have recently produced an attractive 8-page catalogue in an attractive folder giving details of their complete stock of shop-soiled, reconditioned and secondhand outboard motors. A copy will be sent post free to readers upon application to the above address. *Practical Mechanics* should be mentioned when making enquiries.

A NEW FIXING DEVICE

CONTINUING their policy as "manufacturers of fixing devices for all purposes" the Rawlplug Company have recently produced a new fixing device which has many advantages. It is known as the Rawlplug Screw Anchor.

Rawlplug Screw Anchors do not in any way supersede the fibre Rawlplugs ; they have been devised to supply a demand for an anchor made of metal that would resist climatic conditions and overcome prejudices against non-metallic fixings without sacrificing the advantages of resiliency associated with the fibre Rawlplug.

With the Rawlplug Screw Anchor all difficulties previously experienced with lead plugging have been overcome successfully. The Screw Anchors fit the holes made with ordinary Rawlplug tools and should be used with screws of corresponding size, e.g. No. 8 screw in No. 8 Screw Anchor, the hole being made with a No. 8 Rawldrill.



A garden rose which is constructed in two parts. It can be used for spraying or can be adapted to form an efficient force cup.

A MULTI-PURPOSE GARDEN ROSE

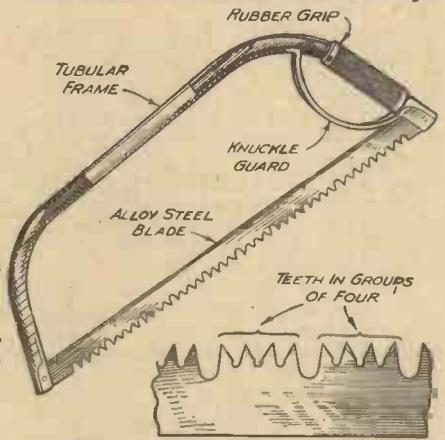
ONE of the main advantages of the rose illustrated is that it is constructed in two parts. The rose itself, fitting into a rubber cap, is easily detachable and thus, should it become clogged after using liquid manure, the cleaning process is but the matter of a few seconds. The rubber cap may also be used as a funnel and by placing it on a round stick it is converted into an efficient force cup. The price is 1s. 3d., post free.

A HANDY VICE

A HANDY little vice has now been placed on the market and as can be seen from the illustration on this page it is ideal for carrying out small jobs in the work shop. The jaws are adjusted by means of a wing nut, and a fairly strong grip can be obtained. It can quickly be fitted to a bench or table by means of the mounting bracket attached to the vice. It costs 3s. 9d.

NEW MOTORS

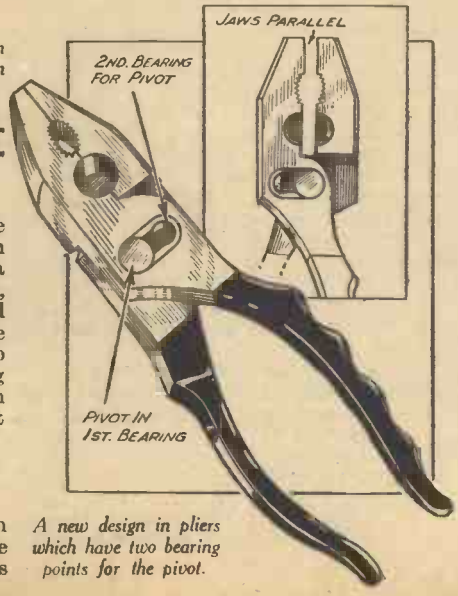
MR. HAROLD CONSTAD, managing director of Batwin Electric Motors, Ltd., has recently returned from an extensive tour of the United States and Canada, where he visited various factories represented in this country by his organisation. Arrangements were concluded to manufacture several products in this country, which will shortly be available to the Electrical industry.



The "Spear-fast" saw which is fitted with a specially designed blade which makes it very efficient in operation.

AN EFFICIENT SAW

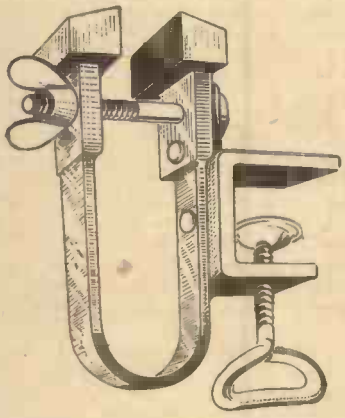
KNOWN as the "Spear-fast" this saw is, owing to its tubular frame, extremely light to use and, owing to the specially designed blade, very efficient in operation. As is shown in the inset illustration, the teeth are in groups of four, the second two teeth of each group do the cutting whilst the first two teeth of the following group do the clearing. This design also facilitates the sharpening operation. The rubber grip and knuckle guard are two further features which make for comfort in use. Three sizes are made, 24 in., 30 in., and 36 in., and the prices are 7s., 9s., and 10s. 6d. respectively, whilst extra blades cost 2s. 6d., 2s. 9d. and 3s. 3d.



A new design in pliers which have two bearing points for the pivot.

NOVEL PLIERS

ALTHOUGH at first glance, the pliers illustrated appear to be of orthodox design, a closer inspection will show two distinct bearing points for the pivot. In the first bearing position, the pliers may be used as a standard tool. By moving the pivot into the second position, as shown in the inset sketch, flat materials may be gripped much more firmly and as the jaws open much wider, pipes up to 1¼ in. diameter may be gripped. The price is 2s. 9d., post free.



