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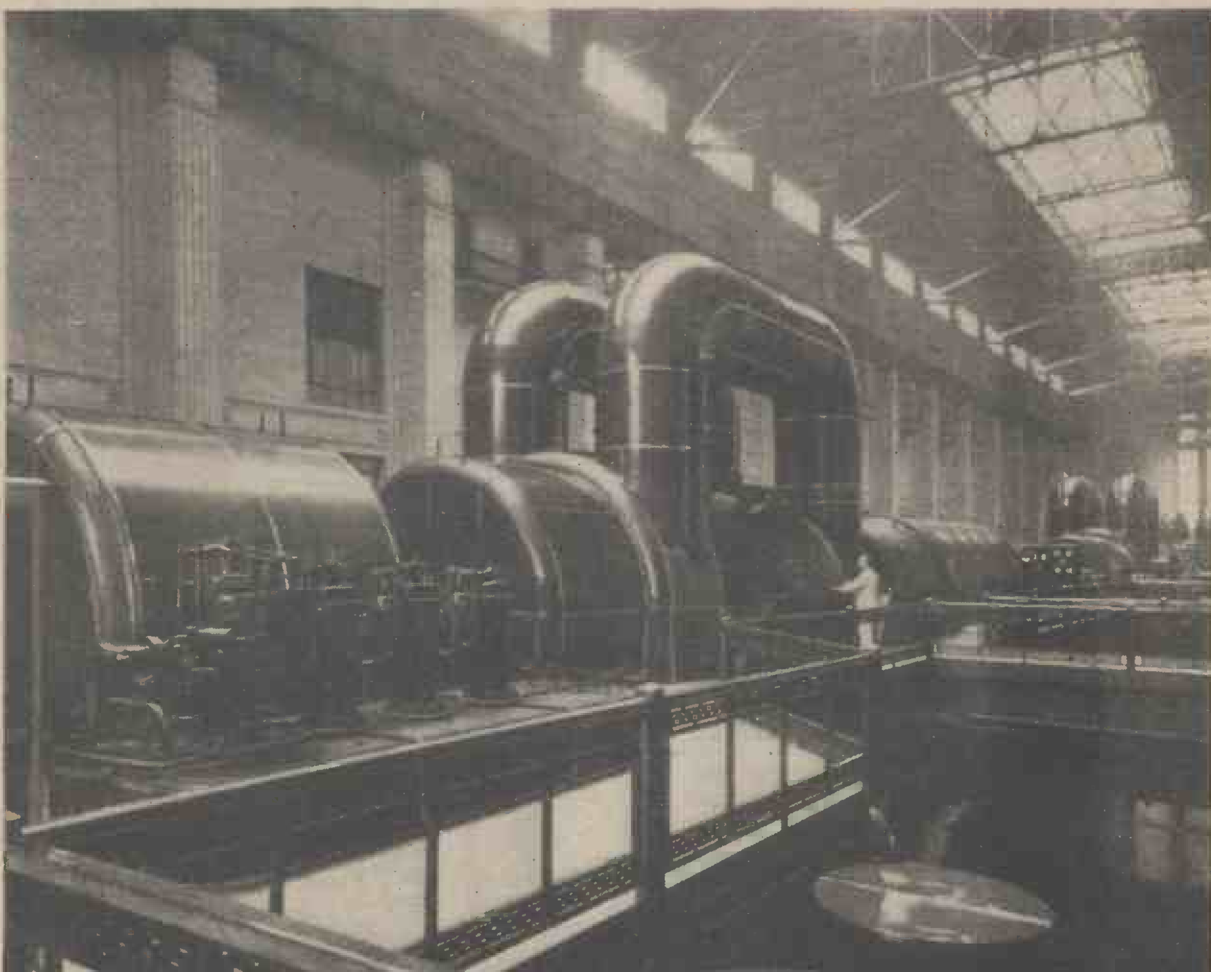

