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PRACTICAL MECHANICS

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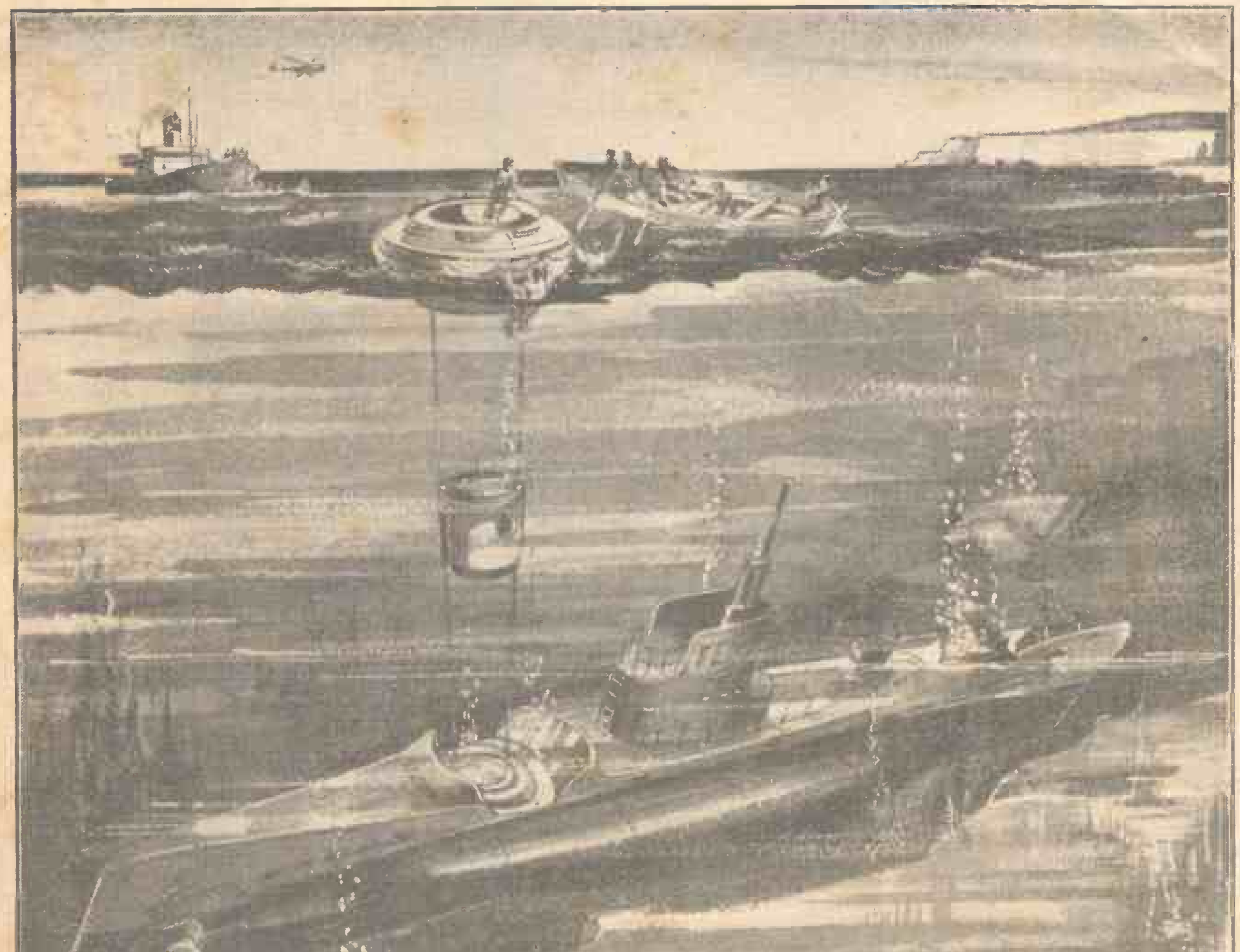
EDITOR : F. J. CAMM

OCTOBER 1951



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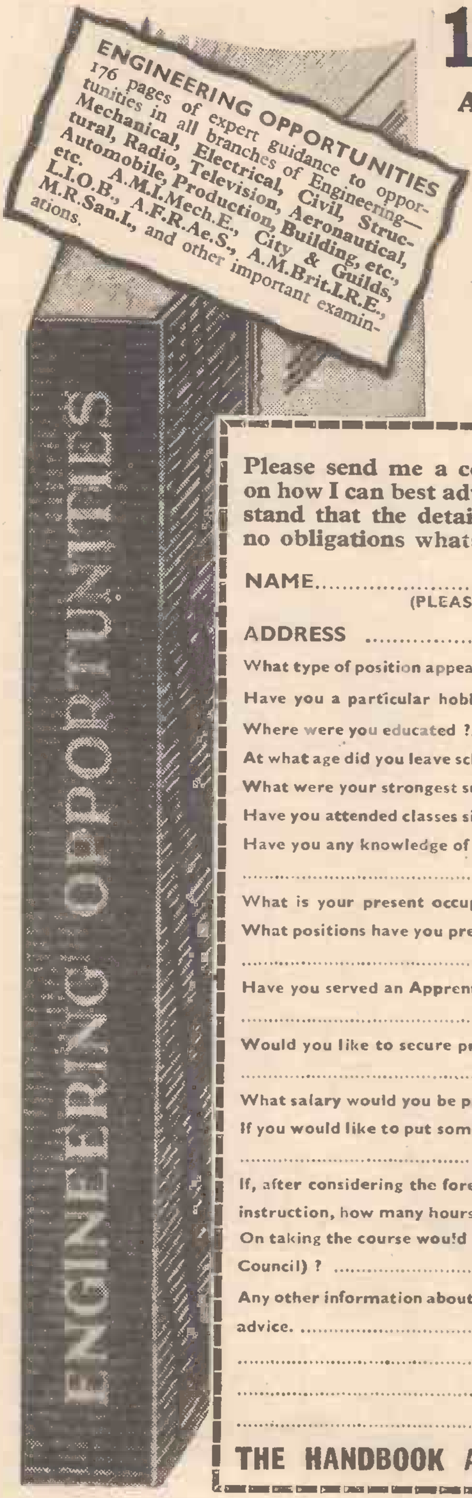

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PRACTICAL MECHANICS

EDITOR F. J. CAMM

OCTOBER, 1951
VOL. XIX. No. 214

Owing to the paper shortage "The Cyclist," "Practical Motorist," and "Home Movies" are temporarily incorporated.

FAIR COMMENT

By The Editor

Is Interplanetary Travel Possible?

EVER since the imaginative fiction of Jules Verne and H. G. Wells there has been an increasing belief in scientific circles that in time we shall be able to visit the moon and some of the other planets which are part of the mysterious Universe. Our knowledge of them at present is scientific conjecture. Practice has been made to fit theory. Our only knowledge of the planets is what we have gained by calculation and by visual examination by means of an astronomical telescope. Perhaps before this century closes a space ship will enable us to visit the moon, which is only 240,000 miles distant, and we shall have ascertained how far our conjectures have been right.

From a practical and from scientific points of view a space ship which could make the journey is not an impossibility. The experimental work would be costly, of course, and no doubt in the attempt there will be loss of life as in the early days of flying. Such a risk would not act as a deterrent. There are plenty of volunteers who would be willing at the present time to undertake the journey if the space ship were available.

The British Interplanetary Society has been steadily examining the problem over a long period of years. Its members are trained scientists well able and qualified to undertake the design of an interstellar ship. The movement is growing in importance, as was evident from its recent lecture session in London, where prominent interplanetary specialists gave lectures disclosing the present state of our knowledge and progress.

Professor Lyman Spitzer, of the Princeton University Observatory, agrees that while it appears possible to project a multi-step rocket into a close orbit about the earth, the next step of proceeding from this orbit to the surface of the moon or another planet and back would require at present prohibitive quantities of conventional propellants. In other words, we shall have to discover a new propellant. Perhaps atomic power will supply the answer.

The application of nuclear energy to heat up a propellant in a conventional type of rocket, however, does not appear to offer a substantial improvement on the chemical rocket because of limitations of temperature and power rating, which prevent the achievement of very high exhaust velocities and the high thrusts needed to lift vehicles against planetary gravitational fields.

In the case of an interplanetary ship operating between a circular orbit around one planet and a similar orbit round another without making a landing, it is possible to employ a new principle which might effect great economies in the amount of propellants and materials which must be carried up into the orbit.

This principle depends on the fact that such a ship can be propelled by very low thrust, whence it is possible to use high exhaust velocities without involving excessive power production. The high velocity exhaust stream would be obtained by accelerating a beam of ions in an electric field, power being provided by a nuclear reactor. Professor Spitzer gave as an example a ship developing an exhaust velocity of 100 km./sec. and a thrust sufficient to provide an acceleration of 0.3 cm./sec. Such a ship could undertake a total velocity change of 30 km./sec. with a mass ratio of only 1.3. The useful mass ratio of the vehicle would be 150 kW/tonne. This ship would be a small one weighing 10 tonnes, the energy source being a 1 tonne U235 or a PU239 reactor producing heat energy at the rate of 4,500 kW. To avoid heavy radiation shields one envisages the vehicle as a separate pilotless power section, towing by means of thin wires a light control car containing the crew at a distance of 100 km. Alternatively, a long cylindrical construction might be adopted with a shield at the end of the pile facing the control car. The atomic pile might use a heavy water both as a moderator and as a working fluid to drive a steam turbine and a D.C. generator. Waste heat from the condenser would be dissipated by radiation from a fin 1,000 sq. metres in area at 450 deg. K. The heat would be taken into the working fluid at 900 deg. K. to ensure 50 per cent. thermal efficiency.

Nitrogen would be used as the propellant, since it could be collected from the atmospheres of a number of planets. A potential difference of 740 volts would be required to accelerate nitrogen ions to a velocity of 100 km./sec. and a total current of 2,000 amperes would be required to produce the necessary thrust. This potential would be applied between two mesh screens 1 mm. apart, and thermionic emission of electrons from the outer screen would ensure electrical neutrality. The area of cross-section of the beam would need to be about 7 sq. metres to avoid space charge limitation. Communication between a space ship of this type and a planetary surface would be achieved by means of a satellite vehicle of conventional type. The interplanetary ship would have to be carried up to the orbit in the first instance by means of a booster rocket weighing perhaps a few thousand tons. In making a landing on a planet such as Mars a winged rocket might be used carrying to the surface the propellants needed for the ascent.

The suggestion has already been made in America that a stratospheric platform should be built as a sort of starting-off point and on which would be "land" instruments, radar apparatus, and transmitting and receiving equipment so that communication could be maintained between the aerial platform and the crew of the space ship.

Of course, there are other suggestions for space ships, such as step rockets, that is to say a series of rockets joined one behind the other to the control car, each rocket being fired at certain intervals of time in order to complete the space journey.—F. J. C.

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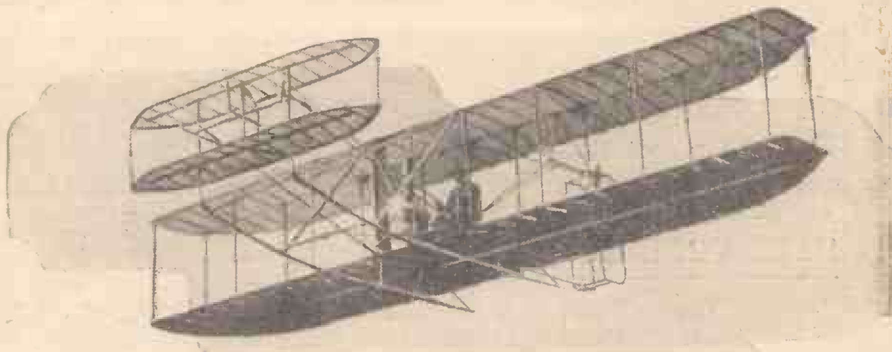
THE BEGINNING OF *Flying*

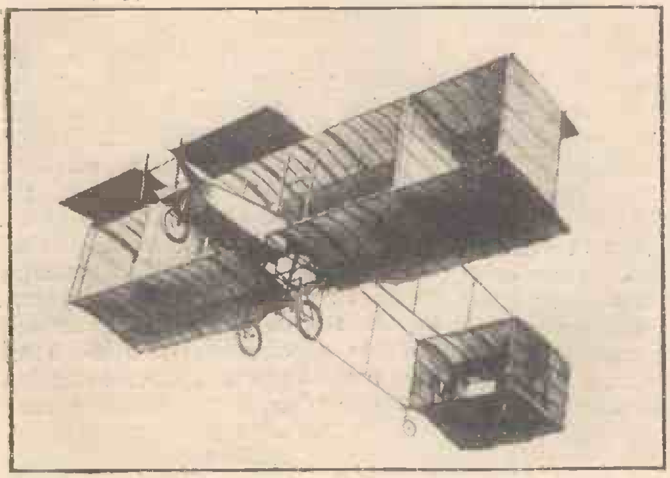


The Wright aeroplane in flight—August 1908.

The Story of the Early Pioneers from Clément Ader and the Wright Brothers to the Pioneer-founders of the British Aircraft Industry in the First World War

By C. G. GREY

IF ever practical mechanics—without the help of scientists or learned professors or bookmen—brought about a revolution in human life with their own hard hands and heads they did so when they built aeroplanes and made them fly. Yet so few know where they did it or when or how. A year or two ago I was shocked when a very senior officer of the R.A.F., whose memory of flying goes back to 1912, as a boy at school, told me that only the officer commanding at the Hendon Aerodrome knew that there had been any flying there before the 1914 war, and that none of the other officers had heard of the great R.A.F. Displays at Hendon between 1920 and 1937, when they ended.



The Voisin biplane of 1908-09.

Leonardo da Vinci

Centuries ago men talked of flying. Leonardo da Vinci designed plausible flying machines in A.D. 1500. Before A.D. 1800 balloons, both hydrogen and hot air, had been used by the French Revolutionary armies, and parachutes were dropped from them in exhibitions, but that was not flying. In 1804 Sir George Cayley, an English country gentleman, built an aeroplane and a rotary engine for it (driven by gunpowder, like a revolver), but it only ran along the ground and broke the leg of its "pilot," Sir George's coachman. But that again was not flying.

Men first *flew* when the German, Lilienthal, in Germany, and the Frenchman, Chanute, in Canada, made experiments with gliders in the 1890s. But they had no engines. So the first authentic instance of a man being lifted off the ground, as against gliding down a hill, was that of Clément Ader, on October 9th, 1890, at Armainvilliers, in France. His machine was called "The Bat," and looked like one, and it had a steam engine and a propeller of sorts. It covered 50 yards, quite out of control and crashed. He tried again in 1897 on October 14th, near Versailles, and travelled 300 yards, mostly off the ground, before he crashed; he then gave up trying to fly. But he invented the name "avion," for all flying machines, and it is still the official word in France.

The Wright Brothers

Meanwhile, in the U.S.A., two practical mechanics, named Wilbur and Orville Wright, who owned a bicycle shop, built a glider on the experiences of Lilienthal and Chanute. Later on they built a four-cylinder water-cooled engine for it. On this, launched from a rail by a primitive catapult, in which a cord ran over a pulley at the top of a wooden pylon and was pulled by a falling weight, Orville Wright made the first authentic flight, of about 11 seconds. Actually it was more of a catapulted, engine-assisted hop of about 40 yards. At a later date it flew 300 yards or so, before coming down. And there is credible evidence that on September 20th, 1904, one of them flew a complete circuit on it.

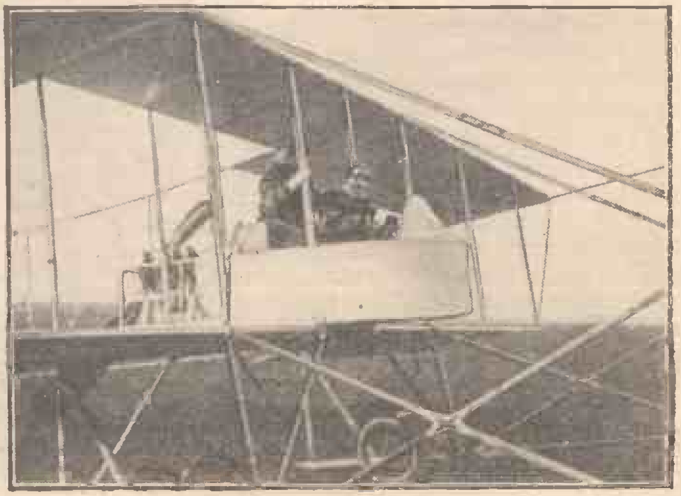
Not until 1908 could the Wrights, or anybody else, claim that they really were able to fly—that is, to take off and land when they wished. Even then the failure of their engine, or the strength of a gust of wind decided for them when they wished to land; and where they landed was more by luck than judgment. But by the end of 1908 the Voisin Brothers and Henry Farman and Louis Blériot and Captain Ferber were flying in France quite seriously for a mile or so at a time. In fact, Farman had flown a circuit in January on his biplane, and on October 31st Blériot on his monoplane had flown 18 miles across country. Also a little Brazilian millionaire, named Santos Dumont, who had done the first hop in Europe in 1906, in a queer thing like a box-kite with a tail in front (really an elevator), was flying in a tiny monoplane of normal shape.

All these things were built of wood with spars and struts and ribs and longitudinal members, bolted and screwed together, braced with wires tensioned by turnbuckles, and covered with fabric—very much the work of practical mechanics. And, believe it or not, the fabric covering was made taut by coating it with ordinary bill-stickers' paste, which shrank the fabric and stiffened as it dried. Naturally, if caught in the rain it all washed out, and when quite dry it worked off as a powder. Not until 1913 did somebody discover the use of celluloid varnish from which was derived Cellon and Titanine and other "dopes" based on cellulose. From that the plastic industry arose.

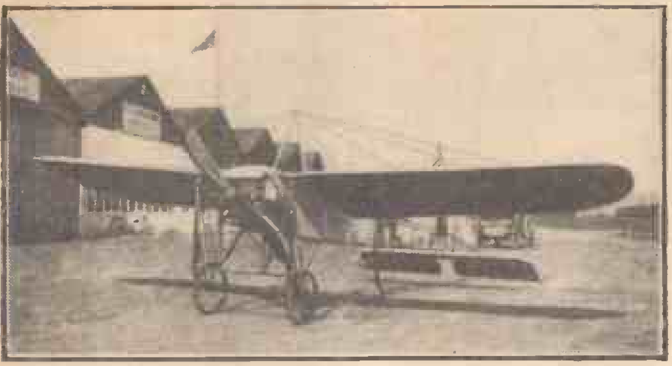
World's First Aero Show

The great revolution in the air (and in the world's transport) began in 1909, after the world's first aero show had been held in Paris around Christmastime, 1908. I was there, and wrote what I believe was the first aero-show report in an English technical paper—*The Autocar*. Only one aeroplane in the show had ever flown.

The great boost to flying was given by the coming of the Gnôme engine, a seven-cylinder air-cooled affair, in which the



Pierre Verrier, with a passenger, on a Maurice Farman "longhorn" biplane at Hendon.



A Blériot monoplane, of the early Type XI kind, but with a Gnôme rotary engine.

crankshaft stood still and the cylinders whirled round it. Petrol was fed through the crankshaft into the crankcase, from which, along with large doses of castor oil, it was fed to the cylinders. (The smell of burnt castor oil causes violent attacks of nostalgia in elderly gentlemen of 50 to 60 years of age.) The whole system was brutal, but it worked, and we used to say that a Gnôme would make a tea-tray fly. Some of the things that it forced to fly were far less aerodynamic than tea-trays.

By the beginning of 1909, S. F. Cody (now dead) and A. V. Roe (now Sir Alliott Verdon Roe, and very much alive) were disputing who was first off the ground in this country. The Short Brothers were beginning to build an aeroplane underneath the arches at Battersea, by the Dogs' Home, and in another arch were Howard Wright (brother of Warwick, the famous motorist, and no relation to the Wrights, U.S.A.) and W. O. Manning.

Glenn Curtiss

In the U.S.A., Glenn Curtiss, the rival of the Wright Brothers and the greatest of all U.S. pioneers, was flying successfully and dodging the patents on aeroplane controls which the Wrights claimed. In Austria, Igo Etrich had built a queer, bird-shaped monoplane, which was later taken up by Rumpler in Germany, and became the Rumpler Taube, or Dove, so well known to our Army in the 1914-18 war, and naturally called the "Tawb."

The first real jolt to our insular self-sufficiency came on July 15th, 1909, when Louis Blériot, by an immense combination of pluck and luck, flew across the Straits of Dover on a monoplane, with a three-cylinder, 35 h.p. engine, from Calais and landed in a heap on the top of the cliff near Dover Castle. Also he landed a prize of £1,000 offered by Lord Northcliffe's *Daily Mail* for the first flight across the Channel.

He deservedly became a popular hero, and the Press of the world told us, in a blinding glimpse of the obvious, that we were no longer an island — which was brought home to us by German aircraft some five or six years later.

Then on top of that, in August, 1909, the French held the world's first flying meeting at Reims (which the French spell without an "h," and *they* should know). Astounding things were done. Farman flew 112 miles non-stop in 3 hrs. 5 mins., and Latham, on his beautiful Antoinette, flew $96\frac{1}{2}$ miles. The distance was governed by the non-stop ability of the engine rather than by petrol capacity or the patience of the pilot. Generally the engine packed up. Incidentally, the Antoinette's engine was a 12-cylinder Vee, with copper electro-deposited water jackets, direct injection of petrol and steam cooling by aluminium pipes along the sides of the fuselage (or body).

The Gordon-Bennett Cup was won by Glenn Curtiss, who took 15 mins. 50 secs. to cover $12\frac{1}{2}$ miles, and he put up the world's speed record by doing a lap of about six miles at nearly 51 m.p.h. Latham won the Height Prize with 500ft. I remember a journalist asking Curtiss whether getting up to 1,000ft. was possible. Curtiss said, "Getting *up* to 1,000ft. is dead easy. . . ." There the he stopped and smiled his slow smile. He and I were firm friends thereafter.

Flying Meetings

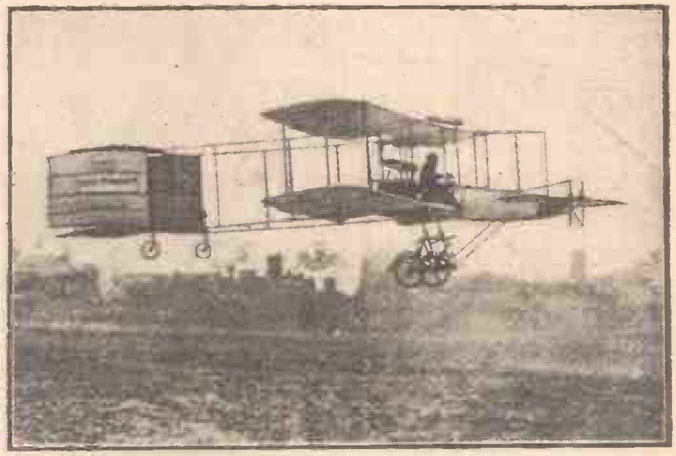
After that, things happened. Blackpool and Doncaster both decided to have flying meetings a few weeks later, and Paris had its first in September. Doncaster stole a march on Blackpool, and opened on October 15th with seven or eight hired French aviators, and S. F. Cody and a Captain Windham, who gave joy to the Press when his home-made monoplane collapsed with a broken back when he sat in it to be photographed.

Blackpool opened on October 18th with the blessing of the Aero Club, not yet Royal. There were half a dozen British machines which did not fly, and of the hired French aviators only Farman, Latham, Rougier and Leblanc flew. A. V. Roe's triplane, covered with varnished paper, appeared, but did not fly. It was called *Bulldog*, because it was financed by his brother, Humphrey Roe, who owned a factory which made "Bulldog" braces—hence the jest, when Avros did fly, that they were kept up by "Bulldog" braces.

At both meetings the rain poured and the wind roared, and there was little flying—what could one expect in October? Hence the story of a fussy official hurrying along the front of a patient crowd, which had stood in the wet for six hours with nothing happening, who was hooked by a Lancashire man and asked: "Eh, lad, when's t' interval ?"

Moore-Brabazon

But on October 30th, at Shellness, on the Isle of Sheppey, Mr. J. T. C. Moore-Brabazon, now Lord Brabazon of Tara, won the *Daily Mail* £1,000 prize for flying the first mile in a circuit on a British aeroplane



Henry Farman flying at Issy-les-Moulineaux, Paris, in 1908.

with a British engine—a Wright type built by Short Brothers, with a 60-h.p., six-cylinder, vertical, water-cooled Green engine.

George Holt Thomas—whose money had been made in the old *Graphic*—brought the French aviator, Paulhan, over with a Farman biplane and arranged for him to fly from a cleared space in the middle of the Brooklands motor track on October 29th and 30th. That gave Londoners their first sight of flying.

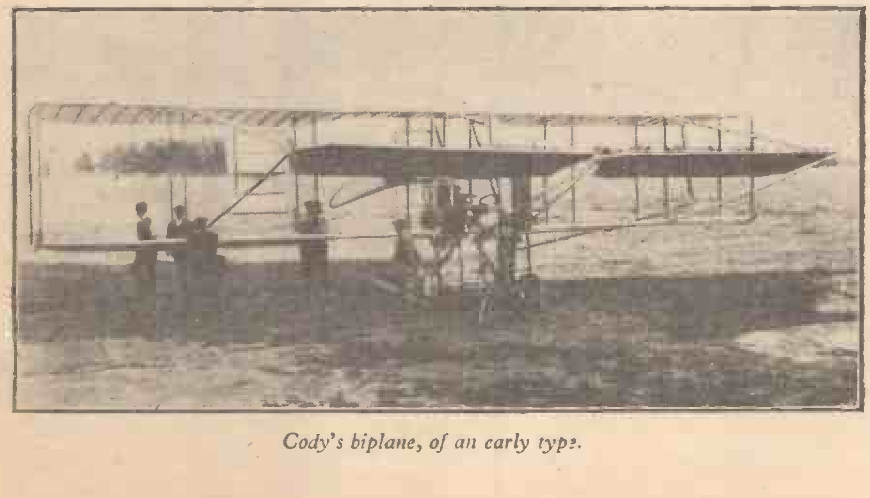
Claude Grahame-White

About this time Lord Northcliffe offered a prize of £10,000 for the first flight from London to Manchester (or the other way). On April 23rd, 1910, a well-known car-driver named Claude Grahame-White, who had learned to fly at Pau, in the South of France, started on a Farman biplane from Park Royal.

Meantime, George Holt Thomas had entered his French friend, Paulhan, for the contest. Looking for a starting-place for him he found a field near Hendon where a Mr. Everett and his partner, Edgcumbe* were trying to persuade an aeroplane of their own design to fly.

(*To be continued*)

* Now Lord Mount-Edgcumbe. The electrical firm of Everett, Edgcumbe & Co. Ltd., is still where it was then, in Colindale Works, The Hyde.



Cody's biplane, of an early type.

Facts About Geneva Steel

A Brief Account of a Remarkable U.S. Steel Plant

By THE MARQUIS OF DONEGALL

THIS modern steel plant is situated at Geneva, Utah, about 40 miles from Salt Lake City. Perhaps one of the most remarkable things about this steel plant is that it is situated in the middle of farming country with a most impressive background of mountains. It produces more than a million tons of steel per year and, in order to do so, it has to allow the many farmers who are employed in the plant to have leave of absence to do their harvesting.

United States Steel paid the Government 47,000,000 dollars for the Geneva Steel plant. This was, of course, not United States Steel's first incursion into the west coast. The west coast had always wanted to produce its own steel, and this enormous outlay from the east was the largest investment of the east in the potentialities of the west since the opening up of the first transcontinental railroad.

It was early in 1930 that it occurred to U.S. Steel that the west had steel possibilities, if it were manufactured on the Pacific coast, and they purchased the properties and business of the Columbia Steel Corporation. This continued to be the only steel operating enterprise on the west coast up to the second world war. In 1946 the War Assets Administration asked for competitive bids for the purchase of the Government-owned steel plant at Geneva, Utah, and U.S. Steel submitted a bid which was accepted. This plant had been a wartime facility largely dedicated to the production of plates and structural shapes for the use in the building of ships on the Pacific coast in connection with the U.S. Government emergency shipbuilding programme. In fact, U.S. Steel had built and operated the plant for the U.S. Government during the war as a war effort.

They took over Geneva on June 19th, 1946, and it has been operated by U.S. Steel since then. As a result various new industries have sprung up in the west and will probably continue to do so when additional steel products become available for western industries.