This handy little vice will find a number of uses in the workshop. It can be fitted up in a few seconds and is ideal for holding small work.

A.R.P. WORK

BENNETT COLLEGE, LTD., Sheffield, is offering to teach, free of charge, anyone who has any work to do in connection with A.R.P. A special course dealing fully with air-raid precautions has been prepared.

A CLEANING OUTFIT

AN outfit is now on the market which will efficiently remove dirt and grease from the hands. Known as Palpak, it not only replaces soap and water where none is available, but does its work much more thoroughly. It can be used without water and is completely free from grit and other harmful matter and is odourless.

The Palpak outfit should therefore appeal to the most fastidious user. It retails at 2s. complete, with refill tubes at 1s. each, and can be obtained from the leading stores.

The address of the makers of any device described below will be sent on application to the Editor, "Practical Mechanics," Tower House, Southampton Street, Strand, W.C.2.

NEW INVENTIONS

Safe Permanent Waving

WHEN M. Marcel introduced those graceful undulations which enhance the glory of the heads of the fair, he caused what one associates with the history of his country—a revolution. However, it does not cut off heads but shows them off. Still, it transpires that permanent waving is not entirely free from danger. A lady whose head had been dressed in the cubicle of the coiffeur has been known to seek redress in a court of justice. The fact is that burning has occasionally happened.

It is common practice, I am told, to use protecting sachets with the heating tongs. A French company has applied to the Patent Office in this country to patent a hairdressing appliance which, it is contended, will make for safe permanent waving. There is provided a moistener comprising a hollow structure provided with cavities or indentations for storing liquid, pasty or solidified hair-treating material which can be volatilised when the latter is heated.

I have not witnessed the mysterious rite of permanent waving in the temple of beauty. But I understand that the fair victim is therein temporarily made to resemble one of the Furies, whose locks were horrid serpents. It is hoped that the new process will enable her to leave the ladies' saloon with a cool head.

Re Marks

EVERY article sent to a laundry must have a mark to identify the owner. This may be impressed on the fabric or on a tab or slip to be attached to the article.

What is claimed to be an improved method of marking is the subject of an application recently accepted by the British Patent Office. The inventor of this new process contends that, when cotton or linen is marked with marking ink of the ordinary kind, the impression tends to spread itself "like a green bay tree." And, owing to repeated ablutions, the marks, *à la* old soldiers, simply fade away. The inventor does not use these similes; but that is what he means. He further maintains that even when the article is freshly marked, there does not appear a full, deep shade.

According to the process of this inventor, the mark is applied to a spot on the fabric made receptive to the ink, by a water-insoluble material, which is capable of penetration or swelling by the solvent in the ink used.

This might be styled the N.B. system, since N.B. stands for "nota bene" which being interpreted is "mark well."

Automatic Gate

A BRAND new five-barred gate is not seen every day. During a week-end in Wiltshire I have seen one leaning against a farm house. It was there ready to replace an aged gate which, I was told, had been demolished by an infuriated cow. Probably it was a bull, as the average cow is generally complaisant.

It is a far cry from the familiar five-barred gate to the latest thing in automatic vehicle-operated gates. This is an American invention which comprises a swinging gate carrying a sliding bolt, resilient guard members mounted on either side of the gate, buffing plates pivoted to the guard members and carrying cranks. These cranks cause the bolt to operate, and the gate is opened when one of the buffing plates is pressed inwards.

Speaking of gates intended to keep cattle from straying moves me to mention that in Cornwall I have seen bars laid horizontally over a ditch. It is a curious fact that horses will not cross such an arrangement which seems to be as effective a barrier as a five-barred gate.

History of the Bus Seat

IT is obvious that while that patient and worthy individual, the bus conductor, is collecting fares, the seats of his bus are perpetually collecting dust. And it is not gold dust. I learn that, as far as the London Passenger Transport Board is concerned, the seats of buses are vacuum-cleaned daily. Perhaps I should say nightly. However, I understand that experiments are being made to produce a fabric which is impervious to dust. This ideal material may shortly be an enjoyable fact.

A survey of the gradual improvement of the bus seat is an interesting review. There are still venerable folk who can recall the antiquated horse bus, whose outside passengers climbed a perpendicular ladder. It was no Jacob's ladder which angels ascended and descended. The modest Victorian lady would not lower herself by scaling such a height. Arrived on the roof, the male passengers sat back to back at right angles with the driver upon an unmerciful seat nicknamed "the knife-board." There they ride alfresco—the target of the weather's slings and arrows in the shape of rain, hail and sleet.

Lounge on Wheels

THEN appeared on the top deck of the bus an arrangement of seats like the pews of a church with an aisle down the centre. The conductor resembled the sidesman taking up the offertory. As the dome of heaven was still the roof, various efforts were made to keep the seats immune from dampness. One attempt resulted in an apron apparently the young brother of a roller blind. Another idea was a reversible seat. Upon one side becoming inconveniently moist, it could be turned down.

When the vermilion two-storied bus blazoned like a gorgeous sunset, the seating accommodation began to develop into a state approaching luxury. The angle of the sitter was catered for, and the seats, like easy chairs, became more resilient. Eventually rubber filling was used. This enabled the staff of the London Passenger Transport Board to invent upholstery that could be fitted and removed in one piece. I am informed that this was patented and introduced in 1933. The present type of seat is an upholstered tubular metal chair. And the current bus is practically a moving lounge.