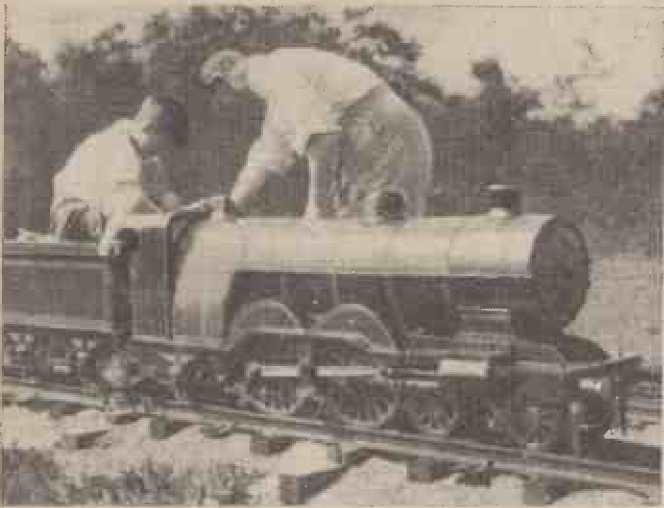

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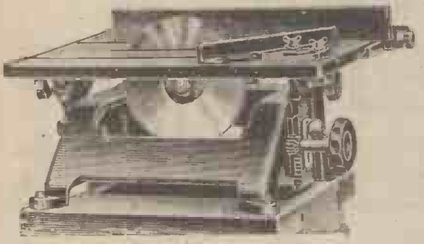

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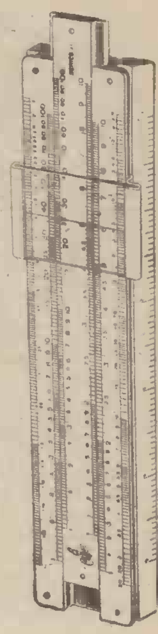

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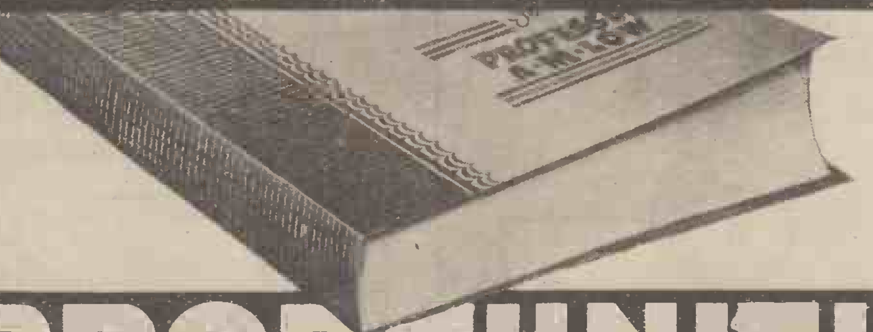

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Owing to the paper shortage "The Cyclist," "Practical Motorist," and "Home Movies" are temporarily incorporated.

Editor: F. J. CAMM

VOL. XII JULY, 1945 No. 142

FAIR COMMENT——BY THE EDITOR

The Battle of the Scientists

DR. C. F. GOODEVE, F.R.S., assistant controller for research and development at the Admiralty, recently lifted the blanket of secrecy which has swaddled the scientific achievements of our technicians during the war. Because of this secrecy, and the fact that we disclosed the inventions of our enemies as they were discovered, the public may be misled into thinking that ability to produce new inventions is only possessed by the Germans and the Japanese. As Dr. Goodeve points out, the battles of World War II have been fought not only in the field, at sea and in the air, for some of the most interesting operations have been behind the scenes, in which the scientists and designers of Britain and the United States have pitted their brains against Germany. They are still working to defeat Japan. The knowledge thus gained will have a profound effect on the struggle to win the peace.

Romance of Radar

THE most outstanding technical battle—almost a war in itself—was won in the field of radio, including radar (as radiolocation is now known). The development of radar has produced the more startling results. A British scientist first realised the military significance of the discovery that echoes from aircraft of wireless waves interfered with television reception. Driven by the fact that the English Channel was no longer a barrier, all possible research was given to this new method of detection and location. When the great day of trial came, in August, 1940, all was ready. In the Battle of Britain it was the pilots behind the guns who shot down the aerial invaders, but it was the band of men behind the radar who led the pilots to their targets.

Radar has not only conquered fog and darkness, it has stimulated the science of electronic physics to such an extent that that science has jumped from a comparatively small size until it is now equal to almost half the total scientific effort in Government Service. Radio valves and cathode-ray tubes are to be found in almost every field of war activity, and presumably before long this will be equally true in ordinary life.

Britain led in all of this. She has retained her lead by a very good margin ever since. With the United States she exchanged all information and worked in close collaboration. The Germans copied some details accidentally given them in aircraft lost over the Continent. Admiral Doenitz is reported to have said, when describing how Britain had conquered the U-boat menace by means of radar, "The scientists who created radiolocation have been called the saviours of their country. It was not superior strategy or tactics that gave Britain success in the U-boat war; *but superiority in scientific research*." The radio war resulted in a demand for physicists such as never known before. All specialists in Britain were mobilised and others brought from all parts of the world. Special measures were taken to train new men either from scratch or from other branches of science.