When I was there they were in the middle of a half-billion dollar construction programme. New facilities were in the course of installation for the production of hot-rolled coils. These coils will be utilised in the manufacture of sheets and tinplate. There will be a new cold-reduction mill which is to be established near San Francisco and another similar sheet mill will be erected in the Los Angeles district. These will, in fact, be the first mills of this type on the Pacific coast.

Wartime Activities

During the war, the critical need of the Allies, as we all know, was keeping open the vital life-line of shipping from America. The Americans responded to this by the inauguration of a programme which resulted in the building of the largest Navy in the world, and the biggest merchant fleet that ever sailed. The largest proportion of these merchant vessels was constructed in the western shipyards, and the means by which this was accomplished is the story of the Geneva Steel plant.

The United States Government asked U.S. Steel to construct and operate an enormous new steel plant at Geneva, Utah, 40 miles from Salt Lake City. This site was chosen because three essentials of steel making were there—iron ore, coal and limestone—all available in great quantities in the surrounding Utah mountains. There was also water. Thus, Geneva, covering 1,500 acres, became the largest complete steel mill west of Chicago.

Undoubtedly, Geneva is one of the most modern steel plants in the world. For instance, one of its features is a huge reversible electric motor which drives the rolls in the slab mill. It is in fact the largest of its kind ever built by the General Electric Company, and I was told that it cost over 1,000,000 dollars. There are four batteries of coke-ovens, three blast furnaces and nine open-hearth furnaces to give the Geneva plant an annual potential capacity of 1,500,000 tons of pig-iron and 1,283,400 tons of steel ingots.

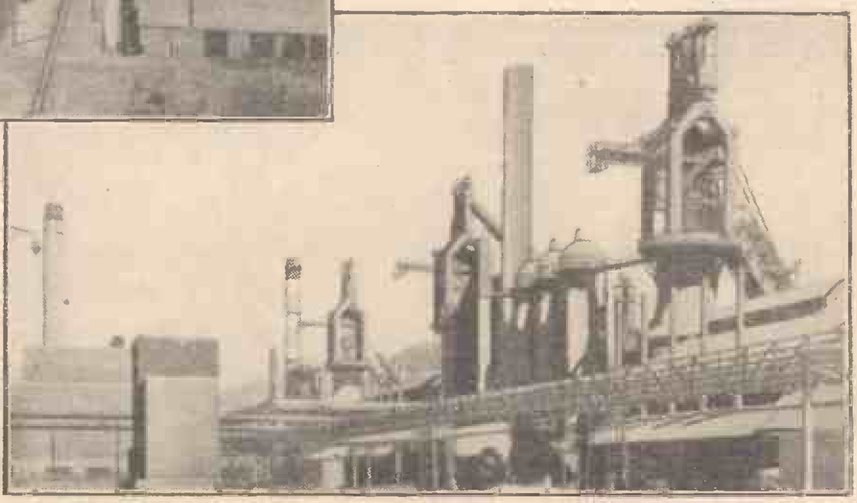
From February, 1944, to October 12th, 1945, Geneva produced 676,447 tons of plates and 144,280 tons of structural shapes and shell-steel billets. At the end of the war there was a certain amount of doubt about the successful operations of the mill in peacetime, in view of its colossal size and the character of its facilities; also because of the distance from the plant to the most important consuming markets in the west. However, there is no doubt that the decision to take what certainly was a chance has opened up a new industrial era on the Pacific coast.

Apart from all this, Geneva, as steel mills go, is very good-looking. It is not covered with dust, nor has rust yet attacked it—it is not even black. Just behind the mill there is an artificial lake which is nearly as large as the entire plant of most of the Pittsburgh and Pennsylvanian mills. In other words, there is plenty of room to expand as opposed to the plants of industrial cities surrounded by houses and covering them with dust and smoke.

Self-contained Plant

Of course, it took a war to do it, and there are some good things that even wars produce. For centuries people have been dreaming about the ideal steel plant with its coke plant, blast and open-hearth furnaces, slabbing, blooming, plate, strip and structural mills. Then, in 1941, the Government, with the lavishness that it only has in

General view of the Geneva Steel Plant, Utah.



The Geneva plant's 1,100-ton blast furnaces; the 50,000-kilowatt power plant and switch house.

time of war, combined all the latest dreams of engineers for many generations into one project and told U.S. Steel to build Geneva —without a fee.

Even so, no one could really say that Geneva is a picturesque addition to the beautiful scenery of Utah, but it may prove to be a big economic asset. That depends on a number of things. It depends on getting the raw materials and the steel economically, and also on whether Geneva can sell the steel that it produces. The ready facilities of Utah have almost removed the first doubt, but the second may last for a considerable time—that is to say, until more and more new industries have come into being to use the steel that Geneva produces. Possibly that question will not be answered for 20 years.

One factor that will probably help is that the Pacific coast has for many years had rather a complex about steel. It has always wanted to produce its own steel rather than fetch it the whole way from the rival east. There was a certain amount of opposition at first from the Mormons and, of course, nothing in Utah can possibly work without their support. At first they were very suspicious of having a vast industry put down on their farming land—and not too extensive farming land at that, but they have changed their attitude.

The big question at present is: " Where is this huge plant going to find an outlet for its products ? "

It is true that the west in general is using some 25 per cent. more steel than it did before the war, but that is not enough, they told me, to keep Geneva going at a profit. There are various States of the west which are not very much help as far as consuming steel is concerned, for instance, Colorado, Arizona and Wyoming. The logical answer to my mind would be San Francisco and Los Angeles; at any rate California is undoubtedly the biggest potential customer.

There is also the problem that Geneva is not yet fully equipped to provide San Francisco and Los Angeles with the requisites for enormous building programmes, such as a new bridge in San Francisco. The sheet and tinplate market is really the basis of Geneva's potential prosperity, but it cannot rely on that alone and will have to gear itself to the requirements of building in every field of architectural art.

The chief competition at the moment is between Kaiser, who bought the Fontana plant after the war at about 20 per cent. above, proportionately, what U.S. Steel paid for Geneva. Kaiser charged high prices and hoped to pay off the capital costs of his plant, but there is a buyers' market now in steel in California, and also in the rest of the United States. Kaiser promptly had to reduce his plate by 10 dollars a ton and cut his other prices by as much as 39 dollars. The fact of the matter is that Geneva sells the cheapest plate available on the west coast and that it will probably, with every increasing adaptation to the needs of the big cities of the west coast, win out in the end.

Making an Electric Heater

An Inexpensive Appliance for Home Use

By T. LAWLEY

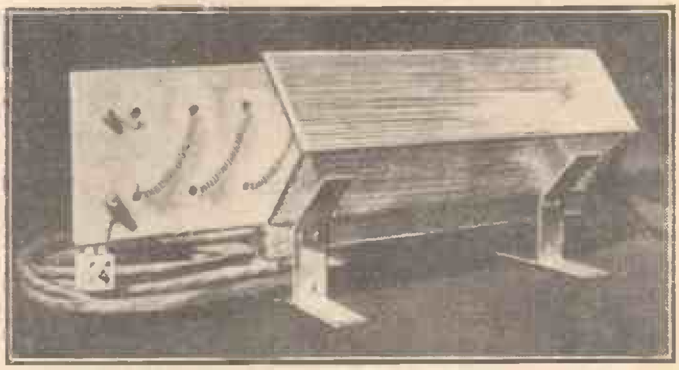


Fig. 2.—The heater with the element partly withdrawn.

An electric convection heater of 375, 430, 500, 750 or 1,000 watts rating can be made quite easily for not more than 5s. by following the simple instructions given below.

The 375, 430 or 500-watt heater if installed in a cupboard or built-in wardrobe will convert it into a very useful clothes airer or drier.

Construction

Cut out the body as shown in Fig. 1 from the piece of 28 S.W.G. perforated zinc. Make a cut at each corner, marked F, for the connecting-block housing. Fold up at 45 deg. along AA and BB and down at 90 deg. along CC, DD and EE.

For the legs cut out and drill four strips of 18 to 20 S.W.G. aluminium, as in Fig. 3a, and bend as in Fig. 3b. Pair the legs off, forming a Y and locate each pair 1in. from either end of the body by drilling 4 B.A. clearance holes in the flange of the body to correspond with the holes P (Fig. 3a) and fix with ¼in. 4 B.A. screws (see Fig. 2). Drill 6 B.A. clearance holes in the sides of the body to mate with hole Q (Fig. 3a) in the legs and fix with 3/16in. 6 B.A. screws. Insert the shaft of a ¼in. drill between the uprights of the leg nearest the connecting-block housing and bend the legs around it to form a loop to take and clamp the 3-core supply cable. Secure each pair of uprights by a further 4 B.A. screw and nuts (see Fig. 2).

Cut out the former from a piece of 3/16in. hard asbestos sheet and drill as shown in Fig. 4. For the 375-watt element two spirals, each of 750 watts are required. For the 500-watt element two spirals, each of 1,000 watts, are required, and for the 430-watt element one spiral of 750 watts and one of 1,000 watts are needed. To wind any of the above elements stretch each spiral to 34in. by pulling at each end only. This will ensure an even spacing of the turns of the spiral. Wind the first spiral clockwise through the ¼in. A holes (see Fig. 4). Anchor the ends by ½in. 4 B.A., cheese-head screws, nuts and washers at A and C. Similarly wind the second spiral through the B holes and anchor to B and C. Only one spiral of the appropriate rating is required for the 750-watt or 1,000-watt element. After stretching the spiral evenly to 34in. and starting at A, thread clockwise through holes A_1, B_3, A_5, B_7, A_9, B_{11}, A_{13}, C^1 then back through B_{13}, A_{11}, B_9, A_7, B_5, A_3, B_1. Anchor the ends at A and B. It is important that each free end of a heater spiral be firmly fixed between a pair of washers. To fix the connecting block reverse one of the brass inserts so that the slotted screw of one is on the opposite face to the other. Locate the block below holes P and Q (Fig. 4) and connect one insert to A and the other to B with a 4½in. and 2½in. length respectively of 16 or 18 S.W.G. bare copper wire (or Nichrome if available) by threading through holes P or Q. The connecting block should now be located firmly against the bottom edge of the former

Drill a 6 B.A. clearance hole on each side of the housing for the connecting block, to coincide with the centre hole of the block when the former is assembled inside the body (see Fig. 2). Assemble and locate the former and block in place with a ⅜in. 6 B.A. screw, nut and washer at each end. To enable the mains supply leads to be fixed to the terminal block without the need to remove the

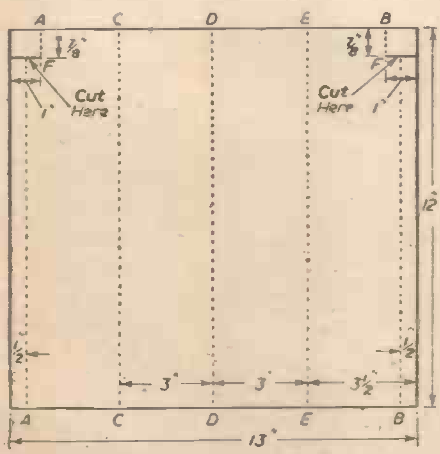


Fig. 1.—Dimensions of perforated metal for forming the main body.

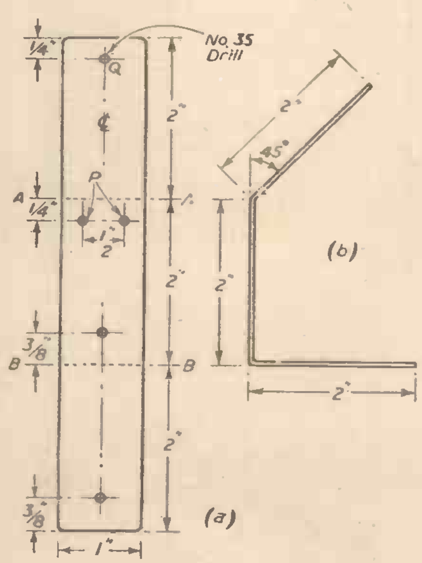


Fig. 3.—Details of the aluminium strip for making the legs.

former or block, drill holes in the perforated zinc large enough to take a small screwdriver blade and opposite the lower slotted screws of the block. There will be one on each face.

Making the Ends

Stand the assembly on its end, place the 5in. × 12in. piece of zinc left over on top, and cut out to shape, leaving a ½in. border along each end. Fold each border down over the outside of the frame at 90 deg. Repeat for the other end (see Figs. 5a and 5b). To fix each end to the frame adjust the end until one of the perforations coincides with a perforation in the body and insert in each side a 3/16in. 8 B.A. cheese-head screw previously tapered at its end. Round off the corners by tapping lightly with a hammer.

The protective guard is cut out as indicated in Fig. 5c.

Connecting to Mains

Use 5-amp. 3-core rubber-covered cable. Pass the cable through the loop in the leg (see Fig. 2). Connect the red lead to the insert connected to terminal B and the blue lead to the other insert (Fig. 4). Make certain that no bare lead shows outside the connecting block, that the screws in the inserts are well below the surface of the block and are tight. Slacken off the 6 B.A. screw fixing the terminal block and insert the guard (Fig. 5c) between the block and its housing below the fixing screw with the open end next to the leg. Tighten up the 6 B.A. fixing screw, and also the 4 B.A. screw to clamp the cable firmly between the uprights of the leg. Connect the green lead of the cable to this screw by a further nut and two washers.

Earth Connection

Under no circumstances must the heater be used without an earth connection (green lead) from the frame to the earth of the mains power supply. If one does not exist the author strongly advises that an earth be made to the nearest water pipe. Failing this, a dangerous electric shock will be felt by anyone handling the heater frame when connected to the supply if an element should break and fall, touching the frame. If a stronger assembly is required the width of the former could be increased by ¾in. at its lowest edge to the right of the connecting-block position and this fixed between the flanges of the body. By inserting the former between the other two corners of the body and re-wiring to the connecting block the heater could then be fixed to a wall.

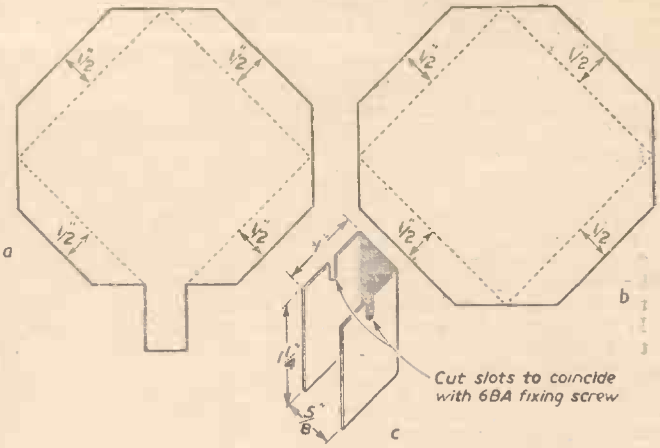
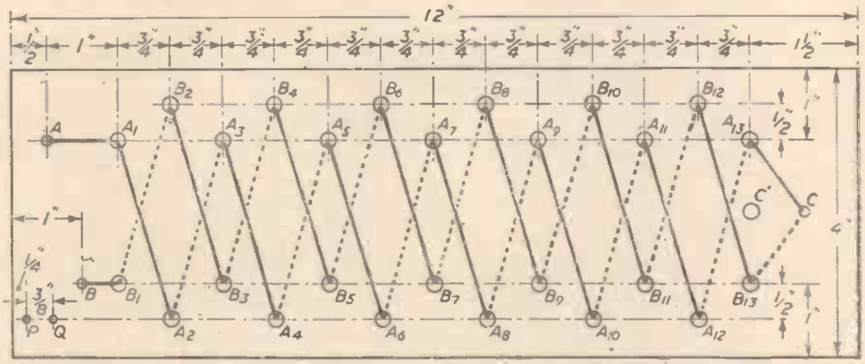


Fig. 5.—End covers and detail of guard for connecting block.



Holes A, B and C No 27 Drill Holes P and Q No 43 Drill All others ¼ Drill The lines joining the holes show the path for the spirals used in making the 375, 430 and 500 watt Heaters

Fig. 4.—Marking out details for the asbestos former.

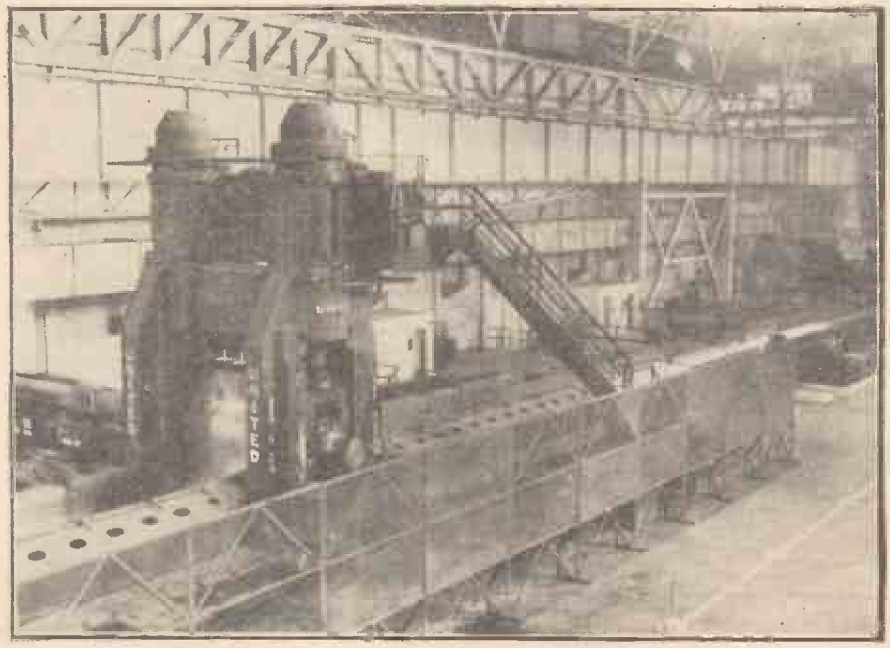
LIST OF MATERIALS REQUIRED

Description	Dimensions	No. off
Perforated zinc sheet 28 S.W.G.	12in. × 18in.	1
Aluminium 18 or 20 S.W.G.	6in. × 1in.	4
White two-way connecting block (plastic)	Approx. ¾in. × ½in. × ⅜in.	1
Nickel-chrome heating spirals	750 watts 1,000 watts	As required
3/16in. hard asbestos sheet	12in. × 4in.	1
Bare copper wire 16 or 18 S.W.G.	12in.	1
Assorted B.A. screws, nuts, washers (all round head or cheese head)	8B.A. × 3/16in.	8
	6B.A. × 3/16in.	4
	6B.A. × ¾in.	1
	4B.A. × ¾in.	5
	4B.A. × ½in.	4

Europe's Largest Steel Mill

THE most impressive contribution to the reconstruction of British industry has taken place in South Wales, where the Steel Company of Wales has undertaken a vast £60,000,000 reconstruction project which will completely modernise the sheet steel and tinplate industries in the south of the Principality. The steel side of the project has been carried out at Margam, near Port Talbot, but equally important work has been carried out at Trostre, near Llanelly. The Margam project has consisted of enlarging and modernising the existing Margam Steelworks by reconstructing the coke ovens, blast furnaces, and coal and ore handling plant.

The blast furnaces are the most up-to-date in the country. The old blast furnaces were reconstructed to produce enough pig-iron to feed the old works at Margam and Port Talbot, as well as the new Abbey Works which are adjacent. These works were recently inaugurated by Mr. Hugh Gaitskell, Chancellor of the Exchequer. The Margam Steelworks are now the largest in Europe.



Our illustration shows the slabbing mill, where the steel ingots are rolled into slabs.

Submarine Escape Apparatus

Two Suggested Devices for Solving the Problem of Preventing Loss of Life in Foundered Submarines

By J. WORDSWORTH

ALTHOUGH I have it on the authority of Professor J. B. S. Haldane, and the professor is one most qualified to know, that gradual suffocation resulting from the exhaustion of oxygen in air is painless, I am appalled that more has not been done to prevent loss of life in submarine disasters.

When a submarine founders, the "Davis" apparatus is the one chance of escape for the men inside, and when they come up at night-time, as they did in the *Truculent*, their chances of being picked up before succumbing to exposure in the water are only fair.

The alternative is to wait inside the submarine until daylight, by which time the air may have deteriorated to such an extent that the use of oxygen in an escape apparatus, after breathing air deficient in oxygen and with a high carbon-dioxide content, will cause vomiting, with consequent loss of life by drowning.

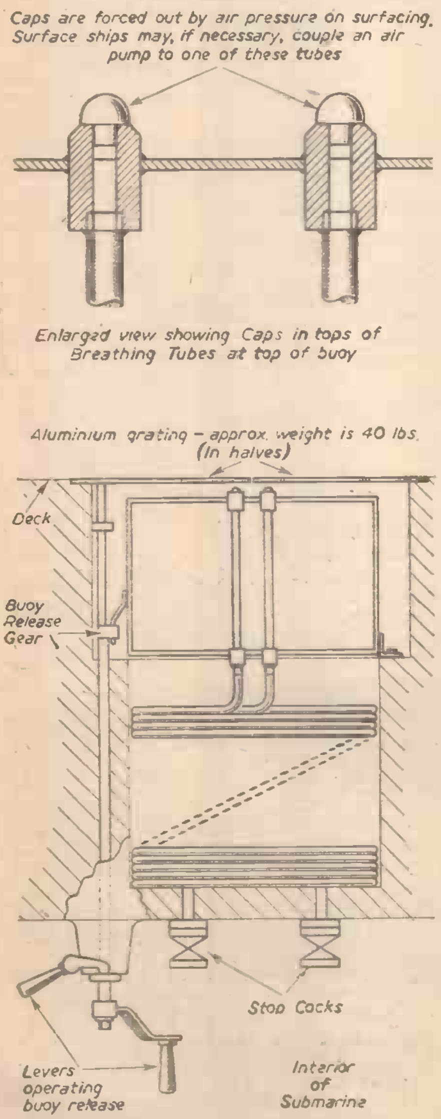


Fig. 1.—The breathing buoy in position in a pit in the submarine.

"Breathing Buoy"

There are two ways by which the problem can be eased: (1) by the storing in the submarine of oxygen in cylinders to replenish that lost by breathing, and a mixture of soda and lime to take excess carbon dioxide. This is a temporary measure: (2) by the use of a "breathing buoy," typified in Figs. 1 and 2. The apparatus consists of an air cylinder, sealed against leakage, and a length of rubber tubing. The whole fits snugly into a pit beneath the deck and is protected from above by a grating in two halves. There may be two, three or more buoys to a submarine, so that the men will have access to one or more, whichever compartments may have been flooded.

When the submarine sinks, the release

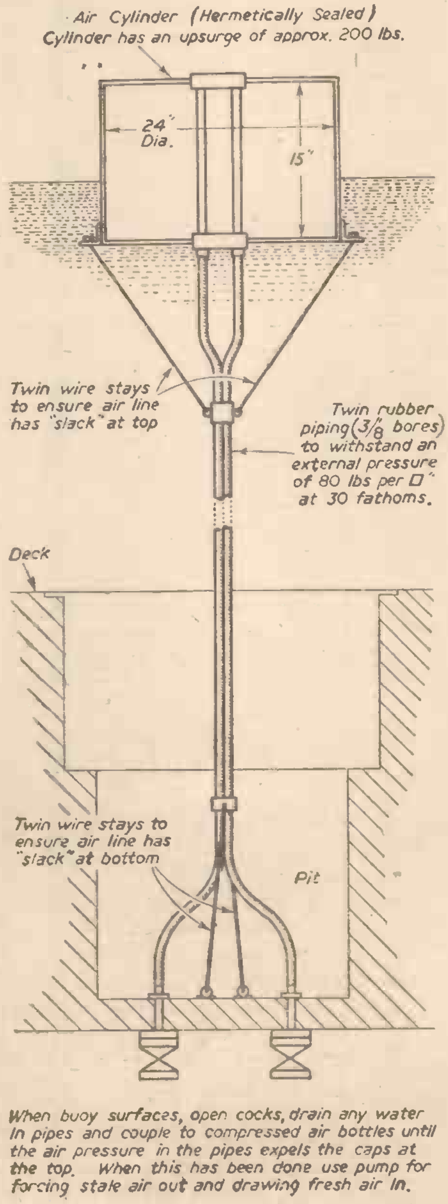


Fig. 2.—Showing the breathing buoy after surfacing.

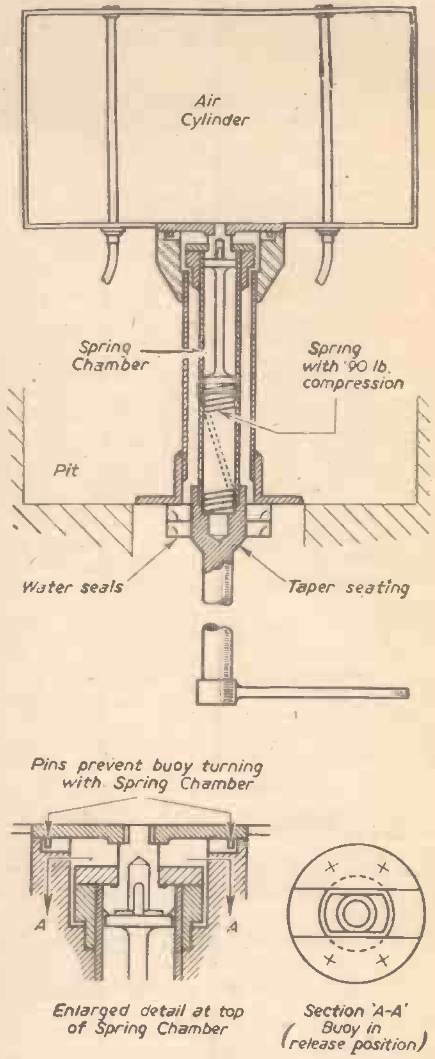


Fig. 3.—Details of buoy ejection mechanism.

mechanism (Fig. 3) is operated and the buoy, shot out of its pit, rises to the surface, throwing off the grating in its component halves as it does so. Caps fitted to the ends of the breathing tubes in the top of the buoy are ejected by connecting bottles of compressed air to the lower ends of the tubes in the submarine. Pumps are then fitted and stale air is forced out of the submarine and fresh air pumped in. Surface ships, when they arrive, may, if necessary, couple an air-line to one of the tubes.

Of course, circumstances might prove much more difficult than this. The submarine may be submerged at such a depth that the buoy stops rising some distance below the surface. When the caps are blown, water, instead of air, will enter the submarine, but should more enter than would normally fill the pipes, it may be shut off altogether by closing the stop cocks. In this event, it would be imperative to have oxygen cylinders and soda-lime to use as an alternative.

This "buoy" should at least keep trapped men alive until help arrives.

There is one important qualification. For the buoy to operate successfully, the compartments in which the men are trapped must be watertight. As the bulkheads are tested to 70lbs. per sq. in., I presume this will be so.

Escape Lift

Another idea of mine, an escape lift (see Fig. 4), is based on the McCann rescue bell, which was used successfully by the Americans to rescue men from their submarine *Squalus*.

The McCann bell is lowered from a surface ship to a facing on the submarine, and is guided to its objective by an operator inside. The rescue chamber shown in the illustration is guided by wires held taut by a buoy of substantial lifting power.

The buoy, which fits around the lift, is released first. It rises to the surface paying out guide wires which pass through the lift to two revolving drums inside the submarine. The drums are locked when the buoy surfaces (ie., when the drums stop turning) to ensure there being no excess "slack" in the wires.

Two men now enter the inner chamber of the lift, and the two watertight doors, one in the lift, one in the submarine, are closed and latched. Compressed air is then admitted to chamber "A" (the space between the two doors) until the pressure rises above the external water pressure, when the lift, rising from its seating, ascends to the surface. The door at the top is opened, the men climb out and drop into the sea. The surface buoy has a number of trailing rings to which they can cling until rescued.

Flooding the Outer Chamber

To return to the lift. The closing of the top door operates a valve which quickly floods the outer chamber. The valve closes automatically after a fixed period while the lift is still comparatively near the surface. The outer chamber is of such a size that the lift descends slowly when it is flooded.

The lift is guided to its facing by the wires, but now comes a complication. The submarine will most probably be tilted in two planes at least. Hence the convex landing surface. The lift, its underside shaped like an inverted saucer, drops on to the landing surface and its weight tilts it. There should be just sufficient "slack" in the guide wires to allow it to settle into its original position.

Chamber "A," now full of water under pressure, is drained by a valve. The pressure drops and the water pressure outside the lift forces it immovably down on to its seating again. The submarine door is opened and the water in the outer chamber of the lift drained. The lift is now ready for its second ascent.

The success of such a lift is, of course, a matter of conjecture. The effect of surface conditions may be such as to render it impracticable, but I feel it may be worth while making some experiments along the lines I have indicated.