The seat of the driver has also received attention. One of its characteristics is an adjustable arrangement which adapts itself to the stature of the driver. An easily operated screw-mechanism permits the seat to dovetail with the dimensions of the Jehu of our motor chariots. Like a dentist's chair, it can be lowered or raised, though with the object of drawing something more tractable than the average tooth.

Interesting to Gardeners

OWING to the long period of drought, our lawns have not been with verdure clad. Parched through lack of rain, the once fresh, green blades themselves make hay while the sun shines. But, as they continue to grow, though not with their normal luxuriance, it is still necessary that they should be the victims of that rotatory guillotine—the lawn mower.

In this connection, the amateur gardener will be interested in a new appliance which will enable the box of the lawn mower to accommodate about three times the quantity of grass it has been accustomed to carry. When the cuttings begin to overflow, a movable panel in the box, fixed well back, compresses the grass behind it. The cuttings can be scooped up with the hand and placed beyond this panel. As the amount of cuttings becomes greater, the panel can be lowered.

The increased capacity of the box means a saving both of time and labour. And it is affirmed that the augmented weight assists the rolling action of the mower. A yet further virtue of this device, for which a patent has been applied, is that the cuttings are prevented from trickling out of the box.

Accommodating Cuff-Links

THE fashion of men's garments is not subject to the change which characterises the dress of the fair sex. Yet there are slight variations. For example, whereas, during the last few years, trousers have definitely widened, this has been compensated by a narrowing of the coat sleeves. As a consequence, what may be called the inner tube—the sleeve of the shirt—has also decreased in latitude. Now, when one doffs the intimate garment in question, the limited cuff makes it not easy for a big-fisted man to remove his shirt without undoing a link. Expansive links overcome the difficulty, provided they endure without disintegration the constant stretching.

An inventor has recently had accepted by the British Patent Office an improved cuff-link of this type. The special feature in this case is that the hinges and arms are stamped or pressed out of one strip of metal. Presumably such a construction will prevent the links from dissolving partnership.

Pocket Dialler

DEVICES for operating the dial of a 'phone have long been in existence. They may consist of a simple detached rod or may be permanently fixed to the instrument. However, in spite of these contrivances, dialling is usually done by a pencil, or by that tip that no one parts with—the summit of the index finger.

The characteristic feature of a newly invented dialler is a groove, a projection or like break in its surface which prevents it from slipping out of the apertures of the dial. The inventor has had in mind a device which can be carried in the pocket or in a lady's handbag. If desired it may be equipped with a protector. And it may be used, like many pencils, as an advertising medium.

Another pocket article which has come to my notice is a letter weigher whose dimensions approximate to those of a fountain pen. The tiny scale will weigh letters from half an ounce to half a pound. This appliance will test the avoirdupois of one's correspondence which, all the same, may not carry much weight. DYNAMO.

FINDING BREAKING POINT

How all types of Building Materials are Tested by special machines, which subject the materials to Tremendous Pressures to find their Breaking or Bending Point.

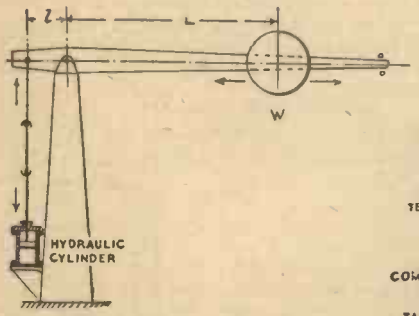


Fig. 1.—The single lever machine for testing the tensile strength of metal.

ALTHOUGH all engineering structures have to be strong enough to stand a big margin of safety over the actual loads and stresses to which they are subjected, it is the general practice to submit all materials of construction for mechanical purposes to definite strength tests. This applies not only to metals, but also to woods and most building materials.

These tests are made to determine the ability of the material to stand tension, compression or crushing, shearing, bending, torsion or twisting, and so forth, according to the nature of the work which the material structure has to perform.

Apart from the general suitability of the particular material in question for the use to which it is put, the greater the strength of that material the smaller the dimensions will have to be, while the cost and weight will be less. In some cases, such as in aircraft construction, the matter of great strength combined with the lightest weight possible is of paramount importance, and the cost is a secondary consideration.

Testing Department

Most up-to-date engineering works have some sort of testing department equipped with special machines for making tests of the materials of which they use most, or for research work, but the importance of having the most reliable data for both construction and research purposes, is indicated by the enormous establishment of the National Physical Laboratory at Teddington, near London. Here acres of ground are covered with buildings and machines of every description, where the highest technical ability combined with ingenious testing appliances is at the disposal of manufacturing firms as well as Government departments who wish such information.

Tensile Testing Machine

The principal machine for most metal testing is the tensile testing machine. The simplest form of this is shown in Fig. 1 which gives the diagrammatic form of a single lever machine, based on the well-known principles of the lever. The test specimen, made from the actual material to be used, is held in suitable grips, one end of which is either anchored to a fixed point, or held by a hydraulic-cylinder or screw-straining attachment, while the other end is connected to one end of a lever carrying a sliding poise, or weight, W, which

Figs. 4 and 5 (left).—Forms of grips; (right) standard tensile test piece.