Mobilising Chemists and Engineers

THE major technical battle of World War I was for materials, and this was fought by chemists. Britain owed her preparedness in World War II to the strong chemical industry then founded—an industry which is strongly backed by its great research laboratories. The battle for materials has gone on in World War II, but has seldom produced such grave problems as it did in the former conflict.

Design engineers come into every battle, and this profession has experienced the greatest shortage. It is difficult to know how to produce a good design engineer quickly. People with all kinds of training have helped to fill the ranks but a serious national problem remains.

Menace of the Magnetic Mine

IN duration, in technical achievements, and in human effort the battle of the magnetic mine was not perhaps in the same class as the radio or anti-U-boat battles, but it has unique features of interest as the first technical battle of the war and one in which Britain won a decisive and, to Germany, totally unexpected victory. It had important repercussions.

In any battle one must first know what weapons the enemy has to use and correspondingly in a technical battle, especially of a defensive nature, one is very dependent upon technical intelligence. Although Britain was practically certain in October, 1939, that the enemy was using a magnetic mine, she did not know its characteristics accurately enough to make any real progress to its counter.

The story of the capture and analysis of the first magnetic mine has now largely been told both in press and radio. So, too, much has been told about degaussing—that electric safety belt for ships which was divulged to the world on the day that the first degaussed ship arrived in a foreign port. But that is only part of the story—as degaussing was only partial protection, it was obviously necessary to get rid of the mines, if possible, as fast as the enemy laid them.

The German magnetic mine was based on a World War I type. If a magnetised rod of steel is supported by a horizontal axle through its centre, so that it is free to rotate in a vertical plane (like a see-saw), instead of in the horizontal plane as in a compass, then the north-seeking pole of the rod will dip down to an angle depending on how far it is from the North Magnetic Pole. (At the Pole itself it would dip to the vertical position, at the Magnetic Equator it will not dip at all, and south of this the south-seeking pole will dip.) By fitting such a needle with an adjustable helical spring one can accurately balance the force tending to make the needle dip by an equal and opposite force of the spring.

Under a steel ship the magnetic field is greater than normal, and a balanced needle is forced down to make the electrical contacts.

The German scientists improved on the old design in many ways. One was in devising an ingenious clock which automatically measures and sets on the spring the exact force necessary to balance the magnetic force on the rod in the latitude in which the mine is laid.

The analysis of the first German magnetic mine, on that famous night of November 24th, 1939, not only showed the mechanism by which it worked, but gave the crucial technical figures of the strength and duration of the magnetic field required to fire it. Without these, counter-measures were barely possible. On that November night the technical battle was joined.

When the full story of this battle is told, it will describe the many schemes that were put forward (and some tried), varying from flat fish fitted with bar magnets, to giant coils on aircraft. The story will show the excitement of the first exploded mine, the competition in the rising scores of the runner-up schemes, and the final emergence of one method with such effect that the mine menace never again reached dimensions comparable with that of the first year of the war. This method was the Double L sweep.

The Double L Sweep

"DOUBLE L" stands for Double Longitudinal, and the sweep is made up of two minesweeping ships, each towing a long tail of self-buoyant electric cable. The current is generated in the ships, stored momentarily in batteries and passed through both cables simultaneously as a large surge. The current goes into the sea via the electrodes. By this means 10 or more acres of the sea bottom can be subjected to a magnetic field of sufficient strength and duration to explode all the mines therein. The ships proceed on their parallel courses and make a second "surge" of magnetic field. In this way is cleared a continuous line of the sea bottom, providing a safe channel through which ships can pass.