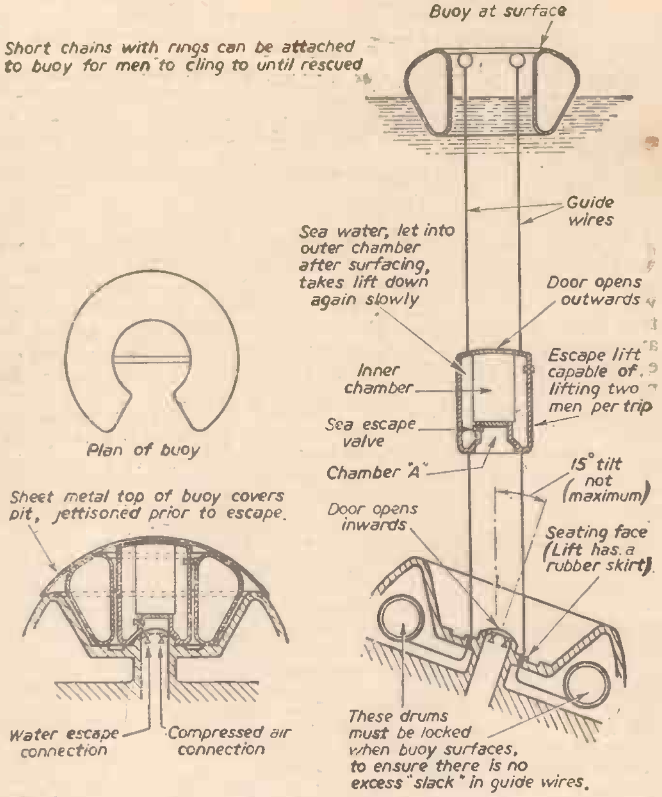


Fig. 4.—Details of a submarine escape lift. Right-hand diagram shows the lift in operation.

One advantage this lift enjoys over other methods of escape (including the "Davis" apparatus) is that at no stage are the men rescued subjected to a rapid decrease in pressure. The pressure is "atmospheric" all the time; consequently they do not get "bends," nor do they have to go into a compression chamber when they surface.

Silver Solders

Notes on the Composition of the Alloys and the Technique of Silver Soldering

By H. C. PIGGIN

THE use of silver-alloy solders, once confined to work in precious metals, is now so universal in engineering practice as to warrant the attention of the amateur craftsman. Silver solders have many advantages over the usual zinc-copper spelters which by far outweigh the slight extra cost.

They are obtainable over a wide range of melting-points which enables, by careful control of temperature during use, the fabrication of two- or even three-heat joins of quite complicated structure. In the joining of copper and brass parts ordinary spelters would cause loss of efficiency by annealing the work at the very high temperatures required to "run" them. Silver solders "run" at only a few degrees above their comparatively low melting-points, and become very fluid, quickly penetrating quite close clearances with the minimum of void. Excess solder and flux can be quickly and easily removed, so that, over-all, an important saving of time and fuel can be effected.

Again, in joining dissimilar metals such as copper to steel, internal stresses are set up owing to expansion differences between the two metals, but the extreme ductility of silver solders makes them freely available for the most complicated work of this nature.

Temperature Ranges

There are on the market over a dozen different silver solders, each alloyed for specific industrial purposes, covering a temperature range of from 610 degrees Centigrade to 830 degrees Centigrade.

Obviously in amateur work it is unlikely that such properties as electrical conductivity, tensile strength, etc., will have to be so closely regarded, and a range of (at the most) four different alloys is all that will ever be required. Of the four shown in the table, I have found Easyflow to satisfactorily cover all light-engineering jobs, and I have had to resort to a harder solder only on one or two silverware jobs where "whiteness" is required.

Silver solders may be obtained in several forms—sheet, wire, strip, powder, etc. Probably wire about 20 s.w.g., or ¼in.-wide strip, is most economical.

The practice of silver soldering follows closely that of ordinary brazing, but is, of course, quicker.

Simple Rules

The following simple rules that apply to all hot-joining of metals, whether with soft or hard solders, should be borne in mind:—

1.—A clean, well-fitting joint.
2.—The right flux.
3.—The right heat in the right place.

With regard to the joint, it is generally advisable to wire together any loose parts, using a soft iron-wire for preference. Soldering jigs are ideal but not always practicable except for repetition work, whilst clamps tend to take so much heat and prolong the operation.

The right flux, except for Easyflow solder, is borax. Although the old silversmiths still prefer to grind a wetted lump on to a piece of slate, I usually buy the powder form and mix up small quantities of paste as required. For Easyflow solder, the special fluoride-borax preparation sold as Easyflow flux is, without doubt, the best. Ordinary borax does not become active at a sufficiently low temperature.

The action of the flux is, as with lead solders, to clean the work initially, and to prevent further oxidation of both work and solder under heat.

The flux is best applied as a smooth paste and brushed well into and over the joint. One end of the solder strip itself should also be coated.

Source of Heat

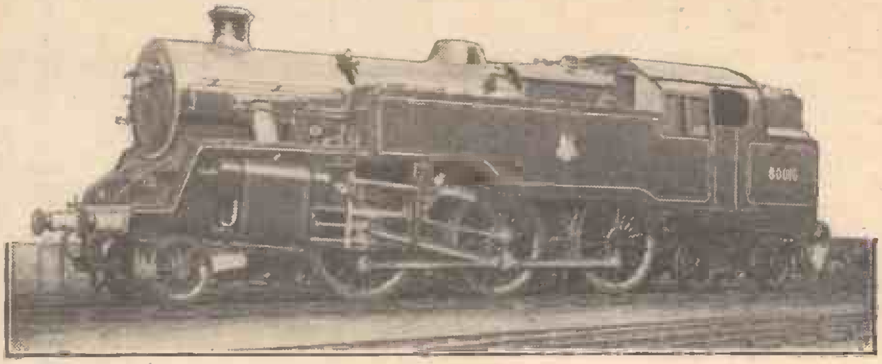
To fulfil rule No. 3, any clean flame of sufficient temperature will suffice. Small work may be heated by an ordinary Bunsen, or a mouth blowpipe, on a charcoal block, but larger work will need a blow-torch, and should be well-packed with small pieces of asbestos brick (coke is a good substitute) to conserve the heat. The envelope of the flame at the point where it just becomes ragged—well in front of the air-cone—gives the best heat.

At the commencement of the operation, the flame should be large and soft, and should be applied all over the work, being kept slowly moving so as to prevent excessive local heating. Larger components of the join should be given more heat than smaller ones, and in the case of dissimilar metals, the more rapid conductor (e.g., copper in the case of a

(*Continued on page 21*)

B.R. New Tank Locomotive

A Brief Description of the Chief Constructional Features



The new B.R. standard 2-6-4 mixed traffic tank locomotive No. 80010.

OF the six standard types of locomotives to be built this year two will be tank engines, the larger having the 2-6-4 wheel arrangement and power classification 4, and the smaller one the 2-6-4 wheel arrangement and power classification 3. The erection of the first Class 4 2-6-4 T locomotive has now been completed at the Southern Region's Brighton works and is numbered 80010.

A total of 54 of these locomotives is included in the 1951 locomotive building programme, 44 of which are to be built by the Southern Region at Brighton and 10 by the London Midland Region at Derby. The manufacture of the details of the locomotives being built by the Southern Region is divided between the works of that Region, viz., Eastleigh, Ashford and Brighton.

They have been designed and built under the direction of Mr. R. A. Riddles, C.B.E., Member for Mechanical and Electrical Engineering, Railway Executive. The parent office for the design of this class is Brighton, whilst certain sections have been designed at Swindon, Derby and Doncaster. The work of designing the new locomotive has been carried out in the Brighton drawing office concurrently with the design of the Class 4 4-6-0 locomotive. These two types are of similar size and operating capabilities from the point of view of power output, the tank engine being intended for short-distance working, such as suburban and cross-country passenger trains, and the shorter distance freight workings, and will have almost universal availability over main and secondary lines throughout Great Britain.

Many of the details of the two Class 4 types are interchangeable, whilst various features of the design, including nearly all the fittings, are common with those of the other British Railways' standard types.

Boiler Design

The boiler is of the same general design as the L.M. Region Class 4 2-6-4 tank, except that the staying has been redesigned to accommodate the higher boiler pressure, which has been increased from 200 to 225lb. per sq. in. The shell is of ordinary quality steel plate and the barrel is made of two rings, the second of which is tapered. The front barrel ring is rolled from 9/16in.-thick plate and the second ring of ⅝in., the outside diameter being 4ft. 9in. at the front and 5ft. 3in. at the firebox end. The smokebox tubeplate is of the drumhead type, ¾in. thick. There are 21 large flue tubes 5¼in. dia. outside, No. 7 S.W.G. thick and 157 small tubes 1¾in. dia. outside and 12 S.W.G. thick. The length between tubeplates is 12ft. 3in.

The Belpaire firebox has outside dimensions at the bottom of 8ft. 6in. in length and 4ft. 0½in. in width. The grate area is 26.7 sq. ft. The inner firebox is of copper, the wrapper plate being 9/16in. thick and the tubeplate 1in. thick. The outer steel wrapper plate is 9/16in. thick.

The regulator is located in the dome and is of the vertical grid type with an operating shaft placed transversely across the boiler and mounted in a stuffing box on the second barrel ring. An external rod is employed for the connection to the regulator handle in the cab.

Smokebox

The cylindrical smokebox is supported by a fabricated saddle, and has the self-cleaning arrangement which consists of plates and a wire mesh grid arranged to prevent accumulation of ash and the emission of large particles of unburnt fuel. The blast pipe has a plain circular cap 4¾in. dia. which also contains the four Cardew-type blower nozzles.

Frames and Axleboxes

The engine has 1¼in.-thick steel plate frames braced by horizontal and vertical stretchers, the majority of which are fabricated. The axlebox guides are steel castings riveted to the frame plates and are provided with manganese steel liners on the wearing faces.

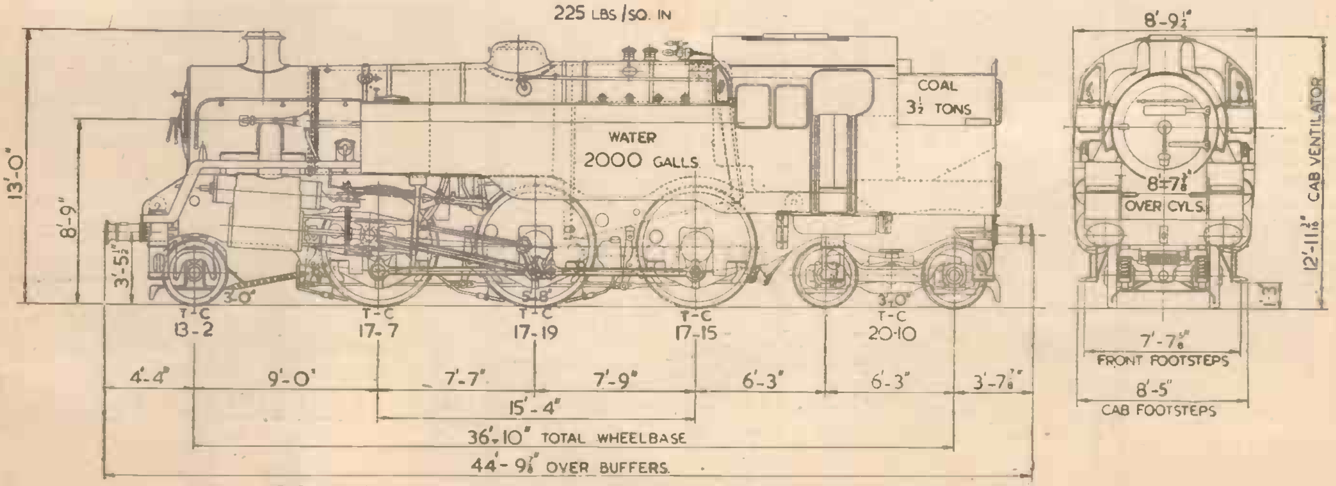
The boiler is carried in the frames by rigid attachment between the smokebox and the saddle, and by a downward extension at each back corner of the firebox foundation ring resting on shoes supported by a frame cross stretcher, to permit longitudinal expansion.

The engine is fitted with plain bearing axleboxes to all wheels. The coupled wheel axleboxes are steel castings, with pressed-in white-metalled horseshoe brasses, and sliding underkeeps of ample oil capacity with pad lubrication supplied by oil from a mechanical lubricator. Guide wearing faces are provided with manganese steel liners welded to the axlebox and lubricated by grease.

The coupled wheel springs are of the laminated type with carbon steel plates. Underhung spring brackets with solid tension links cottered at top and bottom ends and rubber damping pads are provided, weight adjustment being made by fitting cotters of suitable depths.

Cylinders and Valve Gear

The two cylinders, 18in. diameter by 28in. stroke, are of cast iron and placed outside the frames. Piston valves, 10in. diameter, are provided, operated by Walschaerts' valve gear, giving a maximum travel in 75 per cent. full forward gear of 6 37/64in. with a steam lap of 1½in. and a lead of ¼in. The box-type piston head has two rings with a bronze spring-loaded slipper on the underside to minimise the piston head and cylinder barrel wear. The cross-



Side and front elevations of the new locomotive, giving some of the leading dimensions.

head is guided by the two-bar type of slide-bars with upper and lower bars.

Lubrication of the cylinders and piston valves is by atomised oil supplied from a mechanical lubricator. The valve gear is mainly lubricated by grease and plain bearing joints are used, except for the return crank rod big end, which is equipped with a self-aligning ball bearing. Screw reversing gear of the conventional type is fitted, but for convenience of operation the cab handwheel is arranged with a bevel gear drive at 45 degrees to the axis of the reversing screw. Steam-operated cylinder cocks are provided.

Wheels

The coupled wheels are 5ft. 8in. diameter, and the tyres have the lip fastening adopted for all B.R. Standard locomotives. A lip on either side of the tyre ensures its security to the wheel centre, the lip on the inner side being sufficiently shallow to allow the tyre when expanded to pass over the wheel rim. 40 per cent. of the reciprocating masses are balanced, the weights in the wheels being built up with steel plates to form pockets for the insertion of lead.

Steam sanding is provided to the leading and driving coupled wheels for the forward direction and to the driving wheels also for reverse running.

Bogie

The bogie employs laminated springs for compensating beams and side bolsters. Side-play control is effected by means of double helical springs. The wheels are 3ft. diameter.

For the pony truck helical bearing springs are employed, with two nests of springs, each nest consisting of two springs, one internal to the other, arranged on either side of each axlebox. The load is transmitted to the axlebox by means of a yoke and shoe. Side-play control is effected by double helical springs, and helical springs are also employed for the side movement retarding gear fitted fore and aft of the truck centre on the axle centre line. The wheels are 3ft. in diameter.

Brake Gear

Steam brakes are provided and may be operated by means of a separate steam brake valve or in conjunction with the vacuum brake. The coupled wheels only are braked, by means of a single block on each wheel.

Water Pick-up

This is provided for both forward and backward running on engines operating in the London Midland Region only, but provision is made for the fitting of the gear on all engines if required.

Cab

The cab, although dimensioned to suit the smaller of the B.R. loading gauges, follows the approved layout for all the standard locomotives. All the driving controls are grouped for easy access and operation in the left-hand driving position, the vacuum brake, blower and sanding valves being mounted on a pedestal, which also serves as a firehole screen, to the right of the driver. Seats are provided for both driver and fireman.

Two live-steam injectors are fitted on the right side of the engine, under the cab, with steam and water controls grouped within easy reach of the fireman.

Tanks and Bunker

The tanks and bunker are of welded construction throughout. Each tank has curved sides and a pressed U-shaped bottom, forming a structure of considerable rigidity, and is supported at the forward end on the outside slidebar bracket and at the rear end on a frame bracket.

The tanks have a water capacity of 2,000 gallons and the bunker a coal capacity of 3½ tons.

A Simple Hygrometer

An Inexpensive Appliance for Home Use

By J. E. C. STRINGER

MANY common materials are hygroscopic, i.e., they take up water from the atmosphere. For example, silk and wool fibres take up a little moisture, cotton fibres rather more; paper commonly holds about 8 to 13 per cent. of its weight in water. These materials tend to expand in length as the moisture content increases and shrink as it is lessened. Human hair, freed from grease, has been used for the construction of hygrometers. Seaside holidaymakers in Victorian days were in the habit of taking home seaweed to be used as a sort of "weather glass," because seaweed, dry and hard in fine weather, becomes soft and supple to the feel when wet weather is expected. Another material that is hygroscopic is glue, and the following notes refer to a hygrometer making use of this fact.

Details of Construction

The plastic capsules in which lighter-fuel is sold are made of a glue-like material which varies in hardness from quite soft in damp weather to nearly rock-hard in extremely dry weather. The change in hardness is accompanied by a considerable dimensional change, the material shrinking when dry. Consequently, a capsule of this material will have a larger volume when damp than when dry, the change in volume being considerable.

An empty capsule is fitted to a glass tube about 14in. long by 1/16in. bore. This is conveniently managed by leaving the capsule overnight in a damp place, such as a cellar, which makes the material quite pliable; the end of the glass tube is then warmed and inserted into the neck of the capsule, the warmth melting the glue slightly so as to cement the capsule to the tube. The joint is then allowed to cool and harden. (See Fig. 1.)

Filling the Hygrometer

When the joint has become firm, the open end of the tube is placed under the surface of some paraffin oil in a tin lid and the capsule squeezed to drive out some air; upon releasing the finger pressure, paraffin is drawn up into the capsule. The tube and capsule are now held upright and the capsule squeezed again to expel more air, followed by inverting and again drawing in more paraffin. This operation is repeated until all air is expelled and the capsule is completely filled, the paraffin level coming about halfway up the glass tube.

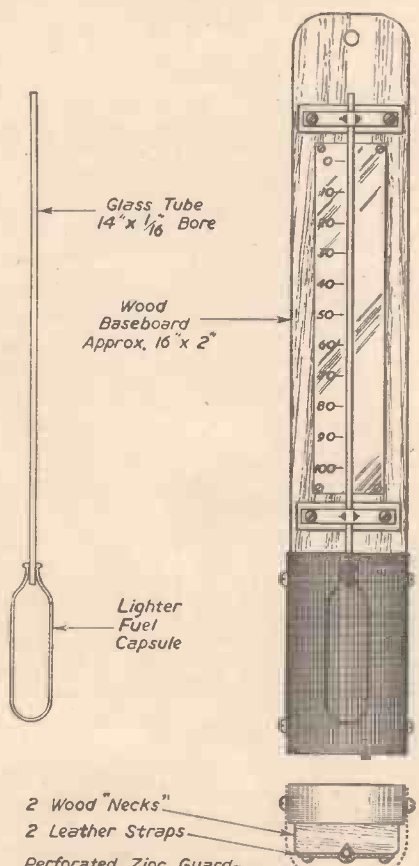


Fig. 1.—Detail of the glass tube and capsule.

Fig. 2.—Front view and plan of the completed hygrometer.

Mounting

Fig. 2 shows a suitable baseboard. Two wood "necks" are fitted and the glass tube held in place with leather straps and No. 4 wood-screws; the capsule hangs free. To guard the capsule from damage, a piece of perforated zinc should be fitted as shown. A small pledget of cotton wool should be inserted in the open end of the glass tube to prevent entry of atmospheric dirt and to stop evaporation of the paraffin.

Calibration

A paper scale may be attached to the baseboard with drawing-pins.

The most convenient and accurate method of calibration is to hang the instrument alongside a wet-and-dry bulb hygrometer in a gardening friend's greenhouse; reference to the tables supplied for use with such instruments will give the percentage relative humidity from day to day and these values may be pencilled on the scale. Calibration marks should be made for dry, normal and humid conditions.

A new scale may then be made from white ivorine or similar material, utilising the original scale markings. This greatly enhances the appearance of the complete hygrometer.

If the constructor wishes, the paraffin may be tinted with an oil-soluble dye. Manufacturing chemists can usually supply a small quantity at a reasonable charge.

Light Punching Machine

Constructional Details of a Handy Tool for the Workbench

By R. G. ILSTON

THE machine described here is a great advantage in the home workshop or garage where light metalwork is carried out. As will be seen by reference to Figs. 1 and 2, its construction is simple yet strong and it is capable of punching holes up to 5/16in. diameter in 18 gauge M.S. Machining limits are ±.005in. and the finish should be as smooth as is possible.

Construction

A body of B.M.S. is first machined to size, i.e., 4in. x 3in. x 2in. and a throat 1⅛in. wide by 1⅞in. deep is milled in it, after which the bores for the punch holder and the die are turned (Fig. 3).

Following the above operations the fixing bolt holes for the back bearing are drilled and tapped 7/16in. B.S.F. in the top, and the ¼in. Whit. socket screw hole is drilled and tapped in the centre of the front, ¼in. down from the bottom jaw face.

Two feet are made from 1in. x 1in. x ¼in. M.S. angle, with two holes in each for bench fixing, after which the front bearing of 2in. x ¼in. M.S. plate and the back bearing of 1¾in. x 1¼in. x ¼in. angle, 2in. long, are cut and drilled.

Handle and Punch Holder

A handle is cut from 12in. length of 1in. x ⅜in. M.S. flat (Fig. 3), and the pivot hole and the ¼in. Whit. hole for the spring fixing screw are drilled and tapped, following which two distance pieces are turned from ⅞in. diameter B.M.S., A, 9/16in. long, and B, 13/16in. long, both having a bore of 7/16in. diameter.

The punch holder (Fig. 4) is turned from 1⅛in. diameter B.M.S. and the ⅜in. Whit. socket screw hole is drilled and tapped.

Assembling

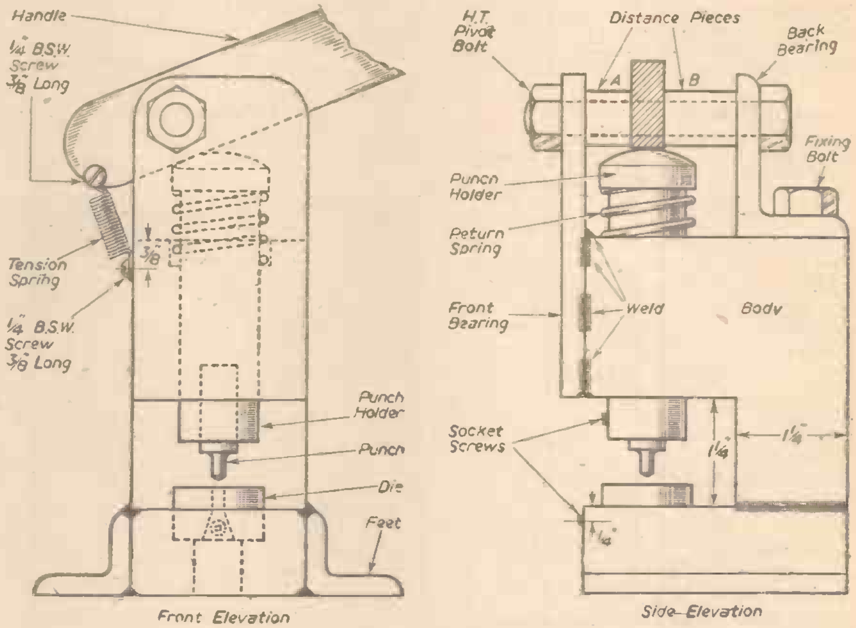
In assembling the machine the front bearing and the feet are welded in position and any surplus weld is cleaned off.

Next a compression spring ⅞in. free length x ⅞in. inside diameter consisting of five turns of 16 gauge wire is obtained and slid on to the punch holder shaft, the two parts then being inserted into the body; the spring seating in the 1⅛in. bore. The back bearing is fixed to the top by two 7/16in. B.S.F. set-bolts 1in. long, and the handle and distance pieces are fitted and held in position by a high tensile 7/16in. B.S.F. bolt and nut 2⅜in. long.

One end of a tension spring ¾in. long x 5/16in. outside diameter of 16 gauge wire is fitted to the handle by a ¼in. Whit. round head screw, ⅜in. long, the other end being fixed to the body in the required position by another ¼in. Whit. screw.

Punches and Dies

The punches and dies (Fig. 5) are made from short ends of cast steel or other suitable material and, providing that a sectional area equal to that of 5/16in. diameter is not exceeded, punches and dies of shapes other than circular will give satisfactory results, while small bending sets for light sections can also be made and used satisfactorily on this machine.



Figs. 1 and 2.—Front and side elevations of the completed punching machine.

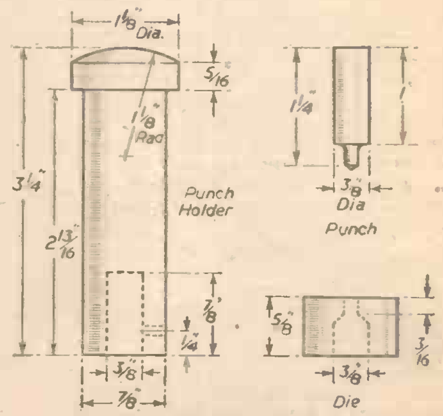


Fig. 4.—Punch-holder and die.

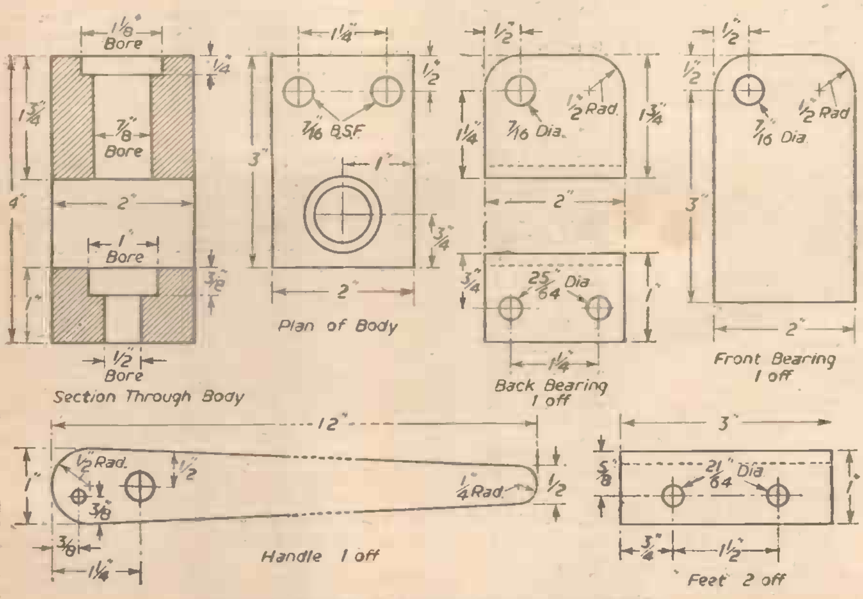


Fig. 3.—Details of the body, bearings and handle.

Hardening Plaster Castings

Notes on the Various Methods Used

By C. V. THOMPSON

THIS is not an article on how to cast in plaster. There are plenty of books on the subject that can be obtained in any public library, but a few remarks concerning plaster in general is necessary in order to point out its advantages and disadvantages.

There are many kinds of plaster (or gypsum, as it is correctly called), and they all have differences. Colour, density and setting time are the main differences, but they are all alike in one respect. They are soft and extremely porous. I shall confine myself to those suitable for casting ornaments, figures, etc.

There is no really hard plaster. Some are certainly harder than others, but they are all very chalkish. There has been a rock-like plaster in ancient Egyptian days (it can still be seen on the walls of the tombs), but I think I can say without fear of contradiction that how it was made, or of what materials, is not known to-day. True there are certain kinds of Nile mud that will harden very much indeed, but whether it would harden in the English atmosphere as it does in the dry hot air of Egypt is very doubtful.

I have tried for many years to get a plaster that would set hard, but in spite of many hundreds of mixes, I have dismally failed.

There have been several liquid marbles (Marblex, Marblene and Marbleite, to mention three of them). They were going to revolutionise the plaster casting trade, but to-day they are out of existence. Why ? I have tried most of them, and they just did not come up to expectations.

Any mixes of plaster and cement are suspect. If one tries to mix a plaster, with a setting time of ten minutes, with a cement with a setting time of five to 20 days, theoretically one should get something harder than plaster and softer than cement. But it doesn't work out like that. To slow a plaster and quicken cement simply spoils both. They must harden in their own time and, anyway, cement mixed so that it flows is not hard at all.

The hardest plaster I know is Stonecast (Dohm Co.). This is very strong, as it contains metallic dust. It has a reddish colour and is rather heavy, but it is very fine, and will give a wonderfully sharp impression, especially when used in Castogel moulds (Dohm Co.). Their white cast is perhaps a trifle harder than the usual plaster of Paris, but not much.