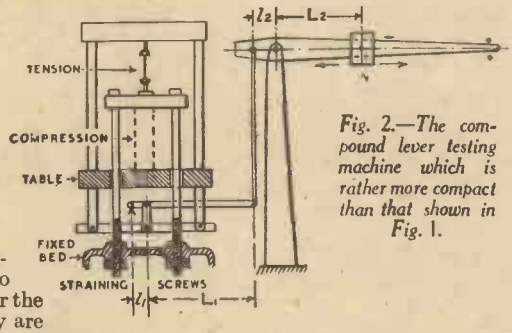


Fig. 2.—The compound lever testing machine which is rather more compact than that shown in Fig. 1.

can be moved along its length as in a steelyard or ordinary weighing machine. The distance *l* in Fig. 1 is made as short as possible in relation to the variable distance L The pull exerted on the test piece

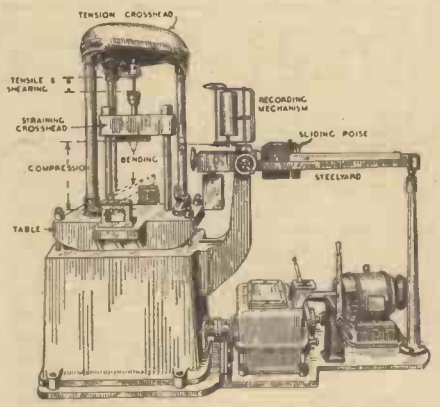


Fig. 3.—The Avery universal testing machine.

multiplied by the short lever *l* is equal to the weight W multiplied by its long leverage L. The weight W is slowly travelled along the steelyard by a screw or other means until the test specimen breaks, when the measurements are taken. In some machines a compound system of levers is used, as in Fig. 2, which makes a rather more compact machine and enables a smaller weight to be used. In large tensile testing machines pulls of 100 tons and upwards are possible, while for special purposes they may run to many times this figure.

Fig. 3 shows one form of compound lever machine. The table rests on knife edges fitted to cast steel weighing levers connected to a load indicating steelyard, all the bearing points being made as "knife edges" for greater accuracy. The upper tension crosshead is supported on steel columns secured to the compression table. A straining crosshead is secured to steel screws which engage with rotating nuts in the base of the machine, and which are rotated by worm gearing driven by an electric motor.

Fig. 6 (right).—Forms of fractures.

Recording Mechanism

Sometimes a recording mechanism is fitted, which gives a graph diagram on paper of what actually happens during the period of the test.

Tensile, or shearing tests are made between the straining crosshead and the tension crosshead; compression, or crushing tests between the straining crosshead and the table, while bending tests are carried out between the straining crosshead and the two roller supports for the specimen on the table. In order that the pull on the test specimen shall be dead true along its axis, the ends are held in special wedge grips or spherical form as in Fig. 4. For tensile tests the standard size and form of specimen is shown in Fig. 5. The cross sectional area of the central shank is exactly ¼ in. square. As the ultimate strengths are generally given in so many tons per square inch of section, the load required to break the piece multiplied by four will give the breaking strength in tons per square inch. Steels range in ultimate tensile strength from about 25 to as much as 80 or 90 tons per square inch.

All metals are more or less ductile, and the act of straining the test piece to breaking point also stretches it, at the same time causing a certain reduction in area at the centre as shown in Fig. 6, while the point of fracture takes slightly different forms according to the physical properties of the metal. Two marks are made a certain distance apart on the specimen by which the amount of elongation can be measured

Other Tests

For other tests such as compression, shearing, or torsion, it is usual to make specimen pieces to standard sizes and shapes, so that all test results can be compared on the same basis, and specifications standardised.

Another form of test is to find out what materials will stand in the way of a sudden blow or shock. This is carried out on an impact testing machine, the most common type of which is known as the Izod impact machine, Fig. 7. Here a weighted pendulum,

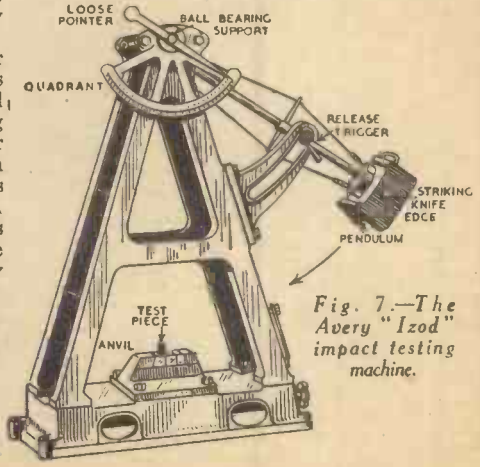


Fig. 7.—The Avery "Izod" impact testing machine.

mounted on ball bearings, is arranged to swing from a definite fixed height and strike a blow on the test piece which is held in an anvil on the machine base.

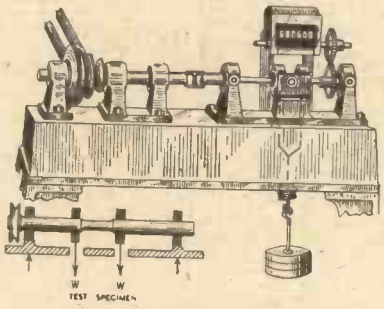
As the test piece breaks, the pendulum tends to swing farther, the distance to which it swings depending on the resistance offered by the test specimen. As the pendulum swings from its starting point it carries with it a loose pointer at the top end, the extremity of the pointer passing over a marked quadrant. The distance the pointer travels over the quadrant indicates the resistance of the specimen in foot-pounds of energy. The standard machine has a capacity of 120 ft. lbs., or the equivalent of 60 lb falling from a height of two feet.