The next hardest I would say is Stonehard (Dental Manufacturing Co.). This is nothing like so hard as Stonecast, but it is much harder than plaster of Paris. Both are about 1/- a lb. There is not much to choose between the other kinds of plaster.

Plaster of Paris

That is the position in plaster, with a natural casting hardness. A very popular idea is that plaster of Paris, mixed with a saturated solution of alum, baked and ground, then mixed with water, sets rock hard. It just doesn't.

The main reason why plaster of Paris (or any other superfine plaster such as made by Gypsum Mines Co.) has held its own for hundreds of years, is that it is still the best. *For work with fine detail it cannot be beaten.* It can be controlled easily and is cheap. Its only faults are liability to breakage and the little black specks. These are not noticed much except in miniature work when a black speck only the size of a dot on a face a quarter of an inch from ear to nose shows up badly, and has to be dug out and filled in, which is not an easy task.

When one tries to give the plaster strength by adding something during casting, it must not be forgotten that anything added is prone to make it shrink, and anything that shrinks must lose detail and distort. The addition of alum increases speed tremendously as to be almost unmanageable.

The reason plaster of Paris gives such a good impression is because it dries out on setting and becomes a mass of tiny holes where the water was, but occupies the same space. The only satisfactory way to harden it, therefore, is to fill those holes with something tough and hard. Little difference is made by packing plaster (that is, putting in as much plaster as the water will take). The fact is that the material itself is soft. With cement this is different, and the more that can be packed in the harder it will be. Any of the quick-setting cements now obtainable will mix with a slow plaster, such as Belpite No. 3 (Gypsum Mines Co.), and give it a reasonably hard surface, but it is not so hard inside.

Removing a cast from a one-piece mould. The cast is plaster, the mould is "Vinamold" HMC.774.

(By courtesy of Vinyl Products, Ltd.)

Hardening Solution

First on the list of hardening materials is glue or gelatine, which are both the same, except one is purer than the other. Presuming the object to be hardened is ready, immerse it in a warm solution of glue water (½ ounce to the pint) till all bubbling ceases. Take it out and let it dry in warmish air (75 deg. F.). When dry repeat, and keep on repeating till no bubbles appear on immersion. This may take up to six immersions. Remember on every immersion water goes in with the glue and when it evaporates it leaves holes. These holes get smaller and less every time. When finally done the cast may not be unbreakable, but it will be very hard and strong indeed.

The snag in this is liability to damp. Immersion in formalin cures this, but I have found this not to be permanent. Of course it can be painted, but that fills in the crevices and rather spoils the detail. Varnish is better, but usually has a darkening effect. In case anyone thinks of mixing the glue direct with the plaster during the casting, there is the possibility that it will crack in the drying.

A very good thing to harden plaster with is a clear cellulose, but it must be a really clear one such as Ercalene (Canning and Co.). Here again several immersions, up to four, are necessary. Although much dearer than glue it is waterproof and very hard and tough at all times.

Shellac Varnish

A good white shellac varnish is splendid. Less immersions are necessary, and on completion the object is harder than the other two, but more brittle.

Immersions in anything of an oily nature hardens only slightly and makes the object semi-transparent. Immersions in skim milk will harden a fair amount and give a marblish appearance. This can be mixed direct, but great care must be taken to make sure that there is no trace of butterfat in the milk.

I was talking recently to an official on the technical side of a firm that makes a casting plastic. I showed him a small pendant of an Indian's head and shoulders in plaster of Paris. It is only an inch and a quarter long, but all the fronds of the feathers show quite clearly. He said that he didn't think such detail possible in plaster of Paris. (It had been hardened with Ercalene.) Then I showed him a plastic casting from the same mould and he could see how the detail had blurred in the shrinking when compared with the other.

In immersion always remember that it is better to immerse many times in a thin liquid rather than try to cut out immersions by making the liquid thicker. If you do you will probably find cracks come where the liquid has settled thicker in some places than others.

Using Catalin

If shrinkages don't matter, Catalin has a very good urea resin that mixes freely with water. It is not dear if bought in fairly large quantities (28lb. upwards) and with it one can obtain whatever degree of hardness is required, even sufficient to blunt files in trimming.

This is mixed during casting, but beware of bubbles. They come in the mix very easily and unless care is taken the object is spoilt by pin holes.

Of course, it is not worth the trouble or expense to harden rough things like the dogs sold at a market for 2/6 a pair. Such things are best broken up anyway. But if one does try to cast something worth while, then hardening it should be worth while too. It is very annoying to do a really nice job and then to knock off a nose or a finger in handling it.

Miniature Casting

Miniature casting, such as I do nowadays, has a fascination all its own, but hardening such things is very necessary. They are much too frail otherwise. If colour doesn't matter, adding Stonecast to a proportion of 25 to 50 per cent. of the mix is a great help and comes cheaper.

Finally, don't be deceived by surface hardness, it is possible to get a very hard surface shell with cement, plaster and glue water, but underneath it is very soft even to the consistency of ordinary dry mud. And any of the water celluloses are very tricky. Baking will harden, but makes brittle.

Fitments for Pipe Smokers

Two Simple Devices for Providing Added Pleasure for the Regular Smoker

By "HANDYMAN"

AS a reader, sitting in an easy chair, after my day's work is done, and as a draughtsman, bending over a drawing board, I have found that in many a pair of trousers or a waistcoat I have burned little holes and from many a drawing I have had to quickly brush red-hot particles of tobacco. Even when such particles are not hot they soil the drawing by being crushed under the tee-square or set-square.

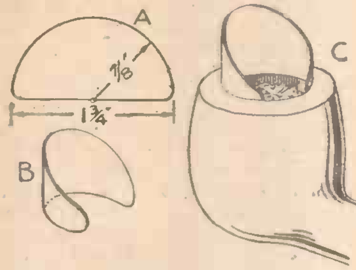


Fig. 1.—Details of the pipe shield.

Pipe Shield

These things I put up with until it occurred to me, some time ago, that they could be prevented by a most simple fitment to the pipe.

From the thin vacuum seal tinplate of a tobacco tin, in some cases, and from the tin lids of pots of vacuum-packed jam—the kind on which you are told to "pierce with a pin to open"—I cut, with scissors, semi-circles of size and shape as at A, in Fig. 1. These were rolled with a cylindrical object, such as a pencil or fountain pen, to such a curvature, B, as would enable them to spring into the bowl of the pipe, as at C. To use it the pipe is first filled with tobacco, the shield inserted and the match or lighter applied. Or, of course, if preferred the shield can be put in after lighting up. I have found, when drawing, that it is best to tilt the shield back a little towards the stem. In any case, it effectually prevents any half-burned tobacco or ash from falling out of the pipe.

Possibly a more convenient fitting could be permanently attached to a pipe of the pattern which has the usual barrel-shaped bowl; this I have not yet made but intend to fit it to one of my pipes. It is of thicker tin, sheet brass or other metal, cut to somewhat the same shape but long enough to embrace half of the circumference of the outside of the bowl. In it are soldered two small pins which fit into little holes drilled in the sides of the pipe, near the top. Such a shield can be folded back towards the stem, as at D, Fig. 2, for carrying in the pocket and for filling with tobacco, and then swung over to the position E, when smoking. If the shield is of tin it may be black lacquered and if of brass can be oxidised brown.

Perforated Plug

Another little "gadget," which is of more recent date than the shield, is a fitment to go into the bottom of the pipe bowl. Like most other smokers I had always been bothered with wet tobacco—which has been called "the dottle"—and which, in these days of high tobacco prices, is a wasteful item. The popular idea that this moist, unsmokable, plug is due to a "wet" smoker is, in most cases, fallacious. The moisture rarely comes from the mouth of the smoker. Everyone knows that the products of combustion are water and carbon. If the pipe bowl is deep and is filled with tobacco that portion of the tobacco at the bottom will become saturated as the result of the combustion at the top. To some extent the accumulation of moisture depends upon the water content in the tobacco itself and this cannot be avoided any more than can the product of combustion.

To get over the trouble I tried many things fitted into the bottom of the pipe bowl; little fireclay buttons, blotting paper rolled into flattened balls and cinders out of the firegrate. Of these the last was the best, and the blotting paper useless. I used the cinders for some time but they quickly became clogged and were a lot of trouble to find of the correct size or to cut and shape to fit the bowl, and then I thought that an air space might get over the trouble and this I found was the case.

To provide this air space I used the tin caps from small size tins of denture fixative powder (A, in Fig. 3) and drilled seven holes in them with a number 42 drill, reducing the depth of the knurled flange by cutting, as at B. It is not essential that the holes should be drilled; they can be punched from the inside with a round steel spike on the end grain of a piece of softwood, the burr on the outside being then filed away.

One of these caps is placed in the bottom of the pipe bowl with the flange upwards as in the sectional view of the pipe at C. By the use of these caps—I keep one in each of my pipes—every bit of tobacco put into the bowl can be smoked and none of it becomes moist.

Cleaning

The caps need to be taken out from time to time, according to the frequency of smoking, threaded on the end of a piece of wire and held in a tiny blue flame of a gas ring to burn off the accumulated carbon. At the same time the nicotine tar can be cleaned out of the bottom of the bowl and the stem with cotton wool. If the caps are left in too long they will become locked in place by the carbon lining the bowl above the cap; this must be scraped away and the cap can then be lifted for burning off, with a wire hook shaped as D in Fig. 3. I keep such a hook for the purpose.

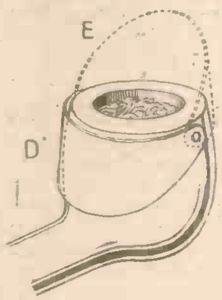


Fig. 2.—A hinged pipe shield.

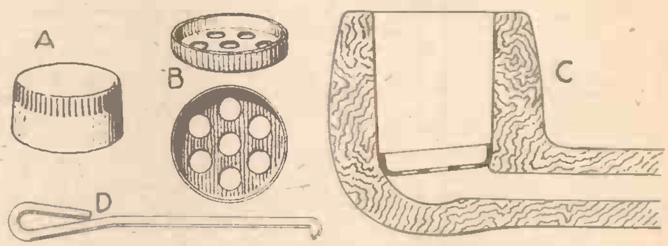


Fig. 3.—Details of a perforated plug for a pipe bowl.

SILVER SOLDERS

(*Continued from page 16*)

copper-iron joint) will require more heat.

At first the flux will bubble as it is dried off, but this will soon cease, and the flux will melt into a glassy liquid under which the work will appear clean. Assuming wire or strip solder is being used, the ready-fluxed end should now be touched on the work. The flame should be shortened slightly and brought to bear on the joint itself, being moved slowly along the whole of the seam. The solder should melt easily into the joint, being attracted towards the hottest part, following the flame even to the extent of running "uphill" slightly. Any lumps should be smoothed over using a fluxed iron-wire tickler, and, when the joint is filled—allowing for shrinkage on cooling—the flame should be removed.

Flux Residue

Flux residue may be removed by stiff brushing in hot water, or if obstinate, in a mild acid pickle.

Occasionally, usually with beginners to the technique, the silver solder is applied to the work not by strip but in the form of small snippets about the size of a pin-head. These should be fluxed and applied to the work by means of tweezers as soon as the initial bubbling of the flux is finished. Allow one snippet about every ⅜in. along the joint.

Comparative Table of Silver Solder Alloys

Solder	Approximate composition	Melting point, deg. C.	Remarks as to use
Easyflow ..	Silver 10, Copper 5, Zinc 1	630	Only Easyflow flux.
Easy.. ..	Silver 2, Brass 1	723	White for hall-marked silver articles.
Medium ..	Silver 3, Brass 1	778	First in two-heat joint with Easyflow.
Hard ..	Silver 4, Brass 1	800	Used in enamelled jewellery work: three-heat first.
Spelter for comparison	Copper 5, Zinc 4	890	

A Passenger-haulin

Constructional Details of a $3\frac{1}{2}$in.-gauge Locomoti

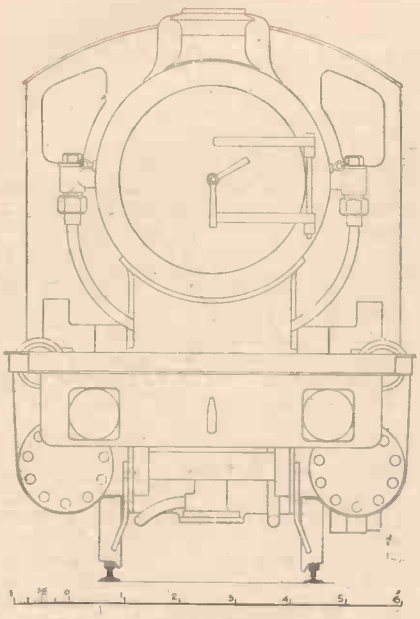


Fig. 2.—Front elevation of the locomotive.

IN designing this engine for the model-railway reader of PRACTICAL MECHANICS, I have kept certain outstanding features in mind ; I set out to design an engine of the most simple scale prototype, involving, for its scale and size, the minimum amount of labour and time in construction. An engine which shall be capable of hauling—again for its scale and size—the maximum passenger load. So I cut out all superfluous wheels and axles and other useless complications—useless in so far as a working model is concerned—and adopted that " maid of all work " type: the 0-6-0 wheel arrangement. This makes possible small coupled wheels which, of course, results in a maximum tractive effort and draw-bar pull.

The scale of the model is three-quarters of an inch to one foot, so the gauge of track is the standard three-and-a-half inches; a width between rails upon which one can safely ride without overturning. Locomotives can be, and have been, made to half-inch scale and even for the $1\frac{3}{4}$in. gauge, capable of pulling an adult person, but it is a somewhat precarious job balancing oneself on such a track, to say nothing of the materials used for a solid foundation for the railway.

I have no particular liking for the 0-6-0 type, but I do think that as a locomotive it can be as handsome a machine as any express passenger type, if it is artistically designed, with some polished metal work and above all painted in an attractive colour picked out and fine-lined as some of the railway companies' goods engines used to be finished before the grouping in 1923.

From the accompanying drawings it will be seen that I have, so far as is possible, simplified everything and have, except in a few cases, cut out castings, thus eliminating the need for making foundry patterns and core boxes. Instead of castings, many parts, notably the cylinders with their valve chests, are built up from tubing and sheet metal. Then again I have adopted what is undoubtedly the most simple and at the same time a most accurate valve gear, viz., Hackworth's. This was invented by John, son of the famous Timothy Hackworth, in the year 1859. This gear has been used very much more in marine engines than in locomotives, because in a marine engine the crankshaft does not move in relation to the die-block guides, whereas in a locomotive the axle—which is the equivalent of the crankshaft—is constantly moving as the engine rides upon its springs ; and so, a factor is introduced which has the effect of varying the periods of opening and closing the steam and exhaust ports by the slide valves.

In order to overcome this defect in the gear in our model, I have arranged for the driving axle to be in a fixed position, that is to say, the axle boxes will not rise and fall in the frames, and there are no springs. This will not matter, because the other two axles are sprung in the usual way, and so any inequalities in the track cannot cause derailment.

The boiler cannot, for an engine of this size, very well be simplified except by using some form of liquid fuel such as vapourising petrol or burning methylated spirit in wicks in the firebox. With something of this sort the old Smithies' type water-tube boiler could be adopted, but it would be an expensive business nowadays to run on methylated spirit, and there are many objections to its use, not least of which is the unpleasant smell. Therefore, although it involves much more time and labour in the making, the ordinary locomotive type boiler burning solid fuel is by far the best and cheapest, besides which I

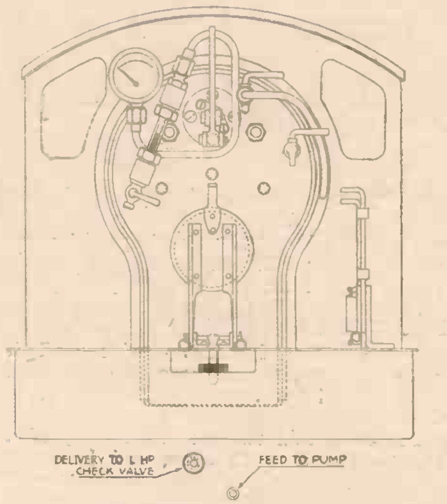


Fig. 3.—Rear elevation, showing boiler fittings.

know of no more interesting job in model work than the flanging and riveting up of such a boiler.

The External Design

The general appearance of the engine when finished may be seen from the three elevation drawings. Fig. 1 is a side view showing only the outside work. This applies to the front-end elevation of Fig. 2 also. From these drawings dotted lines of internal parts

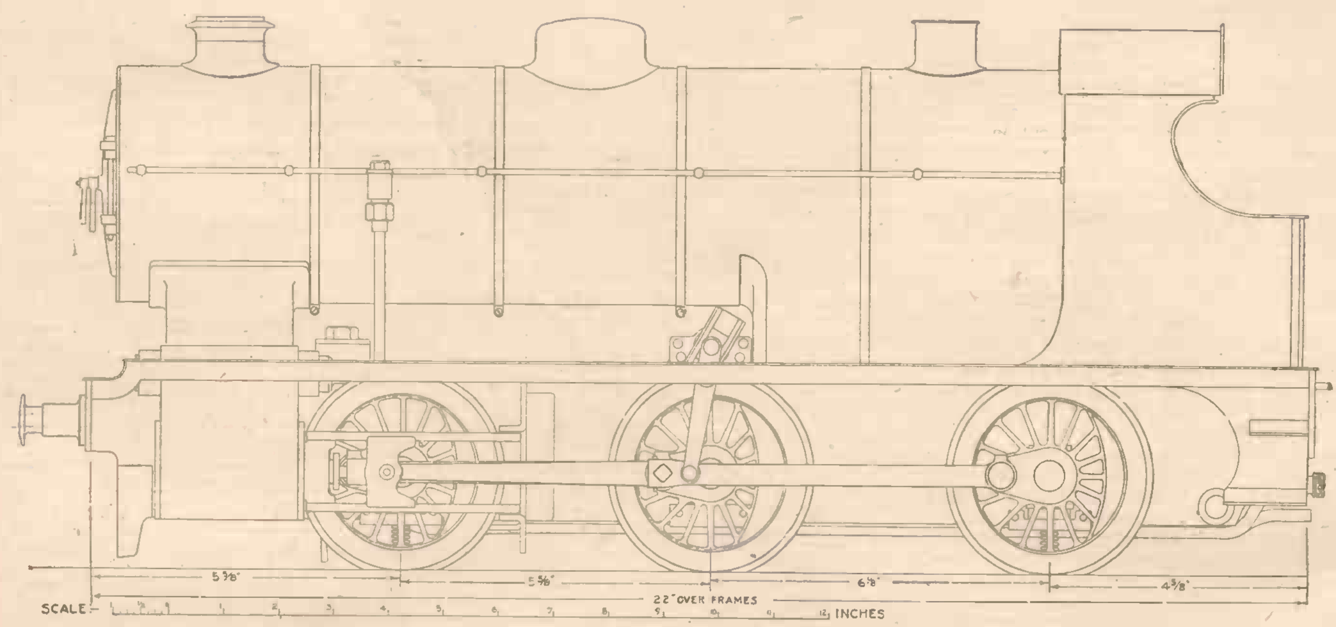


Fig. 1.—Side elevation of the 0-6-0 type, $3\frac{1}{2}$in.-gauge locomotive.

Model Locomotive and Tender

By E. W. TWINING

have been omitted in order to avoid confusion and to give only what will be seen when looking at the model. The footplate end is shown in Fig. 3, but reference to this will be made later when the boiler fittings are given attention.

On Figs. 1 and 2 scales are drawn; these are appended to avoid the necessity of figuring dimensions on the elevation views. Some of the measurements will have to be taken by scale with dividers, since they are not shown on the general arrangement or sectional drawings.

I anticipate that some readers would prefer to have the check valves for the water feed on the top of the boiler instead of at the sides in the positions shown. But for practical purposes there would be no advantage whatever in putting them on the top. The case is altogether different from full-size practice where the incoming water is broken up by perforated trays and so distributed over a large area. Apart from practical considerations there is the fact that the valveboxes would have to be specially designed and made because the ball valves must lift vertically from a horizontal seat. To provide a waterway or port, from above the valve, down into the boiler, means a complicated bit of drilling and the whole thing would be so large, with the covering case, as to be out of correct proportion to the engine. Then again the water feed is to be by an axle-driven pump, or partly so, which means that the whole of the time the engine is travelling a small stream of cold water would be falling upon the steampipe and tending to condense the steam which is passing through it.

The check valves shown in Figs. 1 and 2 are standard fittings which can, like most of the other boiler fittings, be bought from Messrs. Bassett-Lowke Ltd. The only point worth mentioning in connection with these is that they will require internally screwed collars, tapped out for the check valves to be screwed and soldered into the boiler barrel.

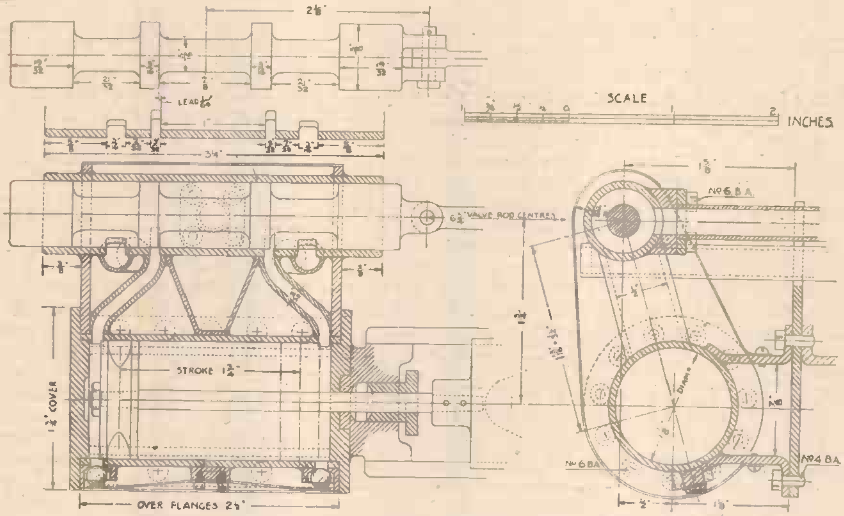


Fig. 6.—Details of cylinder, valve chest and piston valve.

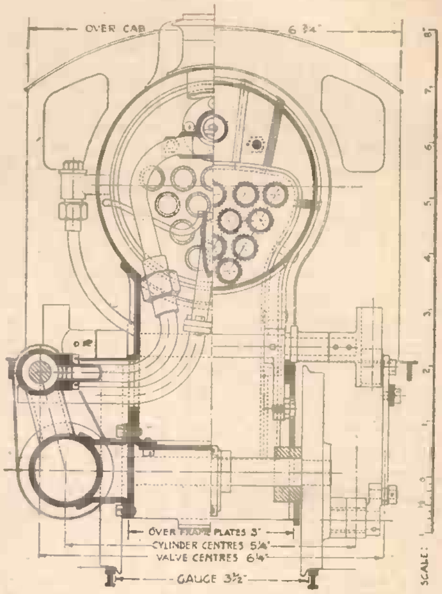


Fig. 5.—Cross-section through cylinders, smokebox, boiler and driving axle.

The Internal Arrangement

A longitudinal section of the engine is given in Fig. 4, whilst Fig. 5 shows on the left a half-section across through the smokebox and one cylinder and, on the right, a cross-section through the driving axle, the boiler barrel and flue tubes.

From these drawings it will be seen that the only parts which are made from castings are: the axle-boxes, the foundation ring of the firebox, the firehole ring, the dome casing, the pump eccentric sheave, the chimney, the smokebox front boiler ring and the smokebox front with door.

All of these castings are in gunmetal. There is one other which will have to be in iron, namely, the firebars and, of course, the six wheels, also in cast iron. Cast parts

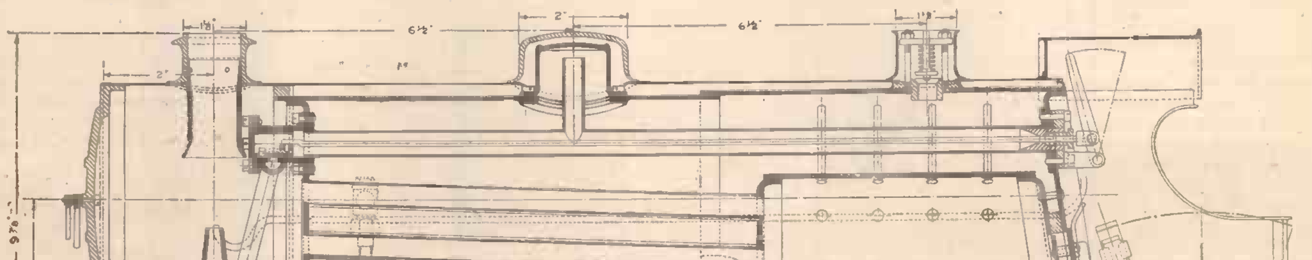


Fig. 4.—Longitudinal section of the locomotive showing the regulator valve and boiler feed pump.

which are not shown in these drawings will be the two pistons, the piston rod stuffing-boxes on the back cylinder covers, the glands for same, and the crossheads.

There are one or two parts mentioned above which are not bound to be cast. For instance, the dome casing can be made from two pieces in copper, using a piece of tubing for the vertical portion, annealing it and beating out to shape, and for the top a piece of plate, dished upwards and edges flanged downwards to meet the tube, the two being silver-soldered together. If, however, the maker of the model prefers a polished brass dome it will have to be cast.

The chimney must be a casting and the pattern must have prints at top and bottom for a simple round core. Obviously, if it is preferred, the petticoat pipe can be cast in one piece with the chimney, but this would involve the making of a corebox since the bore of the petticoat is a taper with a bell-shaped bottom.

The smokebox front with the door all cast in one piece simplifies this part of the making of the engine. The flange is turned so that it is a push-in fit in the smokebox. This arrangement provides a bigger opening for gaining access to the interior of the smokebox. The hinge straps will be added in wood on the pattern so it is only necessary to drill the casting for the long hinge pin and the handles to obtain a front which looks like full size practice.

Constructional Details

The work of construction may very well be begun by cutting out the frames. These are made from 3/32in. steel plate, 22in. long by 2 13/16in. deep. The cross-stretchers and outside motion plates will be of the same thickness and material. Stretchers will measure 2 13/16in. across, which will result in a width outside of the frames of 3in.

To receive the axle-boxes slots are cut ¾in. wide, those for the driving boxes being 1 5/16in. deep from the bottom edge, whilst the leading and trailing boxes will have slots 1 7/16in. deep. The difference is due to the driving boxes having no movement, whereas the other two pairs will slide vertically. No horns are provided; the channels in the axle-boxes will be cut to make a good fit on the edges of the slotted frames. Further, the axle-boxes are without keeps, that is to say, they are solid and must therefore be passed over the axles before the wheels are forced on. It will be years before they need renewing. The sheave of the pump eccentric must also be made and put on the axle between the boxes before the wheels are assembled. When putting the second wheel on each axle care must be taken to get the cranks all dead at right angles on opposite sides of the engine and with the same crank leading. It does not matter which crank; it may be either the right or the left, so long as all three are alike.

With regard to the crank pins it will make for greater accuracy if the marking off for drilling of the wheels is done with square and scribing block on a surface plate after the wheels are on the axles.

The Cylinders

These are the most notable items in the engine, and the whole or nearly the whole of each cylinder is built up of brass tubing and sheet brass, with copper tubing for steam ports.

The details and measurements are clearly shown in Fig. 6. From this it will be seen that piston valves have been adopted. These are machined from hard-drawn brass rod and are lapped into the tubular steam chest. The advantages accruing from this scheme are: larger ports than would be possible with ordinary flat valves, less friction and loss of power in moving the valves; no casting required for the steam chest and no stuffing-box, gland or valve spindle are needed, the valve rod—or radius rod—being coupled direct to the back end of the valve.

In the making of these cylinders the first thing to do is to select lengths of two sizes of tubing which should be very carefully callipered for truth and uniformity of diameter and circular form. Part off two pieces of the larger, which should have an inside diameter of 1⅛in., each 2½in. long and two pieces of the smaller ⅝in. inside diameter (if possible slightly bare ⅝in.). These latter will be 3¼in. long. Cut all the port openings as shown in Fig. 6. Next, from 3/32in.-thick sheet brass, cut the end cheeks and pierce these with circular openings at 1 27/32in. centres to make a tight fit over the steam chest and cylinder tubes. See that the axial lines of the two tubes are parallel and that there is no twist.

The plates and tubes should now be soldered, and the question arises how is this to be done—by silver solder or soft solder? Obviously silver solder makes the strongest job, but it requires a much higher temperature, and is a blow-pipe or blow-lamp job. In order that the silver solder shall flow, the whole job must be brought to a bright red heat, and it would be necessary to pin, clamp or by wire binding to secure nearly all the parts together and solder at one operation.

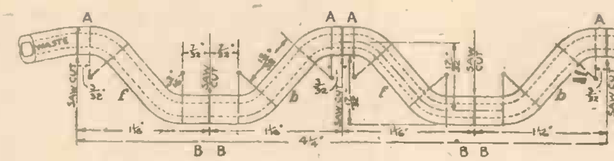


Fig. 7.—Method of marking out the copper tubing for forming the steam ports.

Actually the brackets by which the cylinders are secured to the engine frames call for as strong an attachment to the cylinder tubes as possible, and what I recommend is this: that the cylinder cheeks or flanges be made, as I have already said, a tight fit on the ends of the tubes, and that the brackets, bent as shown in the cross-section on the right hand side of Fig. 6, be made a tight fit between the flanges, then silver-solder these parts only together. All other smaller pieces can very well be soft soldered, using a small blowpipe or even a large copper soldering bit for the purpose. After the silver soldering it will be necessary to clean up bright all parts which have to take the soft solder and also tin the surfaces first.

The steam ports are made by flattening as uniformly as possible a length of copper tubing of ½in. outside diameter, that is to say, about 13/32in. diameter inside. The flattening must be such that the flats are 3/32in. apart inside. About 6in. will actually be required for the four ports, but something over and above this will be needed for holding the tube at the ends whilst bending, so I should flatten about 9in. or 10in., or even 11in. In order to prevent closing up at the bends it will be advisable to fill the tube after flattening with molten lead, or, if it is available, one of the low-melting-point white metals such as Rose's, Newton's or Wood's, all of which fuse at or below 212 deg.

Now, around a bar held in the vice, or in any other suitable manner, bend the tube to the shape, angles and measurements shown in the diagram, Fig. 7. Then, with a fine saw, cut off each port at the points indicated; melt out the filling metal and file the ends to saddle on to the cylinder and valve chest, taking care that the filed ends cover correctly the slits cut for port openings in the chest and cylinder.

In the longitudinal section, Fig. 6, there is shown between the ports a vee-shaped piece of strip brass; the object of this is to put spring pressure on the port tubes and wedge them in place whilst they are being soldered. Since the area of the port tubes at their ends is so small soft soldering will stand up to the steam pressure they have to carry. This argument applies also to the block on the valve chest to which the steam-pipe flange is screwed as well as to the saddled exhaust pipes. As will be seen from the cross-section in Fig. 6, the exhaust pipes have their ends plugged outside of the saddles.

Referring to the ports diagram the pieces marked *f*, *f*, are the front ports and *b*, *b*, the back ports; also that the ends A, A, A, A, will be saddled on to the cylinders and B, B, B, B, on the valve chests.

Lapping the Cylinders

When all soldering is done on each cylinder and chest, and not before, the cylinder bores may be checked up for truth, but I think that even if they appear to be true it will be best to lap them out. To do this get a piece of lead piping a little larger in outside diameter than the bore of the cylinder and about 5in. long; mount this in the lathe and turn it down dead true and parallel throughout its length to a diameter which will just, and only just, pass through the cylinder. Put a film of oil in the cylinder and oil the surface of the lap, sprinkle on the lead a little of the finest flour emery. Put the lap into the cylinder and slide it backwards and forwards with a semi-rotary motion, withdrawing it from time to time until it is seen that the whole of the inside of the cylinder has been ground truly circular. Now do the other cylinder: wipe them both out, clean the lap and finish the polishing of the two bores with metal polish on the lap.

Now get another piece of pipe, a little longer than the first, and with an outside diameter of just over ⅝in. This will be the lap for the valve chests. Unless the walls of this pipe are of heavy gauge it would be advisable to knock a hardwood core into it in order to avoid the risk of bending. Turn it parallel in the lathe and lap out the two valve chests, taking special care to get the bores of these perfect and with a good internal surface.

Not until the valve chests are lapped should the piston valves be made. These are fully detailed at the top of Fig. 6. They must be turned truly cylindrical, so the mounting in the lathe, and the lathe itself, must be checked up to ensure that they are not coming out in the slightest degree conical. Try this out with a micrometer. Turn out the three channels or recesses for steam and exhaust passages and, lastly, the four piston surfaces. These should make a somewhat tight fit in the bore of the chests and should be eased by lapping, preferably with metal polish, until they slide slowly, in a film of oil, with a perfect fit: they will then be steamtight.

When all lapping is done thoroughly wash out the whole assembly of each cylinder with petrol or paraffin making sure that no emery powder is left in the ports, or other passages or cavities.

(*To be continued*)

Studies in Electricity and Magnetism

Applying Kirchoff's Laws

(*Continued from page 350, August issue*)

IN a previous article, examples were given of load resistance and voltage problems, and we may now state Kirchoff's two Laws with a clearer understanding.

These are :—

(1) *The algebraic sum of any number of currents at a circuit junction is zero.*

And,

(2) *The sum of the potential-differences (or voltages-dropped) around a circuit is equal to the e.m.f. of the source.*

The second Law states the important truth which was emphasised in the first article—that the e.m.f. of a "source" (battery, generator, etc.) is *wholly lost* in the various resistances forming a circuit.

Thus, if in Fig. 1 R_1, R_2, and R_3 denote respectively the resistances of the generator, the connecting cables, and of the load, the current, I, is the same in every part of this circuit, whilst in each resistance we have a "drop" of IR_1, IR_2, and IR_3 volts—the drop, or p.d., across the load being usually by far the greatest.

Therefore, if E is the total e.m.f. generated :—

$IR_1+IR_2+IR_3=E$ ....(1)

or,

$E-IR_1-IR_2-IR_3=O$ ....(2)

Eq. (2) suggests that the potential-differences across resistances must be considered *of opposite sign to the applied e.m.f.*, and, as previously suggested, there is more to this than a mere algebraic rule or convention. In certain A.C. circuits having earthed points (or, in radio, points at "cathode potential"), we actually get an alternating voltage of opposite phase relative to some other reference voltage.

That is so because we tap our output voltage off some point where the sign is that of the *potential-difference* across a resistance (relative to our earthed point), and hence we have a phase-reversal with respect to the portion of the total e.m.f. *applied* to the resistance.

The phase-reversal in such cases is no mere matter of algebraic signs. It can be demonstrated, for example, in a valve amplifier that the output voltage (with a load consisting of a pure resistance) will, if fed back, oppose the original voltage to be amplified—give what is termed "negative feedback." In consequence, the nett amplification may be greatly reduced.

So you see, Eq. (2) can have a very real physical significance. However, when written in the form of Eq. (1), where all signs are positive, it says, purely and simply, that the e.m.f. applied must be numerically equal to the sum total of all the "voltage-drops" in a circuit. Eq. (2) then follows.

Need for Clear Thinking

Some clear thinking is thus essential in writing a Kirchoff's voltage equation for a network.

It may be written in the form of Eq. (1) or (2). To avoid mistakes it may be best to start from first principles by applying Eq. (2) to all cases, doing transpositions afterwards.

Consider the simple circuits shown in Fig. 2. In (a), we have E=6v., R_1=4 ohms, and R_2=6 ohms. Straightforward Ohm's Law gives the current as 0.6A. But denoting it by x, and applying Kirchoff, we have :—

$6-6x-4x=0$, or, $10x=6$, $x=6/10=0.6$A.

In (b), we have an extra 2v. cell connected the opposite way round to the others. Its e.m.f. opposes, or acts, as a *back e.m.f.* to the 6v., giving a resultant e.m.f.=6v.−2v.=4v. Hence, I=0.4A., using Ohm's Law.

Using Eq. (2), we must treat the 2v. as negative, like the potential-differences across the resistances (which suggests more clearly that p.-d.s are of the nature of "back e.m.f.s" opposing the applied e.m.f.) :—

$6v-2v.-6x-4x=0$, or, $10x=4$, $x=0.4$A.

Consider next Fig. 2c. Our two resistances are in parallel giving a combined parallel-resistance of :—

$$R=\frac{6\times4}{6+4}=\frac{24}{10}=2.4 \text{ ohms.}$$

Total current supplied, I=6v./2.4 =2.5A.
Current in 6 ohms =0.4 of 2.5=1.0A.
„ „ 4 „ =0.6 of 2.5=1.5A.

2.5A.

How would you apply Kirchoff's Laws? See if you can get the answers out before reading further. Start by denoting current directions, then write appropriate voltage equations.

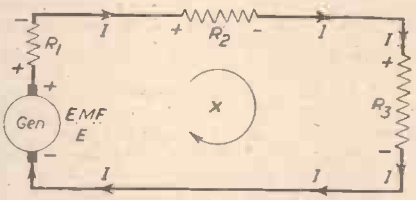


Fig. 1.—Kirchoff's Second Law: the algebraic sum of all the voltages in a circuit (including the e.m.f. of the source) is zero. The + and − signs across each resistance represent the difference of *potential across each.*

If you adopt straightforward conventions the thing is very easy. Thus, in Fig. 3a: let x and y be the parallel branch currents in the directions shown—the positive direction of the applied e.m.f. Then total current from the battery=I=(x+y).

Considering the battery and the 6-ohm resistance :—

$6v.-6x=0$, or, $6x=6$, $x=6/6=1.0$A.

Next, the battery and the 4-ohm resistance :—

$6v.-4x=0$, $4x=6$, $x=6/4=1.5$A.

Total current, (x+y)=2.5A.

Dealing with a Closed Mesh

There are other ways, not so straightforward, but exemplifying useful principles.

Let us denote the current from the battery by x, Fig. 3b using y, say, for the current in the 4-ohm resistance. Current x flows towards, and y away from, the junction p, so that the current in the 6-ohm may be written (x−y) or (y−x), if we used the reverse convention of currents flowing away from a junction as "positive."

Now,

$4y=6$, $y=1.5$A.
$6(x-y)=6$, $x-y=1$,
$x-1.5=1$, $x=1+1.5$
$=2.5$A.

Finally, current in the 6-ohm=(x−y)=(2.5−1.5)=1.0A.

Not, perhaps, quite as straightforward as using x and y for the branch currents, but almost as easy.

Making use of either current-conventions, consider next the closed mesh of resistances, ABCD. There is no *source* of e.m.f. inside this closed piece of network. In fact, the potential-differences add up to zero.

We have 6v. drop across each resistance, but with + and − signs, A to D, and B to C, as indicated. The case may be compared with two cells in parallel, with *like poles* joined together: in the series circuit *between the cells*, their e.m.f.s are in mutual opposition and thus add up to zero, although across the *parallel* combination we have the e.m.f. of one cell.

Providing no additional cell or battery, or other source of e.m.f. is inserted, *the algebraic sum of potential-differences in any closed mesh of resistances is always zero.*

Consequently, using x and y to represent branch currents, we can write our equations :—

For the closed mesh ABCD, $6x+4y=0$ (?) . . . . (Eq. 1).

Then we may form a second equation by equating the p.-d. across either resistance to the battery e.m.f., for example, taking the 6-ohm:—

$6x=6$, or $x=1$A.

Substituting in Eq. (1), gives :—

$6+4y=0$
$4y=-6$
$y=-6/4=-1.5$A. (?)

Something wrong, surely? y is not a current in the *negative* direction—in the opposite direction to the one indicated—which would make the battery current $(x-y)=(1-1.5)=-0.5$A., or ½-amp in the *reverse* direction round the battery circuit!

It shows how careful we must be in interpreting signs. We have our current-conventions correct, but can you spot the mistake? I made a mistake in typing the sign in Eq. (1)! I decided to leave it so, as a typical instance of what comes of using a single wrong sign. It is the *algebraic* sum of the voltages in the closed mesh that is zero, hence Eq. (1) should be :—

$6x-4y=0$.............Eq.(1) Rewritten.

Of course, it matters not which term we make negative—the algebraic sum is equally zero if we write :

$4y-6x=0$.....................Eq.(1)

With x=1A, either gives y=1.5A.

Pitfalls with "Signs"

Again, suppose we used a wrong current direction. Suppose y was reversed—shown flowing against the battery e.m.f., as in Fig. 3c.

Then, at junction p, y is towards and x away from the junction, when it appears we should write (y−x) for the supply current. Working out on this assumption gives x=1A, y=−1.5A that is, y is opposite to the wrong direction assumed.

So the answers for x and y come out correct. But we must be careful about reading our signs if we next proceed to find the battery current, using (y−x), forgetting that y was in the *wrong* direction! Thus, if we keep to

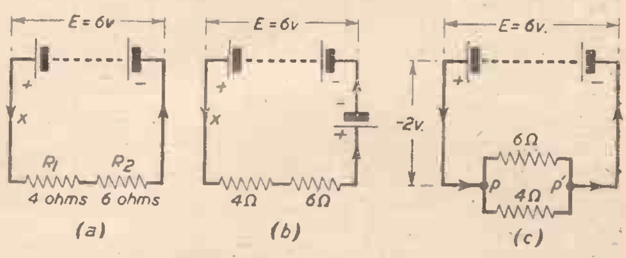


Fig. 2.—Applying Kirchoff's Laws to simple series and parallel circuits which can be worked by ordinary Ohm's Law.

the signs as they stand, $(y-x) = (-1.5-1.0) = -2.5$A, which goes to suggest the current supplied by the battery is also the wrong way.

Actually, as seen, y is " positive," the same as x ; both flow in the + direction of the e.m.f. In other words, x and y are really currents flowing away from junction p. Hence, in reckoning the total current, if x is of + sign, so is y. The total is $(x+y) = 2.5$A.

Alternatively, $-(x+y)$ signifies not a reverse current round the battery circuit but a current opposite to the (assumed) wrong direction of y. Or again, keeping x positive, we can write : total current $= (x-y) = 1-(-1.5) = 1+1.5 = 2.5$A.

It is seen that various meanings—electrical and " algebraic "—may be assigned to the word " negative." These few hints will indicate some basic confusions which arise.

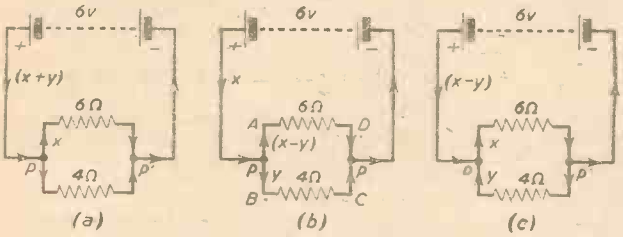


Fig. 3.—Some possible " conventions " in applying Kirchoff's Laws to the parallel network of Fig. 2c.

Can we formulate general rules ?

Watch Negative Signs

Let us go back to fundamentals.

Consider junction p with the currents as shown in 3a. and 3b. Exactly why did we write : supply current $=(x+y)$? (Fig. 3a).

Obviously because that is so! Obviously, the total current is the sum of the parallel branch currents. But let us not presume upon this bit of electrical sagacity. Let us stick to the algebra.

Currents x and y both flow away from p, and should thus be written $-x$ and $-y$, on the convention that currents towards p are to be of +signs. Therefore, the battery current $= -x-y = -(x+y)$; or is it not ?

Would this negative sign imply a current flowing the wrong way round the battery circuit ? Clearly not. The Kirchoff equation is :

$(x+y)-x-y = 0$,

or $(x+y)-(x+y) = 0$.

This implies nothing more than that

$(x+y) = (x+y)$.

The sum of the branch currents = the supply current.

So $(x+y)$ is correct for the supply current even though x and y flow away from p. With the equation written as above, i.e., equated to zero, the signs of the branch currents must be negative to make the algebraic sum zero.

Thus, if we decide to show y negative as in Fig. 3c, we must keep to these fundamentals. The supply current is simply $(x-y)$, instead of $(x+y)$, i.e., $1-(-1.5) = 1+1.5$, as in the above example.

On the basis of currents flowing towards (and away from junction p), we have : $(x-y)$ flowing towards p (+sign) ; y flowing towards p (+ sign) ; x flowing away from p (−sign). Hence :

$(x-y)+y-x = 0$,

which is clearly true.

Of course, all difficulties may be avoided by not choosing wrong current directions. But matters are not always as straightforward in more complicated circuits, whilst one of the purposes of these articles is to touch upon points of doubt.

The Wheatstone Net

As an example of a fairly complicated network, let us briefly outline the Kirchoff rules as applied to a Wheatstone Bridge network of resistances, as in Fig. 4.

This may be regarded as equivalent to two potential-dividers (Fig. 4b). If the p.d.'s across R_1 and R_2 = the p.-d.s across R_3 and R_4, the potential-difference between points B and D will be zero, and a galvanometer across these points will give no deflection. The bridge is then said to be balanced, and this is the condition required for measuring an unknown resistance.

In Fig. 4b we have omitted the " diagonal " resistance R. The circuit is then a simple one of two parallel branches having in each two resistances in series. The potential-difference between B and D may be calculated by considering the voltage dropped across R_1 and R_3, and estimating if the difference acts from B to D, or D to B.

But, except at the exact balance-point, the addition of the diagonal complicates matters enormously, so much so that the network cannot be analysed by Ohm's Law, or ordinary principles of resistances in series-parallel.

Generally, we want to know the currents in all the resistances, particularly in R, and the potential-difference across points BD. For simplicity, we suppose the battery is an accumulator of negligible internal resistance, e.m.f. = 6v. I am not going to work the problem in full, but show how to write the Kirchoff equations with due regard to signs.

Let x and y be the currents in AB and AD, in the directions shown. Then the battery current $= (x+y)$. Next, considering junction B, let z be the current in R, from D to B as indicated. This direction may turn out to be wrong in the final solution, as indicated by a " negative " answer for z.

Never mind about that. At B we have : x and z flowing towards B, therefore the current in BC must be written $(x+z)$.

Similarly, at junction D : y flows towards and z away from D, so that the current in resistance CD is $(y-z)$. We have altogether three unknowns, x, y, and z, which requires the solution of three simultaneous equations. Let us proceed to write the voltage equations.

For the arm ABC we have :

$4x+6(x+z) = 6$v.

or $10x+6z = 6$..................(Eq. 1)

Also, for ADC :

$5y+5(y-z) = 6$v.

$10y-5z = 6$..................(Eq. 2)

For our third equation let us take the mesh ABD. Remembering that for every closed mesh of resistances the voltage acting in the closed-circuit = 0, we must write :

$4x-10z-5y = 0$. ....(Eq. 3)

The rest is fairly straightforward algebra. But why the *minus* signs for the potential-differences across R and across AD ?

Well, observe that we are treating the p.d. across AB as of " positive " sign. The current-direction assumed for R is the opposite way round the mesh to the current shown in AB, whilst y (in AD) is also this opposite way round. Therefore, the sum of the (negative) p.d.'s across AD and R must be equal and opposite to the positive across AB—if the algebraic sum is to be zero, or :

$4x-(10z+5y) = 0$, or,

$4x-10z-5y=0$,

as above.

Alternatively, you could consider mesh BCD, or even not consider any " mesh " at all, but write a third equation for the circuit ABDC :

$4x-10z+5(y-z) = 6$v.

$4x+5y-15z = 6$. ...Alternative (Eq. 3)

Here again, a negative sign must be used for the p.-d. across R, because the (supposed) direction of z is opposite to x, and to $(y-z)$.

The answers are: $x = 0.624$A.; $y = 0.58$A.; and $z = -0.04$A., i.e., with the resistance values given, z is a current from B to D, the reverse direction to the one assumed.

If at first you cannot get your answers to agree, go over all *signs* carefully ; it is so easy to make mistakes in solving three or more equations.

More on Magnetic Circuits

In a previous article I finished with a reference to M.M.F. A current-carrying coil sets up a magneto-motive force given approximately by 1.25 (ampere-turns) ; then, that M.M.F. ÷ axial length of an isolated coil (or the total " mean length " of a complete iron/air path, if provided) gives us another quantity, the *magnetising force* (H).

The M.M.F. is the equivalent of a "*magnetic* potential-difference " between the ends of a solenoid—or along some complete magnetic path.

It is appreciated that concepts such as " magnetic potential-difference " are not easy to picture, whilst there are some things in magnetic theory which take a great deal of explaining : for example, the fiction that " 4π Lines "—approximately $12\frac{1}{2}$ Lines !—emanate from a " unit pole "—if such a thing could be realised.

What is interesting is that these fictions work fairly well in calculations of electromagnets and machines. Meanwhile, we may think of M.M.F. simply as a magnetic force—the total magnetic force—set up by the coil.

The magnetising force (H) = the M.M.F. *per unit length* of magnetic path. In fact, it is shown that H is the same as the *field intensity*, expressed in *lines per sq. centimetre*, in air or other *non-magnetic* material. For an isolated coil having " air " or non-magnetic core, it is necessary to add : field intensity *at the centre of the solenoid*, because lines of force diverge outwards towards the ends, as in Fig. 5a. When a complete iron path is provided as in Fig. 5b, the M.M.F. has to be divided by the total mean length of path (l) to find H.

When iron is introduced, both the total flux, and the " intensity " (lines per sq. cm.), become much increased.

Permeability

H lines per sq. cm. " in air " become B lines per sq. cm. in the iron, where B may be many thousands of times H, and is termed the *flux-density* in the core.

The molecular theory of magnetism is

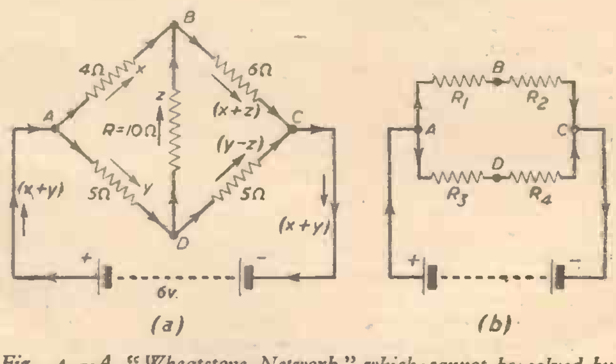


Fig. 4.—A " Wheatstone Network," which cannot be solved by Ohm's Law, or series parallel circuits. See if you can find x, y, and z by solving the equations explained in the article. The current in R is assumed to be in the direction indicated (z).

probably the true explanation. Iron and steel possess a large amount of inherent magnetism; each separate molecule is itself a minute magnet having N.S. poles. But in the unmagnetised state, the molecules in a mass of iron are in disorganised, " higgledy-piggledy " formation.

When a magnetising force H is applied, the molecules are aligned in one definite direction—all the n-poles pointing one way, hence the mass as a whole becomes a strong magnet with N. and S. poles appearing at the ends.

The theory is well borne out by many facts. The relative ease with which soft iron can be magnetised compared with the hard steels, having closely packed molecules; the magnetic *retentivity* of the hard steels, once magnetised; the fact that a bar or horseshoe magnet can be demagnetised by heating to a red temperature—as is well known, molecules are in a state of rapid vibration when the temperature is raised.

Thus, whatever may be said for the latest theories of magnetism, it is pretty certain the molecular theory is a good enough explanation of how " H " gives rise to a greatly augmented flux-density " B."

But in developing the theory which compared magnetic with electric circuits a different concept was introduced. Iron and steel were regarded as " good conductors " of magnetic lines, compared with air and other non-magnetic materials.

The number of times B is greater than H (or the ratio B/H) was looked upon as a figure of merit denoting " magnetic conductivity," or, to give its precise name, *permeability* (μ). Thus, if for a given iron specimen $\mu = 400$, then, if a coil sets up, say, 20 lines per sq. cm. " in air " (= H), the flux-density (B) in the iron will be $H \times 400 = 20 \times 400 = 8{,}000$ lines per sq. cm.

" Reluctance "

Permeability is a " specific " quantity: like conductivity—and other " -ivities " or " -ilities "—it represents the magnetic conductance of a " unit piece " of material—1 cm. long, and 1 sq. cm. cross section.

In a magnetic circuit such as Fig. 5b, what we require is a term analogous to " Resistance " of an electric circuit, where conductors of various lengths and cross-sectional areas may be used. We want a simple formula, of the form,

$$\text{Current} = \frac{\text{e.m.f.}}{\text{Resistance}},$$

or, *Total* Magnetic Flux,

$$N = \frac{\text{M.M.F.}}{\text{Total " Magnetic Resistance."}}$$

N is then conceived of as a thing that " flows " in the iron circuit, somewhat in the same sense as a current flows in copper wires. We do not speak of " Magnetic Resistance," however, but of the *Reluctance* of an iron circuit.

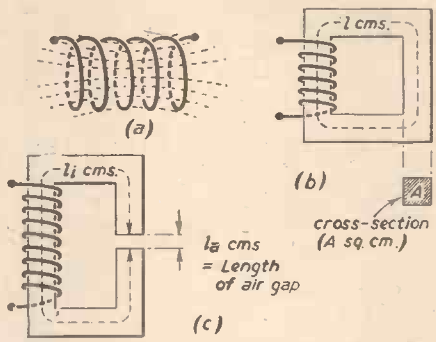


Fig. 5.—Simple " Magnetic Circuits " : (a) isolated coil; (b) completely " closed " iron path; (c) part iron, and part air-gap paths of l_1 and l_2 cms.

The electrical resistance of a wire of length l cms., and cross-section A sq. cm., is given by:—

$$R = \frac{lK}{A},$$

where K = the electrical *resistivity* (specific resistance) of a unit piece: the reciprocal of electrical conductivity.

But μ is of the nature of conductivity, and so must be written in the denominator of our equivalent magnetic expression:—

$$\text{Magnetic Reluctance, } R = \frac{l}{A\mu},$$

where l and A have the meanings assigned in Fig. 5b.

Unfortunately, magnetic permeability is by no means as constant as electrical conductivity. It varies all the time with the magnetic state of a core, and as saturation is approached (all the molecules aligned as described above), μ falls off to a value not much better than the permeability of air, which is 1.0.

Procedure in Magnetic Designs

Then different grades of iron and steel, or often the same grade subject to slightly different compositions, heat treatment, etc., vary enormously in their magnetic properties.

We shall not study magnetisation curves now, but it will be fairly apparent that calculations on magnetic circuits can never be as exact as when applying Ohm's Law or Kirchoff's Laws to networks of resistances. Moreover, close exactitude is seldom required. At best, we can only make rough estimates of the ampere-turns required to produce a given flux, or of the " pull " of electro-magnets, and so forth.

In laboratory investigations much greater accuracies are possible, whilst in every case reliance has to be placed upon B-H curves which have been plotted in the test laboratory for given specimens of the iron and steel to be employed.

The general procedure is to design an electromagnet to work at a given flux density B. This is chosen from a study of a B-H curve of the sample, and may be in the region of 8,000 or 10,000 lines per sq. cm. The value of H which will give this density is read at the same time off the curve.

Then, $B/H = \mu$, which means we are going to " work " our electromagnet at about this permeability. The total cross-section (and therefore the size of core) will have to be large enough to give us the desired *total flux* (N), whilst keeping the density (B) already decided upon: if $B = 10{,}000$, and we require $N = 100{,}000$ lines, our iron section must be $N/B = 10$ sq. cms.

Calculating Ampere-turns

Knowing H, it is a simple matter to calculate the ampere-turns on the coil. H = M.M.F./Length of Magnetic Circuit = 1.25. A.T./l. Or, A.T. = $Hl \div 1.25 = 0.8\,Hl$. If $l = 1$ cm. of core path, A.T. = 0.8H = ampere-turns *per cm.* of length of magnetic circuit.

This is somewhat simpler than calculating the Reluctance, but amounts to precisely the same thing. Where there is an air-gap as in Fig. 5c many more A.T. will be necessary because the permeability of this part is 1.0.

(To be concluded)

Temperature Control Device

A Simple Thermostat for Use in a Greenhouse

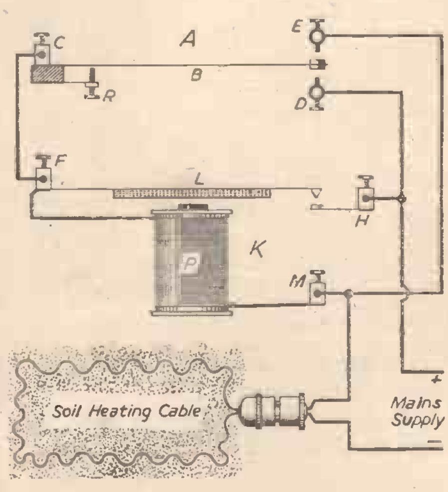
By G. W. B. STUART

THE thermostat described in the following notes has operated successfully in a greenhouse for the past two years, without requiring any maintenance, or attention, other than setting of the temperature regulator. A bimetal strip 4in. long, attached to a terminal at one end, the other being free to move between two adjustable contacts, operates a " cut-out," connected to the mains supply line, and soil-heating cable of 150 watts.