Bending Stress

When a shaft is subjected to a bending stress while it is running, the constant reversal of stress over a long period eventually tends to break it, this feature being known as "fatigue". It is just what happens when you bend a bar backwards and forwards until it breaks. In an ingenious machine—Fig. 8—for testing the fatigue which any material will stand, a specimen piece of shaft of definite dimensions is rotated on ball bearings by a motor, or other means, with known weights hung on the middle portion or at definite points, until the shaft fails. A counting mechanism is fitted to automatically record the number of revolutions made, which may run into many millions, and also to stop the machine as soon as failure occurs, so that it can be left to run for days on end with little attention.

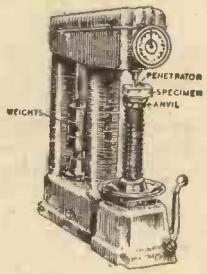
Hardness of Metals

The hardness of certain metals, and their capacity for resisting wear or abrasion is often an important thing to know. Various



forms of hardness testing machines are made one type being shown in Fig. 9. Generally, the hardness is determined by the depth of the impression, or penetration, which a very hard steel ball, or in some cases a diamond point, will make on the metal under a definite load. In the machine shown, a guage at the top gives a direct reading of the recognised scale of hardness for the specimen under test, so much time is saved when large numbers of pieces have to be tried. The load is applied by weighted levers, and easily manipulated by the operator.

Other forms of tests, too numerous to describe, include those for resistance to torsion, bending, drop tests, the effects of temperature, of vibration, tests of bricks, stones, concrete, timber and many other materials, are carried out in specially designed machines for each purpose, and so prove of inestimable value to manufacturers of all kinds of mechanical constructions.



Figs. 8 and 9 (left).—A fatigue testing machine; (right) The Avery direct reading hardness testing machine.

A NEW DEEP-SEA DREDGE

Probing the Deep

A TEN-TON deep-sea dredge, developed at a cost of more than £125,000, after 20 years of experiments by a San Francisco engineer, during a recent try-out three miles off the Monterey shore, California, U.S.A., plunged 700 ft. into the ocean and brought up the first appreciable amount of sea bottom ever taken from such a depth. The demonstration was held before representatives of the United States Navy and the Coast and Geodetic Survey, who expressed the belief that the invention will have a far reaching effect in its application to industry in submarine projects.

The underlying principle behind the operation of the dredge is the conversion of the hydrostatic head of water into kinetic energy by a system of valves and pistons, which take the dead weight of the water and change it into power. When the dredge is lowered into the sea, the jaws are held open by a seal over the valves, which, when the dredge reaches the ocean bottom, automatically opens, allowing the inrush of water. This water forces up the pistons and closes the jaws.

◆ ◆ ◆

Acmonital Coins

ITALY will introduce a new coinage on and after October 28th. A stainless steel alloy called "acmonital," which means "Italian monetary steel," will replace nickel. The effigy of King Victor Emmanuel III will be on one side of the coins, with the Lictor's Rod, the Roman Eagle, and the symbol of maritime Italy on the reverse.

◆ ◆ ◆

Bees and Wasps

MR. D. MORLAND, head of the Bee Research Department at Rothamsted Experimental Station, has proved, by extensive experiments, that wasps are more intelligent than bees. Bees, when placed in an open-top glass bottle, with its base turned to the light, died trying to get through the bottom because, like the sunflower, they are heliotropic, that is, automatically attracted by light, whilst wasps found their way out through the top. Mr. Morland obtained the following facts by painting the backs of baby bees so that he could identify them :

Middle-aged bees are the ones that sting.

Middle-aged bees go out with the swarm; young and old stay at home.

Division of labour is by age; all bees are nurses at a certain age.

The life of a bee is from six weeks to eight months.

Swarming can be controlled by man.

◆ ◆ ◆

Luminous Chalk

A NEW type of chalk has been developed that will prove extremely useful to lecturers during lantern shows. Under normal light, it writes like ordinary chalk, but in the dark glows with a strong green light and is visible at a distance. Thus the lecturer is able to write a message on a blackboard whilst the lantern show is in progress for the benefit of students who desire to take notes.

◆ ◆ ◆

A New Submarine

THE SEAL, a 1,450-ton submarine, so designed that it is immune from the effects of depth charges, has recently been commissioned in the United States fleet.

The cruising range of this new submarine will be from 10,000 to 12,000 miles, and its surface speed is stated to be more than twenty knots. Two hundred and ninety-eight feet in length, it is fitted with one 3-in. anti-aircraft gun and has eight 21-in. torpedo tubes. She will be manned by a crew of about fifty men.

QUERIES and ENQUIRIES

A stamped addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on page 612, must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the sender. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

BATH SALTS AND INSECTICIDE

"HOW can I prepare perfumed bath salts? I should also like a formula for an efficient insecticide." (S. T., Perak.)

IN order to prepare bath salts, dissolve in hot water ordinary washing soda until the water will dissolve no more of the soda. Add to the hot solution a trace of dye to colour it and, also, a small amount of whatever perfume you desire. Allow the solution to cool. When cold, it will deposit coloured crystals, faintly perfumed and coloured. These are "Bath salts." They should be collected, dried and bottled. If they are allowed to remain unbottled for any length of time they will slowly fall to powder.

A good insectidal spraying essence of the type you mention may be made by taking ordinary pine oil and by mixing with it about five per cent. of ortho-dichlorbenzene and two per cent. of citral or lemon oil. You may, if you wish, add other ingredients for the purpose of perfuming the product. Pine oil alone, when sprayed about a room, is a good fly-dispeller. It can be purchased from Messrs. F. Boehm, Ltd. 17 Jewry Street, London, E.C.3.

ORTHO-NITROTOLUENE

"WHAT is the formula for orthotoluidine and how is it prepared?"