Thermostats of the bimetal strip type, unless fitted with a rapid circuit making and breaking device, will " arc " badly and burn the contacts. For this reason a " cut-out " was connected in the circuit.

The soil-heating cable does not by itself raise the air temperature in the greenhouse to any appreciable extent, but warms the soil when the air temperature falls to a predetermined level.

During the day, if and when, the sun shines and the air temperature rises, the thermostat again comes into operation, and cuts the current to the heater. Any source of electrical heat may be used with this device, provided the current is not too heavy for the " cut-out " winding. Referring to the diagram, we have a thermostat A with a bimetal strip B attached to a terminal C, free to move between adjustable contacts D and E.



Circuit diagram for a simple thermostat.

A " cut-out " K is connected to the thermostat A, soil heating cable G and the mains supply.

Operation

The cycle of operation is as follows:—The temperature falls, bimetal strip B bends making contact at D, which completes circuit H, L, F, through " cut-out " winding P, and M, which is connected to the soil-heating cable. The current flowing through P will hold armature L on to contact H until the temperature rises, then the bimetal strip bends on to contact E, when P is shorted out of circuit, releasing armature L, thus breaking the mains supply to the heating cable. The temperature at which the thermostat can be set is regulated by tension screw R, and the difference between the " cut-in " and " cut-out " temperatures, by the adjustable contacts D and E.

The World of Models

Model Making in Zurich : Scale Model Foden Wagon

By "MOTILUS"

MODEL ship enthusiasts will be interested in this month's photograph of a model British sailing trawler, made by Mr. P. W. Kirby, of Benoni, Transvaal, South Africa. This model, the *Three Brothers of Rye*, has an oak keel, with birch planking (1 mm. thick) on mahogany ribs, and was built from plans that Mr. Kirby bought from a well-known models firm in London in 1949. He entered the model in the Rand Easter Show last Easter and was awarded a medal.

In making the award, the judges also passed a few criticisms on the model, which Mr. Kirby has candidly included in a letter to me. I note them here simply as a matter of interest, as I consider the model to be very good in other respects; it shows very careful workmanship and is typical of the prototype in character, which is an important matter in ship modelling.

The judges' criticisms were that not enough detail is shown on the decks; the rigging is too light for a fishing vessel of this type, and the planking is incorrect, as the outside layer of planking on the hull should be "fore and aft" and not diagonal.

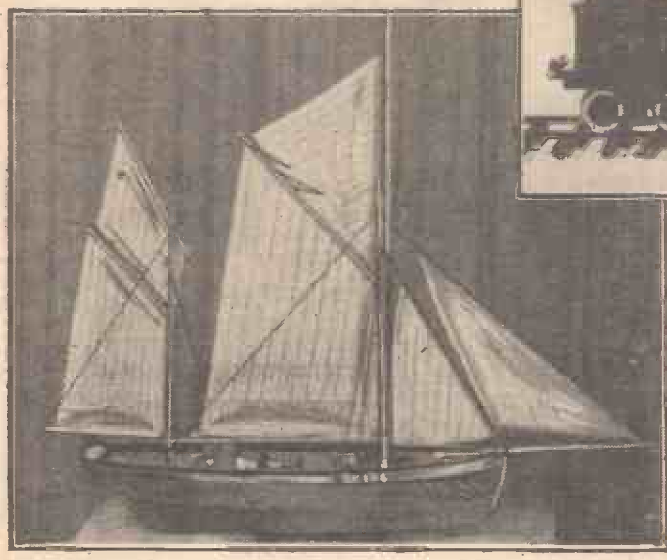


Fig. 1.—A model British sailing trawler built by Mr. P. W. Kirby, of Benoni, Transvaal, awarded a medal at the Rand Easter Show this year.

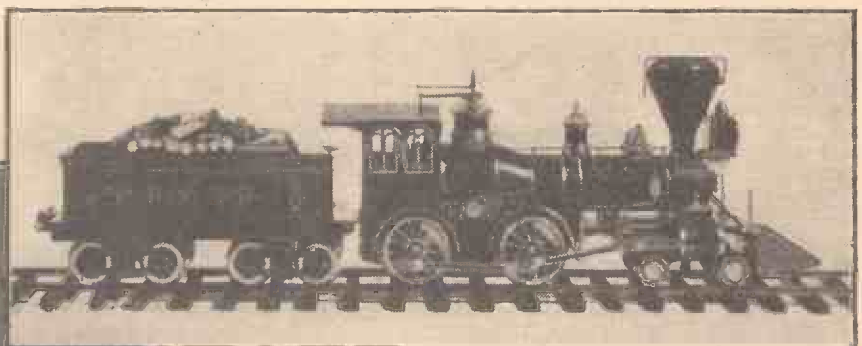


Fig. 2.—Gauge O model of an American steam locomotive of about 1865, from the collection of Mr. H. Buhlimann, of Zurich.

Mr. Kirby has since started building another ship model; this time it is to be a Thames sailing barge, the *Lady Daphne*. With his previous experience to draw on, I am confident Mr. Kirby will produce a first-class model this time.

Zurich Model Railway Club

In the spring of this year I again visited members of the Zurich Swiss Model Railway Club. Among them I was pleased to include Mr. Buhlimann, of Zurich, to whose models I referred in "The World of Models" in November, 1949. Since then I have been able to obtain photographs of two models that are typical of the range of American old-time steam locomotives in which Mr. Buhlimann specialises. Mostly in gauge O scale, these models carry all the detail of a steam locomotive of their day in appearance, but they are operated on the electric, two-rail system.

In looking again at these old-time steam models I wondered whether the Swiss become tired of their up-to-date, simple, electric locomotives and trains, and if this accounts for their fondness for making models of early period steam locomotives, into which they cram as much external detail as they possibly can with accuracy.

One of the illustrations (Fig. 2) shows "Seminole," gauge O model of a 4-4-0 type

(*Continued on page* 30)

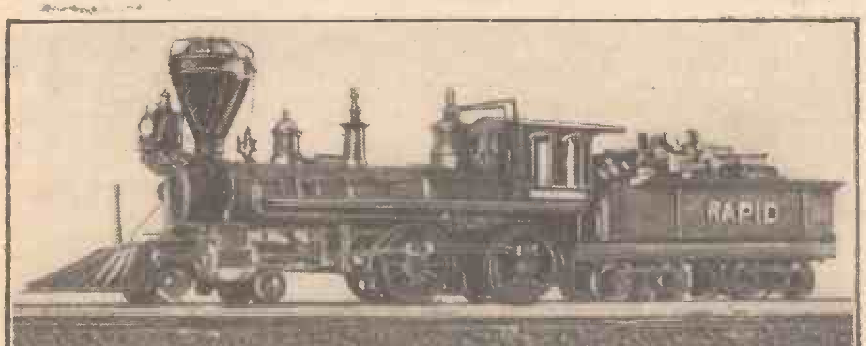


Fig. 3.—Gauge O model of an American steam locomotive as used on the Baltimore and Ohio Railroad about 1880: also from the collection of Mr. Buhlimann, of Zurich.

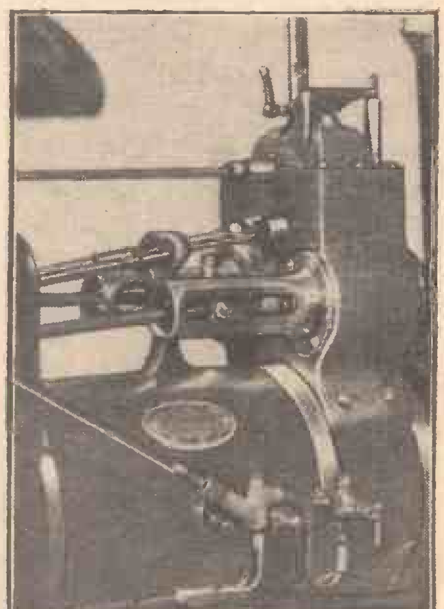


Fig. 4.—A close-up view of the forward portion of the model steam Foden wagon built by Mr. G. Waines, of Innisfail, New Queensland.

Soapless Detergents for Window Cleaning

SIR,—We were interested to see, in your current issue, correspondence regarding the use of a soapless detergent for window cleaning, and thank you for the reference to "Teepol" X. We must, however, point out that this product, which is now known simply as "Teepol," is not generally available to the public.

So far as the domestic market is concerned, our policy is to sell to the repackers, who market our product either as bought from us, or made up to their own formulation with other materials, under proprietary names.

In fact, any of the better-known liquid soapless detergents, such as "Quix," "Laundene," D.10, "Lather," etc., can be safely recommended for window cleaning.—SHELL CHEMICALS LIMITED (Strand, W.C.2.).

Preparing Hydrogen Gas

SIR,—I hardly think the chemical equation given by Mr. Hollis in your August issue (page 353) can be correct. Should it not be :—

$$2NaOH+2Al+2H_2o=2NaAlo_2+3H_2 \ ?$$

If it is a question of inflating one of the 4ft. diameter ex-R.A.F. balloons I calculate theoretically that one filling would require the interaction of about $1\frac{3}{4}$lb. aluminium, $2\frac{1}{2}$lb. caustic soda and 1 pint of water. The heat liberated by the reaction of these quantities would be sufficient to boil about 8 gallons of water.—W. HALL (Dublin).

Author's Note.—I apologise for the slip made in my letter. I agree with the information supplied by W. Hall providing that the pressure inside the balloon is atmospheric. I should like to add that the hydrogen inside the balloon would lift about 43 ounces altogether.—R. HOLLIS (Rotherham).

Destroying Tree Stumps

SIR,—Regarding Mr. R. A. Wilson's query in the August issue of PRACTICAL MECHANICS, in which he asks for advice on the destruction of tree stumps; the following method may be of interest to him and other readers faced with the same problem.

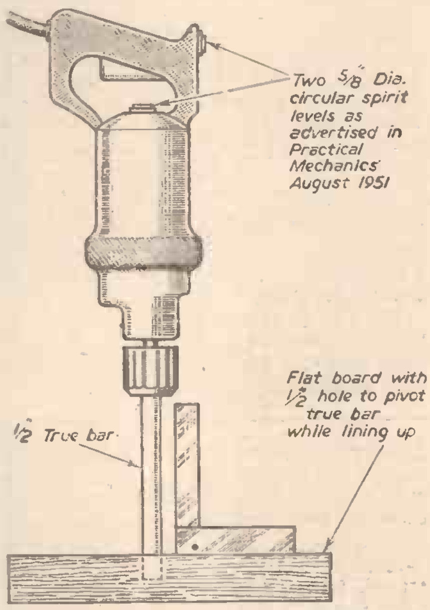
Each stump, cut down to ground level, should have a series of $\frac{3}{4}$in. or 1in. diameter vertical holes at 3in. centres drilled into the cut face for a depth of not less than 9in. These holes should be filled with a saturated solution of potassium nitrate or chlorate and should be topped up every day for a fortnight. After this, they should be allowed to dry out thoroughly. Protection from rain should be provided during the whole of this process.

The stumps should then be ignited, paraffin being used to start the fire. The flames will soon die down, but smouldering will continue over a long period, oxygen being provided by the potassium salt, and eventually the stumps will be reduced to ashes to a depth of about 18in. below ground level.

Mr. Wilson must use his discretion in the length of soakage time allowed. The object is for the solution to soak right into the wood. A dry stump will require less time than a green one.—T. H. ROBINSON (Potters Bar).

Drilling at Right Angles to Surface

SIR,—Working single-handed in a garage I often experience difficulty in boring holes with my $\frac{1}{2}$in. capacity electric drill at



Using spirit levels for ensuring alignment when drilling at right angles.

right angles to the job. I obtained two $\frac{5}{8}$in. dia. circular spirit levels, one to be used for vertical operation and one for horizontal. A flat seat is filed on the end of the casing and to ensure it being at right angles to the spindle a $\frac{1}{2}$in. bar is gripped in the chuck. The end of the bar is steadied in a hole pre-bored in a flat board and the bar trued up, using a square. When the seat is at right angles to the spindle the spirit level is held in position by two short 6 B.A. screws. Similarly, another level was fixed on top of the handle to ensure alignment when boring horizontally. Of course, this level only trues up the spindle for vertical misalignment and not horizontal. A plain rectangular type of level would do equally as well in this position.—R. HURDITCH (Bridge-of-Allan).

Calculating the I.H.P. of an I.C. Engine

SIR,—With reference to the reader's query in the August issue of PRACTICAL MECHANICS concerning the pressure exerted on the cylinder head of an internal-combustion engine, in using the formula $\frac{Plain}{33,000}$ the symbol P denotes not the maximum pressure but the "mean effective pressure," which is the mean value of the pressure taken over compression and expansion strokes. The mean effective pressure in any cylinder cannot easily be found as it requires special apparatus, but for the average type of motor-car engine a value of between 90 to 120lb. per sq. in. would be a fair estimate —the higher value corresponding with the higher compression ratios.

It is also necessary to note that in using this formula the pressure must be given in pounds per square *foot*, the dimensions "L" and "A" in feet and square feet and "N" the number of firing stroke per min., which is, of course, the same as $\frac{1}{2}$ (r.p.m. of engine) × number of cylinders for four-stroke engines. Unless the mean effective pressure can be correctly ascertained the value of the i.h.p. calculated in this manner would, I fear, be very inaccurate.—D. C. BOSTON (Robertsbridge).

Photo-electric Exposure Meter

SIR,—May we thank your contributor, W. L. Peacock, for the mention of our name as the supplier of selenium photo-cells in his article entitled "A Photo-electric Exposure Meter." We have had numerous enquiries and are happy to be able to supply all the standard size selenium cells, but unfortunately we are unable to supply the type meter mentioned or the 100 ohm resistor.

In addition to photo-cells, we market two photo-electric exposure meter construction kits, one a reflected light model, the other an incident light model.—G. R. PRODUCTS (Bristol).

"Making an Electric Blanket"

SIR,—Regarding the article entitled as above, by Mr. E. E. Cheetham, and subsequent correspondence, may I point out that transformer secondary windings must be earthed.

This is a requirement of the Electricity Supply Regulations, 1937. These Regulations cover the supply of electricity by the undertakers (now the B.E.A.) to consumers. Under these Regulations it is necessary to earth one side of a low voltage alternating current system, Regulation No. 4.

A similar point is covered by Regulation 1001 (c) of the I.E.E. Wiring Regulations, 12th Edition.—F. J. BURRIDGE (Brighton).

Black Etching Acid

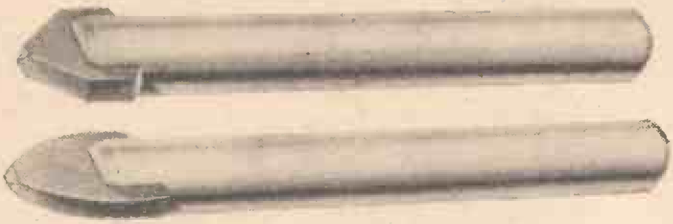
SIR,—Having read the reply to L. G., of Leeds, in the August issue of PRACTICAL MECHANICS on the above subject, I would like to pass on to other readers the following information: Neither hydrochloric nor sulphuric acids, nor any combination of them, will give a satisfactory black etch on polished cast iron or steel. The etchants used in the trade are far more complex in nature. If your correspondent will write to Messrs. Eyre & Baxter (Stampcraft), Ltd., 55, Brown Street, Sheffield, 1, they will be able to supply their "Rapidblack" which will give very satisfactory etchings with a rubber stamp on polished cast iron or steel. Incidentally, the firm mentioned specialise in all types of marking and supply the bulk of the razor, saw and bright goods trades with rubber stamps and suitable etching acids for any type of job.—N. SLATER (Sheffield).

Trade Notes

A Review of the Latest Appliances, Tools and Accessories

Glazemaster Drills

FOR drilling holes in glass of all kinds, John M. Perkins and Smith, Ltd., of London Road Works, Braunston, near Rugby, are marketing two types of tungsten carbide tipped Glazemaster drills. Type "A" is intended for the handyman and householder, and is the ideal drill for windows, mirrors, bottles, plate glass shelves, and black or coloured vitrolite. The drill can be used with hand brace, breast drill, portable electric drill, or in a drilling machine. Type "B" drill is made specially for the tradesman and is a super drill for the production of a great number of holes in all kinds of glass and vitrolite. With this tool holes can be drilled right through without reversing the glass, and with practically no flaking underneath. The cutting edges can be resharpened several times, giving a long overall life. The drill is suitable for use in power drills of all types. Both drills are obtainable in various sizes from ¼in. to ½in. Further particulars, including instructions concerning drilling speeds and the use of lubricants, are contained in a booklet which is obtainable from the above address.



Two examples of Glazemaster drills.

Caravan Service

THE caravan industry has now won for itself recognition as an important national social asset. To-day it provides comfortable mobile homes for an all-the-year-round caravan population of nearly a quarter of a million people, and the seasonal and holiday homes for possibly twice this number.

Two of the principal reasons for the increasing popularity of this new way of life are the revolutionary improvements that have taken place in caravan design and construction, and the ever-increasing service offered to caravan owners by leading manufacturers.

The latest instance which has been brought to our notice is the publication by Messrs. Berkeley Coachwork Limited of a well-produced illustrated loose-leaf handbook designed to tell the owner of the *Messenger* (the company's most popular touring model caravan) everything that he needs to know regarding its mechanical maintenance. This objectively written handbook for the layman, for which no charge is made, contains many helpful hints for the "old timers," and is a mine of information for the novice who is inclined to take mechanical maintenance for granted until something goes wrong.

If all the advice—the "do's" and "don'ts"—in this handbook are faithfully followed, the *Messenger* owner will not only succeed in benefiting to the full from the latest features in caravan design, but his caravan should give him many more years of satisfactory service.

Copies of the handbook can be obtained from Berkeley Coachwork, Ltd., 175, Great Portland Street, London, W.1.

New Electric Fence Battery

A NEW battery produced specifically for powering most makes and types of electric fence has just been introduced by Chloride Batteries Ltd., of Clifton Junction, near Manchester.

Designated the Exide 3-DTG/NT, this battery comprises three 2-volt cells assembled as a 6-volt unit in a light metal carrier. The cell plates are of the well-known "mass" type which are eminently suitable for duties where long discharges at low rates are required. When not in use, a freshening charge once every six months is quite sufficient to keep the battery in a healthy condition.

Great care has been taken with the internal contruction to secure a long trouble-free working life. Intercell connectors are burned to the plate pillars, thus ensuring perfect and permanent connections, while the pillars themselves form an integral part of the cell lids. No acid creepage can take place as a result of their working loose, therefore, and the risk of corrosion is consequently minimised. The non-interchangeable terminals are of different shapes and colours to avoid any confusion. The specification is as follows: voltage, 6; capacity, 12Ah (100-hr. rate), 7 Ah (20-hr. rate); charge rate, ½ amp. Dimensions, 3 3/16in. W x 9 1/16in. L x 5 15/16 H. Weight (including acid), 11lb.

Club Reports

Keighley and District Model Engineering Society

THE above Society held a Festival Exhibition in Keighley between the 7th and 14th July, 1951. It was sponsored by the Keighley Borough Council, in conjunction with local craftsmen, and from the outset proved to be a huge success.

Over 50 models were on show, all of them, with one exception, being made by the members of the Society, the one exception being a model over 50 years old of the original engine installed in the works of Messrs. Dean, Smith and Grace, Ltd., the famous lathe manufacturers, of Keighley. This model and others were working under compressed air.

Mr. Douglas Miller, M.B.E., president of the Brighouse Society, and Mr. Harry Byram—in the absence of Dr. Fletcher, of Colne—judged the exhibits.

The best exhibit as judged was an Austen Walton 5in. gauge 2F dockyard tank locomotive chassis by Mr. W. Whiteley, and won the Founder's Shield offered by the chairman for the best exhibit, and a first-class diploma in the railway and steam section.

A tugboat engine by Mr. Willmore came second, followed by Mr. Greenwood's 1¾in. scale free lance traction engine.

Dominating the Steam Stand was a 5in. gauge L.M.S. 5XP Locomotive entered by Mr. W. E. Wood. This was jacked up and working under compressed air. Like many other models this was under construction, and was unfinished.

The winners in the Workshop Equipment Class were first Mr. G. Batty with a really fine set of lathe accessories. The secretary of the Society, Mr. Allan Hornby, came second with a precision drill made up from a set of Potts' castings. He was followed into third place by Mr. H. Gavins who exhibited a 3ft. 6in. lathe.

Mr. W. Whiteley's prizewinning 0-6-0 model loco chassis

The Aircraft Stand was very busy, and the exhibits here were varied. Mr. V. Smith won a first-class diploma with a Ladybird free flight aircraft. Mr. H. Brownless came second with a solid scale Sunderland flying boat, and Mr. A. Brownless, junior, third with a 60in. glider of his own design.

The Marine Stand was unique in the fact that all the members had commenced their models since the formation of the Society just over a year ago.—H. BROWNLESS (chairman), 159, Redcliffe Street, Keighley, Yorks.

World of Models

(*Continued from page* 28)

American steam locomotive of about 1865, and Fig. 3 shows the "Rapid," as used on the Baltimore and Ohio Railroad about 1880.

Scale Model Foden Wagon

In the September-October issue of PRACTICAL MECHANICS for 1950 I wrote about a model steam Foden wagon built by Mr. G. Waines, of Innisfail, New Queensland. This year I again heard from Mr. Waines, and he sent me a photograph (reproduced in Fig. 4) showing a close-up view of the front portion of this model. In this picture can be seen some of the good detail model work on which I commented when I described the building of the steam wagon. By the time this appears in print Mr. Waines will have added reversing gear to complete this working model.

QUERIES and ENQUIRIES

A stamped, addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on page 8 (THE CYCLIST), must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the reader. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Testing Vacuum in Sealed Envelopes

I WOULD appreciate your advice on the following problem.

I wish to test for vacuum envelopes made of Foil Pliofilm after they have been filled with one ounce of vegetable material.

I have successfully extracted the air from these envelopes and sealed them off, but require some means whereby I can test the packets to ensure that the contents are virtually in a vacuum until required for use.

Can you suggest any means I can employ to apply a quick test to these containers ?—H. E. Newport (Edinburgh).

WE assume that the degree of vacuum within the sealed metal envelopes will not be of a very high order, which means, therefore, that the envelopes will still contain a certain amount of residual air. We assume, further, that the vacuum-testing method desired must be one that will not involve penetration of the envelope and consequent destruction of the degree of vacuum within it.

This being the case, we suggest that the sealed and evacuated envelopes should be placed in a glass container of suitable construction in which a fairly high degree of vacuum may be established by means of a rotary or a mercury high-vacuum pump. The evacuated envelope will now be situated within a vacuum which is of a higher order than that existing within it. Consequently, the residual gas particles within the envelope will cause the latter to swell or to expand in some measure, the exact amount of swelling depending on the amount of vacuum within the envelope and the amount outside the envelope. An envelope which had been subjected to this test would not in any way be destroyed and its internal vacuum and contents would remain intact. For accurate measurement it might be possible to cement a light needle to the outer sides of the metal envelope and to secure the envelope in some fixed position so that the swelling of the envelope would cause the needle to travel across a fixed scale.

The whole arrangement will, naturally, have to be determined in detail by dint of experiment, but, with care in the construction of the instrument, we see no reason why the notion should not work sufficiently well to enable you to derive reliable indications from it.

Cleaning an Electric Cooker

I HAVE an electric cooker in my pre-fab, and the casing is made of aluminium or one of its alloys. Could you please tell me how to clean the burned grease from the inside of the oven, as caustic soda preparations are not to be used on aluminium ?

How can I clean the aluminium grill reflector that has been immersed in a weak soda solution and turned black ?—R. Greenwood (Corby).

METALLIC aluminium is soluble in hot solutions of caustic soda with the formation of sodium aluminate. Despite this fact, a cleaning preparation containing caustic soda may be applied momentarily to an aluminium surface, always provided that it is well washed off afterwards.

Ordinary washing soda (sodium carbonate) does not attack aluminium or its alloys in this way. You would, therefore, be safe in using any such solution to remove the dirt and grease from your cooker. You could also use ammonia for the same purpose.

Another solution for the above purpose is made by dissolving one part each of sodium metasilicate and trisodium phosphate in about five parts of water, and stirring into this solution a quantity of soft soap or of soap jelly. This solution will attack hard, greasy surface grime, but will not injure the aluminium metal.

It is probable that your blackened aluminium plate is composed of a certain alloy, since the pure aluminium would not react in this manner. The only way to clean it is by immersion in weak hydrochloric acid for a minute or two. For this purpose, dilute one part of strong hydrochloric acid with three parts of water. The acid will, of course, attack the aluminium, but it will first act by removing the blackness, so that the acid may then rapidly be rinsed away from the article.

Apart from this method, we can only recommend some abrasive method, such as the use of a scouring powder, followed up with an ordinary metal polish, or a paste of fine silica flour and light oil.

Luminous Paint on Fabrics

I WISH to decorate a fancy dress with luminous paint. Can you please suggest an effective method of applying it to the costume without it peeling off ? As I want it for use in amateur theatrical work I would like to know if there is any method by which the paint could be permanently fixed, to prevent it coming off when the costume is being used and packed.

The costume will probably be made of blackout material.—Eileen Moody (Maidenhead).

WE suggest that you obtain from Messrs. Derby & Co., Ltd., Millmarsh Lane, Brimsdown, Middlesex, luminous powders of varying kinds, these materials being non-radio-active. It is possible that this firm may supply actual paints. If so, you can use such a material direct. If you can obtain only the luminous powder, make this up into a paint by incorporating it into a clear cellulose varnish or lacquer, such as you will be able to obtain from any large paint store.

You can obtain a clear cellulose lacquer of this type from Messrs. Wm. Canning & Co., Ltd., Great Hampton Street, Birmingham, price about 7s. 6d. per pint, or you can make a simple type of clear lacquer yourself by dissolving clear scrap celluloid in a mixture of equal parts of amyl acetate and acetone, and by adding a few drops of castor oil to each half-pint of the lacquer in order to make its film more flexible.

Readers are asked to note that we have discontinued our electrical query service. Replies that appear in these pages from time to time are old ones and are published as being of general interest. Will readers requiring information on other subjects please be as brief as possible with their enquiries.

Always remember that when the luminous paint which has been brushed on to the fabric dries, it will stiffen the area considerably. Usually, such paints are only required for edgings, so that the unavoidable stiffening is seldom of any consequence.

Costumes painted in the above manner must be exposed to sunlight periodically in order to renew the activity of the luminescent paint. A minute or two's exposure is quite sufficient. If sunlight is not available, any strong artificial light can be used, but the direct rays of the sun have the greatest re-activating power.

Do *not* use any of the expensive radio-active luminous paints. They are not safe for costume work such as you describe.

If the paint, when dry, tends to peel off, stir into it a few more drops of castor oil in order to render the paint film more flexible. It is sometimes an advantage in this connection to brush a little of the clear cellulose varnish on to the fabric before the paint is applied. This underlayer will penetrate the fabric more completely than will the paint itself and it will act as a "key" to fasten the paint layer down to the fabric.

Chemical Fly Exterminator

WOULD you please supply me with the formula of the chemicals used in an electrically heated fly exterminator. I understand that when the heater is switched on evaporation of the chemicals takes place and the resulting vapour proves deadly to all insects.—H. Thomas (Bickley).

THE material to which you refer is sold under the trade-name of "Gammexane." It is benzene hexachloride, and is highly toxic to insects. It is volatile, so that when it is spread on a heated surface, it goes off into the air. You cannot possibly hope to make this material for yourself. There is no "formula" for it. You will have to make inquiries at I.C.I., Ltd., London, S.W.1.

Another volatile mixture is one of naphthalene (moth balls) and para-dichlorbenzene, in about equal proportions. This is not anything like as toxic to insects as is "Gammexane." Yet it is a useful mixture for keeping away moths and gnats.

I.C.I., Ltd., produce their "Gammexane" in a special form whereby a charge of it can be ignited. Clouds of vapour are then generated, thus rendering every surface in the room completely toxic to all forms of insect life.

Compressorless Refrigerators

CAN you give me an explanation of how a compressorless refrigerator works ? I understand that, in some way, it makes use of Dalton's law of partial pressures.—G. E. Williamson, (Bickley).

IT is hardly practicable for us to give you a detailed account of the working of a modern compressorless refrigerator, since this would involve our writing at least half a dozen pages and drawing several diagrams. The working method is as complex as it is ingenious but you will find it all carefully described in a volume by H. P. Manley entitled "Refrigeration Service Manual," which is published by Messrs. F. J. Drake & Co., Ltd., Chicago, U.S.A. This book may be obtained from any good foreign bookseller, such as Messrs. Ed. Bryce, Ltd., 54, Lothian Street, Edinburgh, or Messrs. H. K. Lewis & Co., Ltd., 136, Gower Street, London, W.C.1.

Refrigerators of the compressorless type contain ammonia solution and hydrogen. The refrigerator is operated by its heating element which warms up the ammonia solution and drives off the ammonia as a gas. This gas is condensed and then allowed to re-evaporate. The re-evaporated ammonia (gas) is re-absorbed in water, which, not being near the heating element, is maintained relatively cold. This absorbing water, in reality, takes the place of the mechanical pump, because it maintains a state of relatively low pressure whilst the cold-producing initial evaporation of the ammonia is proceeding. The hydrogen obeys Dalton's Law of Partial Pressures, and helps to maintain a pressure equilibrium in the system. It also assists the circulation of the ammonia from the evaporator to the absorber of the machine.

Such is a very brief explanation of this system of refrigeration which forms the basis of the "Electrolux" refrigerating and other systems. If you will procure a copy of the above-mentioned volume or consult it at a library, you will find therein a complete elucidation of the subject in both its theoretical and its practical aspects.

Interior Decorating

I AM shortly moving to a larger house, which I shall attempt to completely redecorate myself, and would like your advice on the following points.

(1) I want to use one bedroom as a nursery, and would like to finish the walls so that they are really washable. Could I use enamel for the walls and if so, what preparations must I make ? The walls are at present papered.

(2) I require a similar washable, gloss finish in the scullery, which is of distempered brick and wooden ceiling. This room is half-tiled with white glazed bricks, so that I require a white paint or finish.

(3) The bath is not panelled, and I wish to do this myself. Can you tell me where I could get thin plastic sheets of a suitable size for this purpose ?—R. A. Horne (Birmingham).

(1) First of all, strip the paper from the walls of the future nursery. This is a tedious task, but it is necessary if you desire a good foundation for the paint. Give the stripped walls a light washing down. Allow them to dry out. Then brush them over with a solution made by dissolving six parts of glue in 94 parts of hot water, and use this solution hot. It will act as size for the walls.

You will now be ready to apply the paint. There are two methods of doing this :—

(a) Use a flat paint as an undercoating, and a gloss or enamel paint as the final layer.

(b) Use a single coat of one of the new "scrubbable" paints. For this purpose, we recommend "Murac," which is manufactured by Messrs. John Hall & Sons, Ltd., 4, Cadogan Road, Hengrove, Knowle, Bristol 4, and from which firm you can obtain literature and addresses of your local retail suppliers. This paint gives a matt finish. It can be had in delicate pastel shades, and it can literally be scrubbed. It is rather expensive, costing about 11s. per quart, but, on a well-sized surface, its initial cost is lowered by its excellent covering-power.

(2) For your scullery, we recommend a thoroughly good scrubbing of the walls, so as to remove as much of the distemper as possible. Follow this up with two sizings (as above described). Then apply a coat of a flat white paint. Over this, use a two-coat finish of white gloss paint.

We are not so sure that you have done well to decide on a glossy finish for your scullery walls. Glossy surfaces tend to condense steam and to give rise to a stream of water on the wall, whereas a semi-matt or a matt surface "holds" the condensed steam better in the form of an invisible film which evaporates much more readily than a stream or rivulet of water. You might, we think, with advantage use a matt finish on your scullery walls. For this you can use two coats of a flat white oil paint, or two coats of "Murac" (white) as recommended above.

(3) You will be able to obtain plastic sheets from Messrs. R. Denny, 15, Netherwood Road, London, W. 14. Such material, however, is apt to be expensive. On the other hand, we would not advise you to use an ordinary hard board in a bathroom, since, by absorption of moisture, this material is apt to buckle and warp. In our opinion, plywood would suit the job admirably, provided, naturally, that it were suitably painted and finished. You could also consider the use of plaster-board. This would require to be well painted in order to reduce its absorptive qualities. It would not buckle, but it is brittle, and would not stand up well to mechanical knocks, blows and other shocks.

Staining and Polishing a Wood Block Floor

I HAVE recently bought a new house fitted with wood block floors. The wood is in its natural state and shall be glad if you can tell me how I can make them have that dark and polished appearance which you see in so many large buildings.—E. Jones (Bristol).

SCRUB the wood block floors with soap and water to remove all dirt, grease, etc. Then, after the blocks have dried out thoroughly, brush them over with a mixture of equal parts of boiled linseed oil and white spirit, to which a little drop black or umber has been added. Let the blocks again dry thoroughly, then polish them with floor polish in the ordinary way. This will give a good floor which should last 20 years without restaining. Umber has a dark brown colour, and you may think it preferable to a true black, even if the latter is only used in small amount. Please note that the above-mentioned colours are not soluble in the oil. They are absorbed by the wood, along with the oil. Be careful not to add too great a proportion of colour to the oil, otherwise it will brush off from the surface.

Before polishing with floor polish, you can brush over the oiled floor a solution of one part of shellac in two parts of methylated spirit. This will give the floor an additional gloss, although, by some people, this gloss is objected to. We ourselves find that a well-polished floor, stained on the above lines, is quite satisfactory, provided that the colour is not overdone. Like all floors, of course, it must be treated with wax polish from time to time.

An alternative treatment is to make use of an aniline dye. Obtain from your nearest paint shop, a quantity of a suitable wood stain, which must be spirit soluble. Dissolve this in methylated spirit—about 1 part of stain in 10-15 parts of spirit. Brush the resulting solution thinly over the cleaned and degreased wood surface. Then polish up with normal floor polish.

Either of the above treatments is effective, but the first method gives a more durable stain which seems to have more "body" in it, and which, also, is quite unfadable in sunlight. Aniline stain, for the most part, will not resist the action of strong sunlight.

Dyeing a Carpet

WILL you please let me know how to make a dye, red or blue, for a carpet of 12 sq. yds.? It is now a medium green colour.—A. J. Gould, (Billingshurst).

IT is not practicable to dye a carpet by home methods of brushing the dye solution on to the carpet. For this reason, we do not advise you to make the attempt. Carpets dyed in the above manner are never satisfactory. They are always patchy and the applied dye comes off very badly indeed. Time and money are wasted and the last state of the carpet is worse than the first. For any type of dyeing, the entire fabric must be immersed bodily in the dye solution, heated gradually to near boiling point, and then thoroughly well rinsed. Even this orthodox process is liable to shrink the carpet.

However, if you wish to go on with the job, the carpet must first of all be washed and rendered clean and grease-free. After this, brush it over with a solution of 1 part of tannic acid in about 16 parts of water. Let this dry in. Then apply the dye solution by means of a brush. The tannic acid, having been absorbed by the fibres of the carpet, will combine with the dye (or with some of it) and will thus "hold" it. Finally, the carpet must be swilled down with COLD water several times and then allowed to dry slowly.

To make the dye solution, dissolve 1 part of any aniline dye in 6 parts of water. The dye solution should be used hot.

You cannot dye a green carpet red, for the reason that the imposition of red on green will tend to give the fabric a grey-black appearance.

Dissolving White Shellac

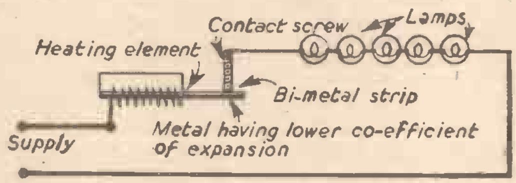
I HAVE about 1lb. of white shellac and I cannot get it to dissolve in methylated spirits; it remains suspended in the spirit no matter how I shake it up.—S. Harper (Wednesbury).

WHITE shellac should be perfectly soluble in methylated spirit, and if you find that the material will not dissolve in it, the inference is that it is not white shellac, or that it is very highly adulterated.

Perhaps, however, your method of effecting the solution is not correct. The white shellac should be placed in a bottle and sufficient methylated spirit added to cover it to a depth of about an inch. The bottle is then allowed to remain undisturbed overnight—or, better still, for an entire 24 hours. After this time, the shellac should be in a partially dissolved, gelatinous state. The bottle is now put into a pan of cold water. The cork is removed from the bottle, and the water in the pan is slowly raised to the boiling-point, the bottle being shaken from time to time. The shellac should now dissolve completely in the hot methylated spirit. If the solution sets to a jelly on cooling, heat it up again, and add more methylated spirit until you have a solution of the desired consistency.

Bi-metal Flasher

I REQUIRE a circuit diagram for a unit to give an intermittent flash on a lighting circuit. I want to use it with Xmas tree lights so that they flash at intervals. The time interval does not matter. I believe there is a circuit which uses condensers and this is the type of circuit I would prefer. The mains are A.C.—J. Hanna (Shiremoor).



Connections for a bi-metal flasher.

A TIMING circuit employing condensers would be unnecessarily complicated for the control of Xmas tree lights. We suggest that a simple bi-metal flasher would meet your requirements. For this you need a bi-metal strip, which consists of two metals having different coefficients of expansion which are joined together throughout their length. This strip is encircled by a heating element, consisting of a coil of resistance wire and the connections are as shown in the diagram.

When current flows through the lamps the heater warms the bi-metal strip, the metals expand and the strip curls so that contact is broken at the screw, provided the strip has been mounted the right way up. When the current is cut off the strip cools, contracts and makes contact again. Enclosure of the element and strip will increase the length of the "off" periods.

The size of element required will depend upon the lamp current. The Midland Electric Manufacturing Co., Ltd., of Reddings Lane, Tysely, Birmingham, 11, make a bi-metal strip and overload element rated at 0.3 to 0.4 amps and also one rated at 0.6 to 0.8 amps., which could no doubt be adapted for your purpose.

Magnification of a Telescope

CAN you inform me if there is any method of calculating the magnification of a telescope without removing the lenses?

Also, what is meant by the light transmitting power of binoculars?—A. Kirton (Normanton).

THE amount by which a given telescope magnifies depends on the focal length (or "focus") of the objective or front lens, and the focal length of the eyepiece lens, and is equal to the ratio of these two quantities. Hence, if you know the focal lengths of the objective and eyepiece of your telescope, you will be able to work out the magnifying power of the instrument without removing the lenses.

The magnifying power of a telescope is usually expressed in "diameters." Thus, if a small telescope is said to have a magnifying power of 16 diameters, this means that the diameter of any object seen through the telescope looks 16 times as large as it appears without the telescope, which is practically equivalent to saying that the object viewed through the telescope appears only one sixteenth as far away as it actually is.

Sometimes the magnifying power is assumed to be the number of times that the area of an object seems to be increased. And because areas are proportional to the squares of lines, the magnifying power of a "16 diameters magnification" might be termed a "power of 256."

When light passes through a telescope or a telescope-prism system (as in the case of binoculars of the prismatic type), some of the light is always lost by absorption and by reflection at surfaces. Hence, strictly speaking, the light transmitting power of a telescopic instrument is the ratio between the amount of light which enters the instrument and the amount which ultimately emerges through it at the eyepiece end.

In the case of binoculars, the term is usually employed more loosely in reference to the diameters of the objective glasses. It will at once be realised that the larger the diameter of an object lens (or "front" lens) of a telescopic instrument, the greater will be the amount of light which will pass through it, and the higher will be the brilliancy of the image as seen through the instrument—other factors, of course, being equal.

Thus, a binocular instrument having object glasses of, say, 32 mm. diameter, will give a more brilliant image than one having object glasses of 26 mm., when these objective glasses are used under the same conditions. In other words, the 32 mm. instrument can be said to have a greater light-transmitting power than the 26 mm. instrument.

"Bee Wine"

I SHALL be glad if you will give me any information regarding bee wine.

This had a vogue about the 1920s and was made from some substance placed in a jar of water and fed daily with sugar, the resultant liquid becoming a palatable, and, possibly, alcoholic "wine." The substance mentioned, in combination with the sugar, apparently caused some form of fermentation. Particles of the substance used to move up and down in the water and also increase in bulk.

What is this substance, and can the resulting liquid be classed as a wine?—J. C. Cox (Hythe).

THE species of mould which is utilised in the making of bee wine is usually known as the ginger-beer plant. It is a white, yeast-like substance which, in a suitable medium, continually reproduces itself by budding. We do not know where you can get it from at the present time, but possibly a good herbalist might be able to procure some for you.

The procedure for making the bee wine is as follows: Dissolve 4oz. sugar and 4oz. treacle (not syrup) in 1½ pints of water. Place the liquid in a glass jar and put a few small pieces of the ginger-beer plant in the liquid. Each day add about a teaspoonful of sugar. This addition will set up a brisk fermentation so that on the following day a portion of the fermented liquid can be filtered off and drunk as the "wine." The ginger beer plant itself quickly grows, and portions of it can be used to set up new batches of liquid in other jars. The plant requires a moderate room temperature in which to grow.

Ordinary yeast can be used in this manner to give an alcoholic liquid, but the liquid derived from the above-named ferment is superior in flavour.

In our opinion, it would be difficult to classify the beverage as a true "wine," but it is certainly an alcoholic liquor, since it may easily contain up to 10 or 12 per cent. of alcohol.

Removing Condy's Fluid Stains From a Bath

I HAVE a porcelain enamelled bath which is badly stained with Condy's fluid. I have been unable to remove the stains. On the advice of a chemist I tried a solution of 1oz. oxalic acid in 1 pint water and with very hard rubbing it was possible to remove the stain but, unfortunately, the glaze of the enamel also came away. I should be grateful if you could suggest any means by which the stain may be removed without affecting the enamel.—J. F. C. Newitt (Wolverhampton).

OXALIC solution will not remove a Condy's fluid stain satisfactorily, besides which it is a very poisonous substance to work with.

You will find the following method quick and effective and entirely harmless. Provide yourself with the two following solutions:

(1) Acetic acid, 1 part; water, 4 parts.

(2) Sodium sulphite, 1 part; water, 3-4 parts.

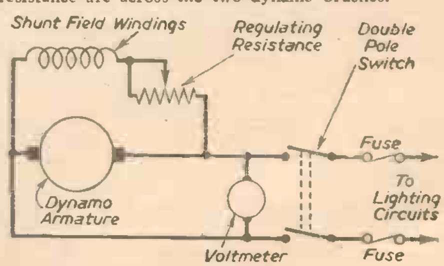
Have two soft rags, one saturated with solution 1, the other with solution 2. Rub the first rag over a stained area of the bath, and then the other rag immediately afterwards so that the bath surface is successively wetted with each solution. The Condy's fluid stain will rapidly vanish, after which the bath should be well rinsed out.

If the stain has penetrated below the surface enamel of the bath it may be very difficult to eradicate. In this case, apply the solution hot and with a brush. Apply them liberally. By repeated treatment in this manner you will get rid of the stains without any actual abrasion of the bath enamel.

Do not use oxalic acid, which is useless for the purpose, quite unnecessary, and severely poisonous.

A CORRECTION

IN the circuit diagram for a small generating plant, published on page 358 of the August issue, the lead from the regulating resistance is shown wrongly connected. It should, of course, be connected as shown in the diagram below, so that the shunt windings and resistance are across the two dynamo brushes.



Circuit diagram for a small generating plant.

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Phone : Temple Bar 4363
Telegrams : Newnes, Rand, London

Comments of the Month

By F. J. C.

UNDER 2 HOURS FOR 50!

IN 1947 George Fleming did 50 miles in under two hours on two occasions, and at that time it was considered by some that he had put the record on the shelf for a considerable number of years; that, in fact, his performance would be like some of those put up by Harry Green. Since that time four other time-trialists have beaten Fleming's figures.

Walter Fowler was the first to beat two hours with an out-and-home ride of 1 hr. 59 mins. 34 secs. Seven days later, G. K. Bentley beat Fleming's 1 hr. 59 mins. 14 secs. with a record of 1 hr. 58 mins. 29 secs., and Fowler lowered his time to 1 hr. 59 mins. 27 secs. D. J. Keeler returned a time of 1 hr. 59 mins. 50 secs. The following week L. V. Willmott did a "50" in 1 hr. 59 mins. 7 secs.

Of course, the time is approaching when the record cannot be beaten. What the ultimate time will be for "out-and-home 50" it will be difficult to say. Certainly the times can only be improved by seconds. What will happen when the record is considered to be unbeatable? Will a different set of records be created? Or will riders still attempt to beat what is unbeatable?

THE BATH ROAD 100

THIS well-known event, one of the highlights of the cycling calendar, proved to be less well organised this year than in others. The marshalling at the finishing point was ineffective and careless, with the result that spectators obstructed the riders. Officials guilty of negligence should be made to answer before a properly constituted tribunal, and be penalised if found guilty. It is a matter of great importance to the riders and to the good name of the sport that courses should be kept clear, thus enabling the riders to sprint to the finish. But most important of all the course should be kept clear to avoid accidents. Many of those present were severe critics of massed-start racing. We have yet to witness, either at the start or at the finish of a massed-start race, the scene at the finish of the Bath Road this year. The conditions were highly dangerous and do harm to the organisers.

We prefer to see a massed start than a massed finish!

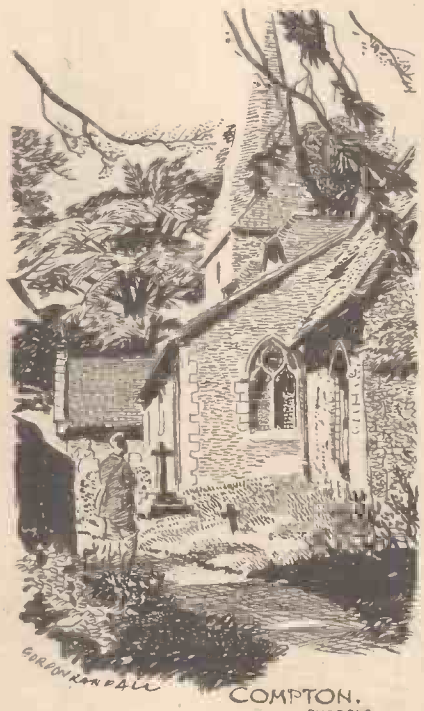
PUBLICITY FOR CYCLING

THE recent Tour of Great Britain sponsored by a prominent morning newspaper brought considerable publicity to cycle-racing. We must remember, however, that cycles were not primarily created so that riders could test their endurance against distance or the clock. Out of 10 million cyclists only about 100,000 at most are interested in racing. Much less than that are interested in track racing, as is shown by gate figures at recent Herne Hill events. Herne Hill has, indeed, turned out to be a bad investment for the N.C.U.

Newspapers, unfortunately, cannot devote the same space to the pleasures of cycle touring and the health benefits which are to be derived from regular cycling exercise. It has no news value, whereas speed events have. Would that it were possible to evolve some non-racing event which could attract the same amount of editorial space in the newspapers as the Tour of Britain. When the Tour of Britain race was discussed with us by a representative of the newspaper, he informed us that opposition to it had been fomented behind the scenes, but we were able to reassure him on the matter and to point out the reasons for such opposition.

The whinings of the N.C.U. and the R.T.T.C. were ignored. The recent malicious and highly defamatory bulletin issued by the R.T.T.C. is, we understand, not to go unchallenged!

When this journal was published weekly it achieved and maintained the largest circulation of any cycling journal in the world, and this was due to its policy of catering for the 10 millions rather than the 100,000. We dealt with sport, but we did not allow it to preponderate in our pages.



One of England's most interesting churches. Unique for its two chancels one above another and its gallery containing the noted balustrade. One of the oldest pieces of Norman woodwork in England.

CORUSCATING CORONERS

WE have on more than one occasion found it necessary to criticise that archaic and out-of-date institution—the coroner's court. The coroner seems to rule by divine right, and instead of confining his attention to the comparatively simple one of ascertaining the cause of death, or the owner of treasure trove, he will deliver an exordium on the accident which is a mere expression of opinion. Quite often the remarks are irrelevant. Thus, amongst our press cuttings the other day came the remarks of a coroner who had held an inquest on a cyclist. These are his remarks: "Very often motor-cyclists and motorists remember that they are in peril of killing themselves, but a lot of cyclists do not realise that with very little effort on their part they can kill themselves by falling from their bicycles as this man did."

The cyclist concerned had looked round whilst riding to see if his rear light was working, had fallen from his machine, fractured his skull and died.

The remarks are so irrelevant and meaningless that we wonder why they were uttered at all. Everyone that is driving a car or riding a motor-cycle or bicycle exercises a proper care for his own safety, or should do, self-preservation being the first law of nature. This particular accident was one of those odd affairs which happen very rarely indeed. We do not believe that the cyclist concerned was not exercising proper care.

On a number of occasions we have written to the Lord Chancellor criticising the conduct of some of these coroner's courts, and in some cases coroners have been told to confine their comments to facts. There is not a cyclist in the land, and never has been, who has not fallen from his machine at some time or another, either in the novitiate stage or when the roads have been particularly slippery. Some, indeed, have been brought off by means of steel studs intended to mark a safety zone for others, or by means of tramlines. It cannot be said in these cases that cyclists fail to exercise proper care.

BATH ROAD SMITH MEMORIAL 100?

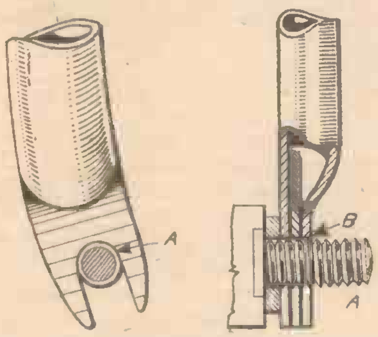
WHEN the late Bath Road Smith died, the original Bath Road 100 Cup came into our possession, and it was left to us to decide what event would be worthy of it. We have given the matter a great amount of consideration and have come to the conclusion that the cup would serve as a Challenge Cup for a Bath Road Smith Memorial 100. It was at 100 miles that Smith won the cup outright, previous holders being Edmund Dangerfield and S. F. Edge. If any clubs are interested in this suggestion we ask them to get into touch with us. The cup is a large one weighing over 80 ozs. and it bears, of course, the names and the times of those who had won it.

Failing any interest in club circles, it is proposed to melt it down and to make another trophy from it.

Wheel Location

How to Ensure True Centring for Accurate Wheel Alignment

MANY cyclists find that they have to depend for the correct location of the wheel rim in the front or back forks on pulling the wheel true with the frame and then tightening it in the forks by means

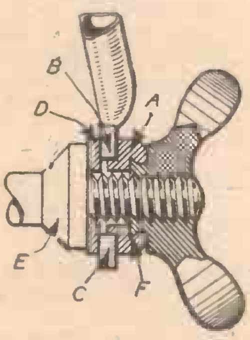


Figs. 1 and 2.—(Left) The end of a front fork blade with the usual slot. (Right) Showing how easy it is for the threads on the axle A to imbed themselves in the surface B.

of the axle nuts. This means that should these nuts slacken at all the wheel is immediately put out of position and the tyre may touch front or back forks or back stays. This trouble seems to occur more often with the front wheel.

Most forks are now slotted so that the wheel can be conveniently dropped out without removing the nuts, and this slotting has had the effect of making the wheel positioning a little more uncertain.

Fig. 1 shows the end of a front fork blade with the usual slot. It will be seen that the axle A rests up against the top of the slot and since the axle is threaded, the weight of the rider rests on the edges of the threads, which indent themselves into the metal of the forks; the section of which is formed of three strips of soft steel brazed together—the "trapped" (flattened) fork side tubes and a strip liner to make up a little width for strength. This shows how easy it is for the threads on the axle A to imbed themselves in the edges of the layers of three thicknesses of soft steel and brass, at the surface B, if the nuts do not hold the axle very tight.



Malalignment

If this occurs, one end of the axle may be higher up the slot than the other, and the rim of the wheel will approach the side of the fork near the crown. A matter of 1/16in. at the axle could make as much as ⅜in. out of centre at the crown.

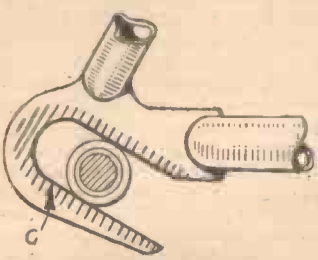


Fig. 7.—The wing nut with an extension the full width of the slot.

To avoid malalignment in the forks, the rider has to hold the wheel true in the forks while he tightens the hub axle or spindle nuts and often the very tightening of these causes the spindle to rise up or down in the slot. To prevent this trouble the method of fixing shown in Fig. 3, *a* and *b*, is adopted by some of the more particular makers.

The slot is formed in the fork ends as usual just wide enough to admit the hub

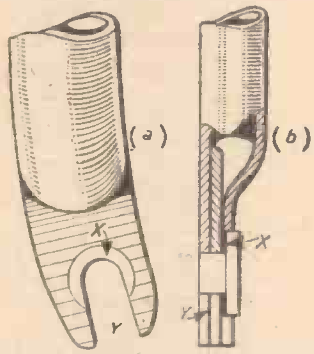
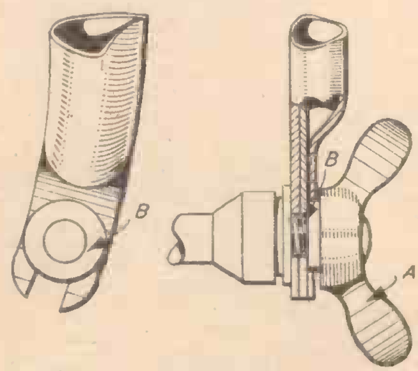


Fig. 3.—The method adopted by some makers to prevent the spindle from rising up and down in the slot.

spindle, and, at the outside surface of the fork a recess X shown at *a* and *b*, Fig. 3, is bored out. The centre of this corresponds with the centre of the top curve of the slot,



Figs. 5 and 6.—(Left) Showing the end of the cone pressing on th washer, and thus distributing the pressure over the width of the fork. (Right) Details of a quick drop-out.

but the circumference is wider than the slot. In Fig. 3, *a* is a side view, and *b* a sectional view, the recess X is of a diameter greater than the width of the slot Y, but the top of the slot Y is concentric with the recess, so that a washer on the axle will locate the axle close up to the top of the slot, but the weight of the rider and machine, instead of being taken by the tip of the slot in the fork end, is taken by the washer, which has more than half a circumference support in the recess X in which it fits, and which also prevents the axle from coming down the slot.

Distortion

Fig, 4 shows the end of the hub cone, the axle, the washers and the nuts in section. A is the cone, the end of which, B, is slotted to take a thin spanner. This makes the end of such a shape that in some positions it would almost fit into the slot in the forks. In any case it would pull in and distort the forks when tightening up the wheel. Therefore, a washer C should always be fitted of sufficient width, shown in Fig. 5, at B, so that the end of the cone presses on the washer and the pressure is distributed over the width of the fork end, and its outer face should be proud of the face of the fork end so that the nut E, Fig. 4, cannot bed down on the fork, but only the washer D. The amount the washer projects is shown at F, and it should fit neatly into the recess in the fork side.

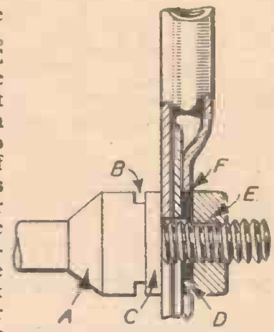


Fig. 4.—A section through the hub cone, axle, the washers and nut.

With such an arrangement, the wheel, once correctly set at the factory, can always be centred and cannot get out of centre at the fork ends.

An Arrangement for Wing Nuts

Where a quick-release thrust nut is used, some cyclists will grudge the little time necessary to clear the washers (D, Fig. 4) out of their recesses before the hub can be dropped out of the forks. In such cases, the washers may be omitted and the body of the wing nut may be turned to a diameter to fit exactly the recess in the fork ends for 3/16in. This arrangement provides a quick drop-out, and yet provides accurate centralising of the hub spindle. It is shown in Fig. 6 where the end of the wing nut A at B is seen to be a parallel fit in the recess in the fork end.

In the case of the back fork ends where chain adjusters are used, and the arrangement is not of the drop-out kind, the chain adjusters have flats and a central projecting part which fits in the fork slots. This is shown in Fig. 8, where A is the projecting piece which fits the slot. It is shown in side view at B, Fig. 8. The axle passes through in the hole A and does not touch the fork-end slots.

Where a quick drop-out is used at the rear, the chain adjusters are not used, but even there the threads of the axle need not rest against the inside edges of the slots and the

(*Continued on page* 3)

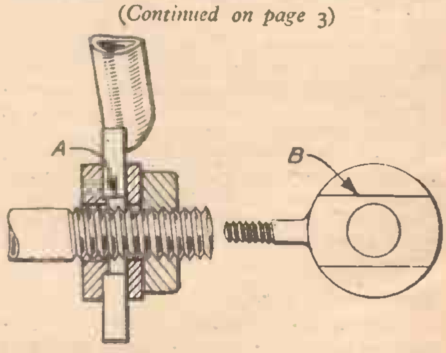
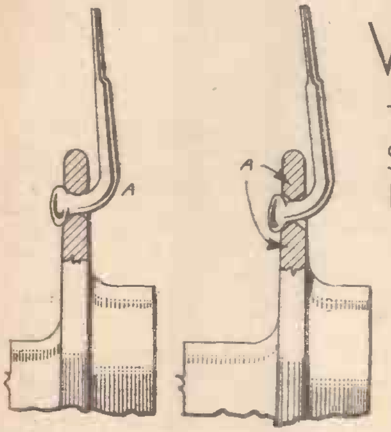


Fig. 8.—Chain adjusters with flats and a central projecting part which fits in the fork slots.