In Pro. C. V. Boy's "Soap-bubbles, their colours and the forces which mould them," he mentions cat-boxes which are simply made by folding a sheet of paper, and are then blown out into cubes. However the book does not tell how the sheet of paper is folded into a "cat-box," so could you enlighten me? (S. W., St. Margaret's-at-Cliffs.)

ORTHO-TOLUIDINE possesses the chemical formula :—

$$C_6H_4\begin{matrix}CH_3\\NH_2\end{matrix}$$

It is prepared by reducing ortho-nitrotoluene with tin and hydrochloric acid, the nascent hydrogen generated by the action of the hydrochloric acid upon the tin "reducing" the *nitro* ground (NO_2) of the nitrotoluene to the *amino* group (NH_2) of the toluidine. Thus :—

$C_6H_4.CH_3.NO_2$ —(NASCENT HYDROGEN)→ $C_6H_4.CH_3.NH_2$

o-nitrotoluene o-toluidine.

The folded paper "boxes" to which you refer are generally composed of two parts pasted together. Two sides and the top of a cube are cut in paper and pasted firmly to a similar paper strip consisting of the two remaining sides and the base. The sides are folded or creased concertina-fashion so that the structure can be pressed flat. It is inflated from a hole pierced at one of the corners of the cube.

POKER WORK

"CAN you give me any information on making an electric poker work machine suitable for 200/250 volts A.C." (N. L., Bognor Regis.)

WE regret that we cannot give you any very definite advice because you do not quote the current taken by the various parts. We advise a small transformer with an output of about 10 volts at various tappings, and 10 amps. The wire points are made of platinum welded to thick rods, the knives consist of short lengths of finer wire wound round suitable points and insulated with mica, similar to a soldering iron. We advise you to experiment with the transformer before using.

BLACK PLASTIC FILLING

"I HAVE taken an oil-furnace ignition transformer out of its case to repair. Can you tell me the composition of the black plastic filling? It seems to contain wax and has a high-melting point.

I need to make up wastage but do not know what to use.

"Would the composition used in junction boxes in the street when mains are lapped for house service be suitable?" (E. H., Bucks.)

THE black plastic filling used in transformers and other electrical instruments varies very considerably in nature and we cannot possibly form an opinion as to the type of material you refer to without actually having inspected it. Some of these black fillings are merely high-class grades of ordinary high-temperature melting pitches. Others are synthetically produced bresin materials of the "bakelite" order. Still more recently, the commercial mixtures of chlor-naphthalene have been used as non-corrosive filling materials for electrical instruments. These are black in colour and have a fairly high melting point.

For home instrument construction, a mixture of good-grade pitch and ordinary resin will suffice as an insulative packing material. Also the material you mention in the last paragraph of your letter should be suitable.

ETCHING GLUE

"I AM interested in etching on zinc, and would like a recipe for a good etching glue." (R. L., Rijiswijk, Holland.)

A GOOD liquid glue may be prepared by heating together on a water-bath for about six hours 100 parts of best gelatine, 100 parts of best hard glue, 25 parts of pure alcohol or rectified spirit, 1 part of common alum and 200 parts of 20 per-cent. acetic acid. This glue will remain liquid over a protracted period, but it should have a little carbolic acid mixed with it to prevent it from turning mouldy.

Another good liquid glue can be made by boiling together for five hours 25 parts of best hard glue, 65 parts of water and 4 or 5 parts of nitric acid.

In the process of etching, the glue is usually coated on to the plate, the glued

surface then being treated with bichromates, whereupon the glue becomes insoluble. The bichromates are not usually mixed with the glue previous to coating.

Carbolic acid added in small quantity to the glue will be amply sufficient to preserve it from decomposition.

CHEMICAL REACTIONS

"CAN you tell me of any chemicals, which, when put together, will either smoulder or burst into flame." (M. S., Swansea.)

THERE are no dry materials which will *reliably* fulfil the conditions you lay down. If, for instance, yellow phosphorous and powdered potassium chlorate are brought together, they certainly inflame, but, usually, they do so with a violent explosion. Hence, the use of this effect can hardly be safe for your purpose.

If lead tartrate (obtained by adding tartaric acid solution to a solution of lead acetate or nitrate, is very carefully heated, it turns grey in colour and becomes converted into metallic lead in powder form. This powder (when freshly prepared) becomes red hot when freely exposed to the air.

Again, if yellow phosphorus is dissolved in carbon bisulphide and the resulting solution absorbed with blotting paper or fuller's earth, the phosphorus which is left behind when the solvent evaporates will, on free exposure to the air, oxidise and either smoulder or burst into flame. This action seems as good as any for your use, provided you can allow the free admittance of air to your apparatus.

If you cannot fulfil this condition, you might saturate a little fuller's earth with strong sulphuric acid until a pasty mass is obtained; and mix this with powdered potassium chlorate. The mixture will instantly inflame, almost with explosive violence. Alternatively, you might saturate fuller's earth with strong chloric acid and then mix it with fine sawdust. Inflammation will again take place.

We feel bound to say, however, that all the above reactions are, from a practical standpoint, often unreliable in their effects and frequently extremely uncontrollable, since they are apt to proceed with explosive violence. It is not possible by the simple admixture of two or three dry materials to obtain the slow and orderly development of self-combustion with its accompaniment of flame and heat.

PATENTING A CODE

"I HAVE evolved a simple code which is manipulated by figures. Is it possible to take out a patent for this?" (A. E., Leicester.)