Why Spokes Break

There are Several Reasons Why Spokes Break, and They are Rarely Due to Negligence on the Part of the Rider



Figs. 1 and 2.—(Left) An incorrect hole in the flange. (Right) A spoke placed in a wrongly shaped hole.

A GOOD deal of attention has lately been drawn to spoke breakages, which for many years were almost unknown, and old riders are puzzled about the epidemic of these troubles, which has lately assumed rather serious proportions.

There are many conditions which lead to such breakages. Actual damage in riding can be ruled out of the question—the breakages are too frequent to be accounted for by extraneous violence. They must arise either from some defect in wheel building, some strain which should not be there, some defect in the shape of the spoke head or the hole in the flange, or some defect in the actual manufacture of the spoke. Some are inclined to the opinion that spoke defects are the principal if not the actual cause in a very large number—perhaps the majority—of cases.

Heading and Bending Process

In the case of a cycle spoke, considerable work has to be done on the metal in the heading and bending of the end. This work is done cold, and the effect of upsetting the metal to form the head (and to a lesser extent the bending of the metal to a right-angle curve) is to harden it and make it brittle; and since it is here that the strain comes, the result may often be fracture.

Those who have had trouble with certain (generally cheap) makes of spokes, have got over the difficulty by annealing the head and the bend by heating to a blood-red heat and allowing to cool in the forge ashes. But this cannot be done when the spokes are polished and plated, without the almost certain danger of spoiling the plating.

If the heading and bending process is carried out on a spoke which is toughened or hard-drawn metal, the likelihood of the metal becoming brittle is great, and sometimes methods of manufacture, which are necessary to produce a tough metal, have the effect of then making it so tough that it crystallises under further working (the crystallisation being the direct result of the further "working"). The metal then becomes, in workshop slang, "short." The molecules of the metal have become so disarranged that the molecular attraction is reduced, and the metal placed under a tensile stress. What was a fibrous arrangement of the molecules, giving great adhesion of the particles under tension (or pull), becomes a crystalline one. It is attended by a slight hardening of the metal, but softening by heating will bring it back nearly to its original formation.

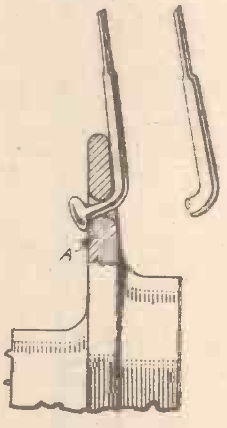
Tendency to Break

The tendency to break is accentuated when the strains are concentrated at definite points instead of being distributed over a fair surface. It is therefore necessary that the shape of the spoke should be such as to conform to the shape of the inside of the hole in the hub flange; and also that the direction of pull on the spoke—the direction of strain—should be such as to have no effect in the direction of bending the spoke. If, since this strain comes on and goes off once for every rotation of the wheel, there is any bend which is unsupported, the metal is subjected to a very slight backward and forward bending many times a minute. And those who have broken a wire by the process of bending backwards and forwards, when a wire-cutter was not available, will know how this rapidly results in fracture—disruption of the molecules.

The Shape of the Hole

Additional to this alternate bending there is the fact that the shape of the hole in the hub flange is often incorrect. The hole is "flared" each side to approximate, in section, a curve, but too often the tool used leaves a knife edge in the hole against which the whole pull of the spoke comes. These two defects are shown in Figs. 1 and 2.

In Fig. 1 we have the spoke head bent to a bigger curve than that of the section of the hole in the hub. Our illustration is drawn oversize to make this clear. The weight of the rider and, in the case of the rear wheel, the pull of the drive (in the case of spokes in one direction), and the retarding strain of the hub brake in the case of spokes in the other direction, has a tendency to straighten out the curve at A, which is unsupported here by the flange.



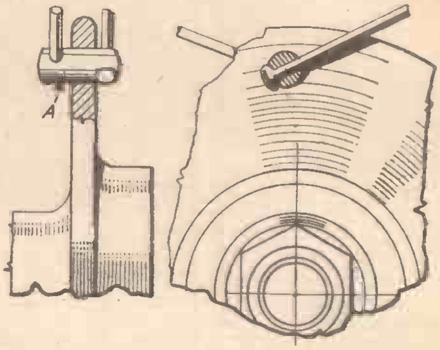
Figs. 3 and 4.—(Left) A spoke with too long a curve. (Above) A spoke with the head broken away.

In Fig. 2 is shown a spoke more or less correct as to bend, but placed in a hole which has been wrongly shaped.

The two ends of the hole have been flared with a tool which leaves a knife edge, as shown at A and A, and the spoke is subjected to the same strain tending to close the bend and, in addition, to what is almost a point contact at A and A, which concentrates the strain. Here we have the alternate bending and releasing strain accompanied by a contact which almost ensures the spoke breaking at A.

Head Sideways

Some spokes are correct as to curve, but the head is sideways. The head should act as an anchorage and should bed down closely in the flared end of the hole. Fig. 3 shows a spoke with the curve too long. The section of the hole is correct, but the head is sideways and the pull of the spoke is taken by one side of the head at A. This concentrates the strain at the most brittle part of the head and the spoke breaks as shown in Fig. 4, which is an enlarged view of an actual spoke taken from a cycle wheel which suffered with continual breaking of spokes.



Figs. 5 and 6.—A section and end view of a hub using straight spokes.

Weakness of the Bent Spoke

Earlier designers were conscious of the weakness of the bent spoke design, and numerous arrangements were devised to overcome the defect of the bend by using straight spokes in a tangent wheel. One design is shown in Figs. 5 and 6 in section and end view of the hub.

A parallel stud, A, is a tight fit in a hole in the hub flange whose axis is parallel with the axis of the wheel spindle. This stud is drilled each end and countersunk to take the spoke and its head. The two holes in the stud were at such an angle to each other as required by the layout of the wheel, and the spokes were direct from the stud to the rim. There could be no bending strain on such a spoke, but the wheel was more expensive to make and the hub was heavier. A somewhat similar arrangement was used on the "New Rapid," a popular machine made by the St. George's Engineering Co.—a firm which made a determined attempt to popularise long cranks and high gears—a vogue at that time, which did not last.

WHEEL LOCATION

(Continued from page 2)

correct method is shown at Fig. 7, where the wing nut has an extension which is the full width of the slot, but does not project as far inside as the width of the metal of the fork end.

This locates the wing nut correctly in the slot and the axle is located by being screwed in the wing nut. Thus a fair surface is in contact with the edge of the slot, and not a threaded surface. Withdrawing the wing nut by the amount of the projection lets the axle free in the slot with plenty of room for movement. But it is not necessary to unscrew the wing nut so far since the wing and projection will slide down the quick-release slot.

The wing nut has an extension A of a diameter equal to the width B of the slot. This extension is a little less in length than the thickness of the back fork end C and so, when tightened up, it does not come far enough to touch the washer D (if one is fitted) or the end of the cone E, where an inside washer is not fitted.

This arrangement allows of a very quick detachment with nothing to watch but that the wing nuts are screwed back far enough to loosen the tension on the nut and cone. It has no loose parts to get crosswise when fitting the wheel up in the fork ends again. In this type of fitting the wing nut has a swivel washer F carrying the projection A.

Around the Wheelworld

By ICARUS

National Committee Rejects B.L.R.C.

A FULL meeting of the National Committee on Cycling has unanimously rejected an application from the British League of Racing Cyclists to be represented on it. This decision, in my view, is a right one, for how could the National Committee representing the R.T.T.C., the N.C.U., the C.T.C., and the manufacturers who have consistently, jointly and severally denounced massed-start racing acknowledge that those denouncements were unjustified, as they undoubtedly would do if they permitted the League to be represented on the committee?

I am surprised that the League was so ill-advised as to make the application, when they must have known what the result would be. By their action they have thus given the committee a further opportunity of obliquely attacking massed-start racing.

Dave Bedwell winning the 1951 "North Wolverhampton Road Race" from Jowett and Clark. Cook, who finished fourth, is screened by Jowett, and the fifth rider is Alec Taylor.

The Tour of Britain

ONCE again cycling has hit the headlines, this time with the Tour of Britain 14 days cycle race sponsored by the *Daily Express* and organised by the British League of Racing Cyclists. The race took place from Sunday, August 19th, to Saturday, September 1st, and it included teams from France, Ireland, Scotland, England, with regional teams representing London North, London South, Yorkshire and Northern.

The race was run without untoward incident, and this will be a further source of annoyance to critics of this form of racing.

Cheap and Nasty?

AT a recent meeting with a number of pressmen not connected with the technical press, the subject of cycling cropped up. One of the journalists associated with a prominent morning newspaper contended that the outlook of cyclists generally was a poverty-stricken one, and he also argued that the sport would never attain national recognition, in the sense that football or cricket have done, until this cheap outlook is replaced by ideas on a much more generous scale.

As an example of this cheap and nasty outlook, let us take the recent N.C.U. 50 miles Tandem Paced Championship. The advertised meeting was rained off, and when the event was eventually held only 2,000 spectators turned up. This, of course, was very disappointing for the promoters, the Kentish Wheelers.

It was known by all interested parties (including the N.C.U. and the promoters) that, barring accidents, the race was a foregone conclusion for Jerry Waters of the South London Road Club. Waters already had two wins to his credit: no one had, up till then, ever won the "paced 50" three times running and there had been many gallant attempts, including Freddie Frost and Ernie Mills, to name only two.

All these factors added up, plus the fact that Waters might beat the record as well as breaking the "hoodoo," which seemed to hang over the event, added spice to the race.

Well, as we know now, Waters led the way home and also broke the record, but, of course, he was not credited with it because the N.C.U. rules required two time-keepers to be present, and naturally there was only one.

I was told that the cost of hiring another time-keeper was 50s., so for this paltry sum a man was deprived of the honour rightly due him. The promoters lost money on the event, and did not feel inclined to risk another 50s.

I think I can say, without fear of contradiction, that if such a thing as this had happened in any other sport there would have been a first-class row. As it was, it passed unnoticed. You see, cyclists expect this sort of thing in their sport; they have grown used to it, having had over half a century of N.C.U. misrule to look back on.

Is it not time that some of the people who are taking so much out of the cycling game started ploughing a little of it back? If things are so bad that they feel they cannot afford it, perhaps someone could take the hat round at the next meeting and raise enough to ensure that such a mistake never occurs again.

As I have said before, the N.C.U.'s style of racing is dying expensively and beyond its means. Just managing, in fact, to keep its head below water!

"Edwardian Flashback"

ON page 72 of the July issue appeared a paragraph under the above title. Mr. J. R. Millburn, of Aylesbury, has sent me the accompanying picture. The design of the bicycle appears to have changed so slightly in the past 50 years that, but for its single front tyre brake and sit-up-and-beg handlebars, it would not look out of place on the road to-day.

Although in general principles the bicycle is the same to-day as it ever was, because its fundamental units consist of a frame, two wheels, handlebars and saddle, and pedals, chain-wheel, chain, and rear-wheel sprocket, it has certainly undergone considerable and continuous improvement in detail design. It is a lighter machine, its wheels and tyres are livelier, braking systems make C.T.C. "Dangerous Hill" notices look silly (in fact, they belong to the period of the photograph!), gears, lighting systems and bearings are vastly different now to what they were then. It is always nostalgic, however, to look back on the past and say that things are not now what they were then. They never were!

Edwardian Flashback

Tricycles Objects of Derision?

I CHORTLED when I read in the *Sunday Times* recently the following: "It must be ridicule that prevents anyone nowadays from riding a tricycle." There are many adherents to the three-wheeler, and they will tell you that it has a fascination not possessed by the single track vehicle. They also forget to tell you of its considerable disadvantages.

It is, undoubtedly, heavier, it has three tracks instead of one, thus making the ride less comfortable, generally it requires a lower gear, and, in fact, it is harder work. I know that those who race on them have put up times which do not greatly differ from those done on the two-wheeler. The fact is that the tricycle was originally introduced for those who could not learn to ride a bicycle, and particularly for elderly gents to whom riding a two-wheeler would look less dignified than riding a tricycle.

To-day, riding a tricycle, except for racing, is chiefly done by elderly gents. There are those who think that it is easier to ride a bicycle than a tricycle. I invite them to have a shot at it!

"Angling for Beginners"

SPRATTS, LTD., have just published an interesting little booklet entitled "Angling for Beginners." It costs 1s. and should be of interest to all those cyclists who combine angling with wheeling.

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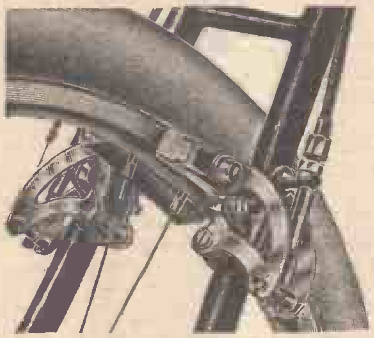

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SIGNPOSTS IN CYCLING HISTORY

No. 2 Kirkpatrick MacMillan, Inventor of the Pedalled Bicycle — and First Offender

On June 10th, 1842, after knocking over a child in Glasgow, Kirkpatrick MacMillan became the first bicyclist to be prosecuted and fined. But it is not because of his unfortunate mishap that MacMillan's name is famous in cycling history. It is because he was almost certainly the first man to fit pedals to a bicycle. The wood and iron machine made by this Dumfriesshire blacksmith in 1839 or '40 was clumsy and heavy, and it never became popular. But its rear wheel drive—produced by a system of cranks and swinging levers—and, to a lesser extent, its plunger brake have since shown the machine to be many years ahead of its time. Indeed, when pedals next appeared they were arranged to drive the *front* wheel, and this method was practically universal until the advent of the modern chain drive.

ISSUED BY **DUNLOP** *—MAKERS OF THE FIRST PNEUMATIC BICYCLE TYRE*

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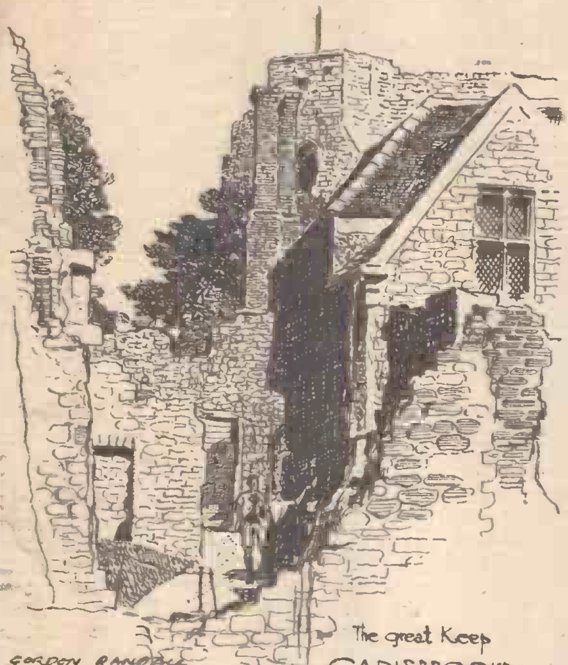
Wayside Thoughts

By F. J. URRY



The great Keep
CARISBROOKE CASTLE
Sketched from a corner on the walls overlooking the Gatehouse. The Castle dates from Norman days and was the place of confinement of Charles I.

How to Do It

RECENTLY, with my daughter as companion, I rode nearly 400 miles round, over and literally through the mountains of S.W. Ireland. We left this country for Cork, and it was a lovely morning when we arrived. We packed a few spare clothes, a primus stove and picnic outfit and, with the addition of a little food, were fairly loaded. I will not detail our route beyond saying the intention was to cross as many passes as possible, find the little lanes to remote places, and really see Ireland from the inside, as it were. And this we did over rough mountain roads wriggling among the hills and only occasionally descending to the valleys, hard highways, leading to and from the main holiday resorts. So few tourists either cycling or motoring risk the bad roads running over the hills, and that is a pity for the loveliness to which they lead is, in many cases, far more delightful than the advertised tourist routes, and no one can possibly know Ireland unless they penetrate, take the rough—and mostly that—with the smooth, and carry food for the day, for stopping places are frequently thirty miles apart ; hence the reason for the picnic things. Taken in this way, Ireland is the best cycling touring area I know. There were days when we saw only a couple of cars.

Easy, This Way

OUR troubles were one broken brake cable—not remarkable on a fourteen-years-old bicycle—and one puncture, a drawing pin, head deep, right in the centre of the tread of my rear tyre, picked up in an area where one would not expect to find a drawing pin even doing its usual job. Not very serious incidents, both of which were easily repairable. During the tour we climbed nearly 12,000ft. over various passes and took our bicycles up crossings we were told it was impossible to make. The value of this tour from the cycling point of view is the fact that a fit man of 72, and his daughter of 44, can, and on this occasion did, enjoy every league of the journey. It is, of course, just a question of the right bicycle, correctly adjusted, and a modicum of fitness to sit on a saddle for an hour or so at a stretch. And the secret of the equipment is first of all a good class, comfortable saddle, and then a range of gears on the low side. Our gears were provided by the S.A. wide range four-change hubs with normals of 60in. and a low of 40in., a very useful gear the latter on the long six-miles climbs which came our way. It was not all sunshine and fair breezes, for we had interludes of "soft" weather, as the Irish term a damp day, and this "soft" weather over mountain roads means mud up to the rims in places, making the going hard. Our longest day was 42 miles, and on several occasions we made a two-day stop at places to travel round the regular tourist routes, using our bicycles instead of motor-coach and boat. Everywhere we were welcomed, and once, when I was busily buying provender, a fat old priest with a jolly smile warned my daughter she must take care of the "old man" and not allow him to ride the hills ! Such, you see, is the average thought of the average ancient who holds the idea this cycling game is only for the vigorous youngster. Time after time we met similar suggestions at the hotels ; it was marvellous I could do the riding and enjoy it! It's nothing of the sort; it's just getting and keeping cycling fit, and loving its freedom.

A Great Success

I CAME home just in time to attend the Festival of Cycling Rally at the Dunlop Sports Ground on June 23rd and 24th. At long last the cycling organisations and the trade have pooled enthusiasm and resources to run a show worthy of the game and its cause. For years I have dreamt of such a happening, and on the date named it occurred and satisfied everyone concerned. Probably no bigger concourse of cyclists and bicycles has ever been seen, and certainly no greater enthusiasm for the sport and pastime displayed. It was a revelation to numerous makers and retailers and a satisfaction to some 30,000 cyclists, many of whom came from 200 miles away, rode through the night and were greeted on the ground with a substantial breakfast provided by the industry. Some idea of the number of all-night riders can be measured by the fact that over 6,000 breakfasts were served. It was the wedding feast of the sport and pastime, and the industry, for never before have the varying interests been so joyfully mixed. And the whole show was a real British Festival magnificently staged by the organisers, and as greatly appreciated by the supporters. No finer venue could have been chosen, for the Dunlop Sports Ground makes excellent setting, not merely as an open space, but because of the great company's close association with cycling, for it should not be forgotten that John Boyd Dunlop's invention was intended to ease cycling—and it did, and still does. The pageant of the cycling procession down the ages was excellently staged and enthusiastically received, so much so that an encore was demanded and given later in the day. We even had a Lady Godiva mounted on a Coventry Eagle white bicycle, with old country dances to match that age of chivalry, besides a hundred other attractions bearing on country life and the cult of the open air. Yes, it was a fine show, and the secret of its success was the support given by riders, the general public and the trade.

And Now What ?

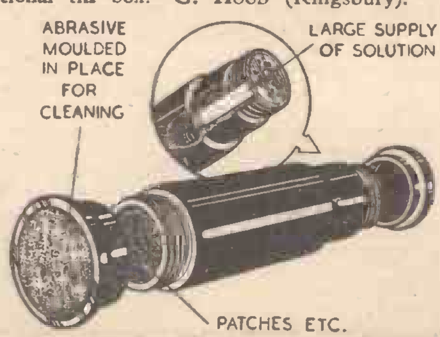
THE question now is, will it remain as an annual function to consecrate, as it were, the marriage of the trade and the pastime ? No doubt that question will be in the minds of the people concerned, and they have in front of them the enthusiasm of their ultimate customers, many of whom glory in the opportunity of congregating once a year to propagate their favoured game among the public and make cycling better known. On this occasion that propagation has been excellently presented on the screen of the Odeon-Gaumont Film Syndicate, for the film folk were an important part of the organisation. Such a rally is, of course, an expensive business, and the folk who find the needful coin will have the last word on the matter ; yet I feel that the cause is worthy of the cost. It may be a compromise will be made that a combined rally of this nature can be successfully held every three years, thus bringing into its enthusiasms the younger folk who are beginning to discover the delight and adventure of cycling.

A Compact Repair Outfit

MR. URRY'S remarks in THE CYCLIST, April, 1951, criticising the usual cyclists' repair outfit gave me cause to ponder. I think he is correct in his assertion that a screw-topped tin is the most satisfactory container for solution; it has always been my practice to carry one.

Surely it would be easy for the manufacturers to supply us with a properly designed repair outfit. It is my idea that something on the lines of the appended illustration would be a convenience as I suppose every cyclist has experienced the exasperation of trying to clean a tube with a piece of worn-out glass paper (probably damp). Hence, a cleaner made by moulding glass particles into the plastic cap should afford a permanent and effective cleaning device that would not be affected by dampness. The container could be made in two chambers, one holding a large supply of solution and the other the usual clutter of patches, valve tubing and talcum, etc. The solution container to have a perforated dispenser.

Made of plastic with a screwed cap at each end, it should provide a convenient, light and unspillable outfit which could probably be produced at least as cheaply as the conventional tin box.—G. HOOD (Kingsbury).



Mr. G. Hood's suggestion for a repair outfit.

CYCLORAMA

By H. W. ELEY

THE CROWN, NANTWICH

Fine half-timber work on the frontage of this old Cheshire inn.

Ancient Repton

EVERYONE knows of Repton's famous school, but fewer know of the ancient and historic St. Wystan's church. I was privileged recently to accompany a party of cyclists to Repton, and the good vicar conducted us over the beautiful and age-old church and into the thousand-year-old crypt. Here in the stillness history speaks from the stones, and it was quite thrilling to hear from the lips of the vicar the story of Repton through the ages—the burying of Mercian kings in the crypt, the pilgrimages of the devout to the shrines; the story of St. Wystan, St. Guthlac and St. Chad; the transfer of the Bishopric from Repton to Lichfield. And, after our tour of the church, we saw a little of the famous school, watched a cricket match on the pleasant playing-fields, and wandered through this ancient place which has been a seat of learning and culture for a thousand years. Not far away . . . busy bustling Derby, with its factories and foundries. Cycling brings many joys, but to me, none so good as these runs out to ancient places where England's chequered story goes back over the centuries, and lichened walls and pillars speak of men and happenings of the past. . . .

A Cycling "Quiz"

AN energetic club secretary I know has recently staged, and staged very successfully, a "cycling quiz." The members of the club foregathered in the clubroom, and over pipes and drinks had an interesting "quiz" . . . asking and answering questions all of which had to relate to some phase of cycling, or be about cycles. Who actually invented the bicycle? (I gather that not many knew the correct answer to this one! Few had heard, apparently, of old Kirkpatrick Macmillan, the Scottish blacksmith.) Who was James Starley . . . and where is there a monument to his memory? Who was William Hume, and why is he famous in the annals of cycling? I can well believe that this "quiz" was a great success, and I commend the idea to those club secretaries who like, when the winter months are upon us, to stage a little "get together" for their members, and are seeking for new ideas of entertainment. Cycling and cycles have an absorbing background and history, and the real enthusiast always likes to learn.

Lure of October

I LOVE this pleasant month of October, when the morning air is crisp, when the trees of the woods and coppices are turning from green to russet brown, when the lordly pheasant flies out of the plantation, and all the world is mellow, and the orchards full of fruit. King Winter is lurking round the corner, but on these pleasant October days the sun is still warm to the bark, the countryside is still colourful and full of charm . . . and no fogs have yet come stealing over the meadows to blot out the landscape and blur the beauty of the scene. Not too late for mushrooms in the big field by the church; not too late for the Michaelmas daisies in the garden border to make their contribution to the pageantry of the autumn scene; and a grand time in which to sally forth with gun and dog and secure a rabbit to augment the rations! I'm making the most of this month and touring the pleasant villages which dot this countryside. Most are rich in old inns . . . and it is traditional that ale is best when brewed in October or March!

An Artist Awheel

MOST ardent riders like to read cycling notes in newspapers . . . and I always rejoice when I find a paper which runs a regular "cycling feature." Such a one is the *Burton Observer*—a weekly paper I read regularly. "Wheelman" is not only a delightful writer, but a keen observer of the countryside, and he is an artist of merit. His little sketches of inns and cottages and wayside curiosities are delightful, and as, of course, his riding is in my own area, I am familiar with most of the places he portrays so charmingly in his notes. Cycling deserves more space in our newspapers than it gets . . . but I know of the difficulties of editors in these paper-shortage days. I salute "Wheelman," whoever he may be, and hope that he will long continue his pilgrimages around the villages and hamlets, and sketch their features. For myself, I am keeping all his sketches in that ancient album which is full of notes and pictures, and records of cycling days.

Maps and Guide Books

WHO can resist the fascination of a map . . . or a good guide book? If ever I find myself in a town with time to spare, I find my way to the best-looking bookshop or stationers and browse in the corner devoted to maps. Ordnance maps, handy pocket maps, guide-books which tell one all about the towns and villages of England . . . how good they are! And I am glad to see that the famous "Dunlop Guide" has been republished for the first time since before the war. This is a grand volume, and apart from the complete gazetteer there is a fine section devoted to the care of tyres. And tyres *do* need a little care! One might not always think so from the casual way in which many riders treat them, but a reasonable amount of intelligent care will result in longer mileage and better service. Whilst the "Dunlop Guide" is published primarily for the motorist, it is an excellent volume for the cyclist's bookshelf, and I am glad to have the new "Festival" edition.

Gipsy Cavalcade

IT was on the fringe of the common where I met them . . . a gipsy family, with the traditional gaily-painted van, the piebald horses, the lurcher dogs, the tawny-faced children, and all the trappings of Romany land. I chatted with them about their travels and discovered that they had come to Staffordshire by way of Gloucestershire, Worcestershire and Warwickshire. I smoked strong tobacco with one, Reuben Smith, admired his earrings and his great silver ring; I drank tea from a tin mug, and was introduced to Lydia, Risina and Belinda . . . all fine looking girls with the dark skins and black hair of their race. I watched the expert preparations for their stay on the common, and saw the pegs and mats which they would, next day, peddle around the villages. A flash of the picturesque, a cameo of wanderlust, a hark-back to an older England! These wanderers are folk apart, and not at all will they unleash their tongues; but I have always found that a silver coin and a pipe of tobacco will unlock the door, and to me, these nomadic people, whose origins are obscure and ways mysterious, are always fascinating. Dusk was purpling the scene when I rode away from that little wayside encampment, where the women crooned ancient lullabies to their babies and the men smoked their pipes under the canopy of a darkening sky. . . .

Slogans

I AM fortunate that in my village there are two cyclists (of the same mature age as myself!) who like to "potter around" and explore the countryside. We foregather to make our plans at an inn which has existed since 1750 or thereabouts . . . and our topics of discussion range from politics to poultry-farming, from radio to runner-beans, from cabbages to cricket. But the other day we talked of advertising slogans in the cycle trade and voted that three of the best ever coined were, "Made like a gun"; "Rudge it . . . don't trudge it"; and "It's time you had a B.S.A." As an old advertising man I found the conversation quite fascinating, and for our "next session" I'm taking along some old cycle catalogues which I have treasured over the years . . . and I have no doubt that from their pages we shall find other slogans and the "sales stories" about "makes" which may now have disappeared from the cycling scene.

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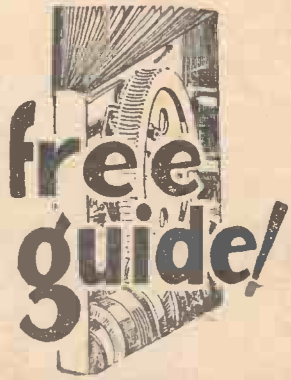

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