AS it is not possible to obtain a patent for a code since no patents are granted where no material product of a substantial character is realised or effected by the alleged invention, or where the only material product is a printed sheet for use in carrying out some scheme, there appears to be nothing that can be done except for you to put your scheme before the Government, and rely on an ex-gratia payment if they adopt this code.

There can be no harm done in following the suggestion proposed, and it will be sufficient to write to the Secretary for War, The War Office, Whitehall. Similar approaches might be made to the Admiralty and the Air Ministry.

ADVANCED CHEMISTRY

(1) "Please give me the names, prices and publishers of books on practical chemistry.

I should like a book of fairly advanced standard, and I do not wish for a book on school experiments on preparation of gases or analysis. I am an amateur with a fairly well equipped laboratory and I should like a book dealing with experiments of interest to one who understands the subject fairly well.

(2) "I require a list of organic chemicals that I could obtain to start a course of practical organic chemistry. I have been told that about a dozen reagents are required and from them many others can be prepared. The first dozen being bought in large quantities.

(3) "How can I make a small quantity of fluoroescein starting with primary substances: i.e., how can I make rescorcin-dihydroxy benzene and phthalic anhydride from benzene and naphthalene?

(4) "How is fluoroescein brominated to give eosin?" (W. H., South Merstham.)

(1) There is not a book which fits in exactly with your requirements. We think, however, that you will be well pleased with J. B. Cohen's "Practical Organic Chemistry," published at 6s. 6d. net.

(2) It is not easy to give you a comprehensive list of organic chemicals necessary for the carrying out of a large number of synthetical operations. However, assuming that you already possess the usual inorganic reagents, as, for instance, reducing and oxidising agents and, also, strong mineral acids, the following organic materials will be of service to you: Acetic acid, alcohol (or rectified spirit), benzene, toluene, phenol (carbolic acid) aniline, naphthalene, formaldehyde, acetic anhydride, salicylic acid, glycerine, chloroform, carbon bisulphide, acetone, pyridine, etheric.

We do not, of course, advise you to purchase all of the above reagents at one time. The list is merely intended to form a rough guide as to the nature of the materials which are frequently employed in synthetical operations.

(3) Fluoroescein ($C_{20}H_{12}O_5$) is made by heating phthalic anhydride with resorcinol. Both phthalic anhydride and resorcinol may, of course, be made from simpler substances, but their preparations are difficult and tedious. One part of phthalic anhydride, two parts of resorcinol and a small amount of zinc chloride are heated in a flask submerged in an oil bath to a temperature of 200°C. When the contents of the flask become solid, the dark mass should be well washed with cold water and subsequently dissolved in weak caustic soda solution, if necessary by gently heating. The solution, which will be strongly fluorescent, is now filtered, made just acid with sulphuric acid, concentrated by heat to a small bulk and finally extracted with ether. From the ether solution, fluorescein will crystallise in red needles. It is practically insoluble in water, but dissolves freely in water containing a little dissolved alkali.

(4) Eosin, which is tetrabromfluorescein, is prepared by dissolving fluorescein in rectified spirit, and by adding to it double the weight of the fluorescein of bromine, drop by drop, with frequent stirring. After standing for two hours, the whole of the eosin will have been precipitated. It is then filtered off, washed with a little water and then converted into its sodium salt by mixing it with a little hot water, neutralising it by the addition of caustic soda solution drop by drop (taking care not to add too much of the latter) and finally by evaporating it to dryness. The final product, which is the sodium salt of eosin, should take the form of bluish-red crystals, or, at least, of a brownish-red powder, which dissolves freely in water forming a bluish-red solution.

Building an All-round Utility Boat

(*Continued from page* 592)

long, ¾ in. thick and 12 in. wide, or made up to that width with narrower stuff.

For the stem, which is of approximately triangular section 4 in. × 3 in. × 3 in. and 20 in. long, a square-cut section of fencing post 3½ in. × 3½ in. is likely to be cheaper than specially sawn timber.

The stem and stern knees, 12 in. × 6 in. and 18 in. × 8 in. respectively can be sawn from any 1½-in. hardwood. Such small pieces as these and the other knees may well be got out of oddments of used timber which, because it will be seasoned, may prove not only cheaper but better than new timber.

With the exception of the pair of inwales, 15 ft. × 1¾ in. × ½ in. and a similar pair of strips for outside rubbers, all the elm required can be got out of coffin boards.

This may sound a strange form for boat material, but apart from elm specially cut for boatbuilders in coastal districts, practically all the elm sawn in this country is cut to coffin-board sizes, and reaches the market in that form. These boards average 7 ft. long × 18 in. to 24 in. wide by a thickness in the rough of ¾ in. to ⅞ in. They cost 2*s.* 6*d.* to 3*s.* each, and three as wide as possible ⅞ in. thick will suffice for the frames, the transom, and a variety of small parts. A bundle of plasterers' laths is required for covering seams, also all the crate-wood you can lay hands on, for strutting the frames into position, and for making up into measuring and fairing battens.

For riveting the frames together there will be wanted 2 lb. of 1-in. copper nails of No. 7 gauge with ½ lb. of roves. For the gunwales 1 lb. of similar nails 2 in. long, with ¼ lb. roves. For the plank fastenings there are wanted 5 lb. of 1¼-in. copper nails of No. 10 gauge, without roves. A pound or so of common iron wire nails should be in hand for fixing up the stocks and other temporary work. The few brass screws required will be of various lengths from 2 in. downwards and are best purchased as required.

The constructional work should start with the making of the thirteen frames (Fig. 5). Each of these consists of a segmental floor of elm 2 in. deep and ¾ in. thick connected to a pair of straight, tapered ribs by riveted half-joints, the ribs of similar material are all 2 in. wide at the foot and 1½ in. at the head, differing only in the bevelling of their outer edges, and in the radius of curvature across the foot, which makes the mid-length ribs a short ½ in. longer than the pair at Station 1. A cardboard template of the longest ribs, taken from the body plan, will help in marking out the set of 26 ribs without waste of time or material.

(*To be continued*)

BUILDING A I C.C. ENGINE

(*Continued from page* 602)

applying liquid jointing sparingly, and the cylinder head is also treated with this jointing before screwing in. As the head needs to be compression tight some means for tightening has to be provided. This may be accomplished by drilling 2 small holes through the fins and making a pin spanner to suit, or by notching the edges of the fins to take a "cee" spanner.

The gland packing for the plug should be well tightened and dried out to make certain that the plug will not blow out under running conditions.

Running the Engine

Cut a slot ⅛ in. wide by ¾ in. deep in the end of a piece of ¼ in. hardwood to clear the bottom half of the crankcase and secure the engine to the board with round head wood screws. A fixed coil, a condenser, switch and battery are required to run the engine. These are wired up as shown. A small petrol tank, preferably with a shut-off cock having an outlet pipe of the same diameter as the petrol feed side of the carburetter. The tank is connected with small rubber piping.

Reset the ignition, if necessary, to fire at ⅛ in. before top dead centre in the fully advanced position.

Trials may be carried out with an 8-in. prop. or small flywheel.

Thoroughly mix petrol and oil in the proportion of 1 part oil to 30 parts petrol. Filter into a clean bottle for future use.

It is advisable, if possible, to drive the engine mechanically to find the starting position as this will save "juicing" up the engine. A motor driven flexible shaft provides a ready means of starting. Some form of dog release can be arranged to let the engine get away once it is running. After switching on run the engine by means of the shaft making certain that the ignition is functioning correctly, turn the petrol on and gradually open the needle valve until the engine starts. The running position should be a little over 1½ turns of the needle valve, but this can soon be ascertained as can the correct setting of the ignition. Do not run the engine too long at one time and watch for any tendency for the engine bearings to tighten up between runs. Should any tightness develop increase the proportion of oil slightly during the running-in period.

STARGAZING for AMATEURS

(*Continued from page* 601)

for the lag is only .0037 of a second in 27,000 years! One of the causes of this inevitably longer day is tidal friction, increased in such narrow enclosed seas as the English Channel and Irish Sea. The dragging movement of vast masses of water acts as a brake on the spinning of the Earth, a process that has been in operation for millions of years. Mathematical calculations deduce that at one period our globe turned completely round on its axis in five hours, whereas it now occupies twenty-four. Concurrently with this retardation, the Moon's revolution round the Earth is also imperceptibly slowing down. Gradually it will be drawn nearer to us and, when it gets within 12,000 miles, will break up into myriads of fragments. These particles will probably continue to circulate round us in immense rings somewhat similar to those encircling Saturn, which are believed to have been produced by a comparable agency.

BUY, EXCHANGE OR SELL

TOOLS

BRAND NEW POWER TOOLS of quality. 10 in. Bandsaws, 54/-. Jigsaws, 22/6. Wood Planing Machines, 80/-. Bench Drills, 11/-. Circular Saws, from 25/-. 3 in. S.C. Toolroom Lathes, from £4 16s. New 1 in. Chromium Plated Micrometers, 12/6. Electric Drills, 32/6. Grinders, Spray Plants, Guns, Air-Compressors, etc.—John P. Steel, Clyde St. Mills, Bingley.

GRAYSON'S Glass-boring Outfits and Tube. Cutters avoid risk.—Below.

DRILLS, Taps, Dies, Files, Chisels and Punches. Best quality at keenest prices.—Grayson & Company, 300 Campo Lane, Sheffield.

10,000 Taps, Whit.; B.S.F.; $\frac{3}{32}$" to $\frac{1}{4}$"; also B.A. 0 to 8, in Tapers; Seconds and Plugs, usual price 6d. to 9d. each, clearing at 3s. per doz., any sizes.—Below.

3,000 High Speed Twist Drills, $\frac{1}{32}$" to $\frac{5}{32}$", actual value from 5d. to 8d. each. Bargain 2s. doz.—Below.

Bright Mild Steel, round, square, hexagon, flat, to 1" diam., 5s. bundle. Very good bargain.—Below.

Finest Quality Tool Steel, Round, Bright, $\frac{1}{4}$" to $\frac{3}{4}$" diam., 4 lb., 2s. 6d.; larger sizes, 8 lb., 4s. Costs 2s. lb. —Below.

1s. 9d. any lot. Wonderful Value.

One Gross Bright Steel Hex. Bolts with nuts.

One Gross Bright Steel Whit. Screws, assorted, $\frac{1}{8}$" to $\frac{1}{4}$".

One Gross Bright Steel Chamfered Washers, $\frac{1}{8}$" to $\frac{3}{8}$".

Three Gross Wood Screws to 3" long.

Dozen Assorted Files, 4" to 6".

Six Assorted Files, 6" to 12".

Three Assorted Files, 12" to 14".

Six Assorted Grinding Wheels, 2" to 2½" diam.

Dozen Twist Drills, $\frac{1}{16}$" to $\frac{1}{4}$" diam. Best quality.

Three Dozen Assorted Springs to 3" long.

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