Our Electricity Supply

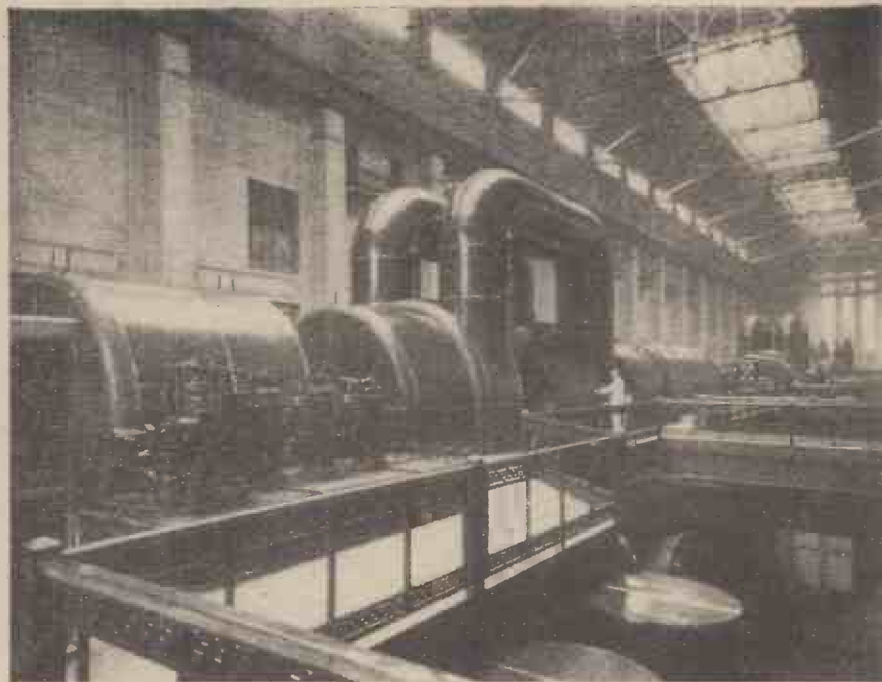
Details of the Structure of the Electricity Supply Industry, and How the Grid System Works

By KILOVAR

THE organisation of the Post Office, the railways, the B.B.C., and of many other bodies is fairly well known to the general public, and the fierce and sometimes blistering light of publicity is not infrequently turned on almost every public utility service. Electricity, however, which has crept in an almost insidious manner into the national body until it is its very breath of life, has relatively seldom been in the news until, a few months ago, the wildest stories circulated during the cold weather spell, when the Grid authorities had to "shed load" (that is, to shut consumers down), over peak periods; and there are widespread misconceptions about the functions of the Grid and its relationship to the local electricity authority.

Behind that simple facet of electricity supply, which is seen by the householder or small business proprietor—the reading of the meter, the paying of the bill, and the occasional mending of a fuse—there lies a mass of complicated organisations in which there is much to admire and much to deprecate. Centralisation of control, monopoly rights, nationalisation, private enterprise, municipal ownership—all these broad principles have their being within the framework of one of the country's most vital and widespread industries.

The purpose of these notes is to set out in brief the present structure of the electricity supply industry, and to give some answers to the questions: "How much public control is there over the electricity supply in my town?" "Why is my electricity bill more than that of my colleague who lives in another suburb?" And, principally, "What does the Grid *do*?"



WHERE THE POWER IS GENERATED. The interior of a London power station, showing a 105,000 kW. 1,500 r.p.m. turbo-alternator.
(Photo by courtesy of Metropolitan Vickers Electrical Co., Ltd.)

How it Began

The first central station for the supply of electricity came into being in 1878, to light the Embankment, in London. It was not until 1882 that legislation took any account of this new "fluid," and in that year the Electric Lighting Act was passed. It gave electricity companies the right to open public roads, and it laid down that a licence had to be acquired from the Board of Trade before supply could be given; and these licences are only granted to one company in one area, except in a few special cases, thus establishing the general principle of monopoly. It is interesting to contemplate what might have happened if this were not so; you would have the choice of one or two or more companies who would importune you to use their supplies, as they were "cheaper" or "more reliable," or because they installed free cookers.

The Act also laid down also that municipalities had the right to purchase the undertakings, if they so wished, after 21 years, and it also made certain provisions as to maximum prices, and exercised some slight control over the technical details of the systems of supply.

The first municipal station was opened at Bradford in 1889, and many others followed. Private companies were also being formed with great rapidity, and the majority of the larger towns had some form of electricity supply by the turn of the century. The systems employed were extremely diverse. Earlier schemes were based on arc lighting, which called for D.C., and it was not until about 1897 that the first A.C. supplies were given on a commercial basis. Voltages varied from about 100 to 260 and, in A.C. systems, the frequencies were 25, 33⅓, 50, 60, 83 and 100 cycles. Single-phase working was the general rule. No interconnection between systems was possible.

Another Electricity Act followed in 1909, and while the control of this fast-growing public utility service was tightened, further powers were given to supply authorities. It also paved the way for the Joint Boards, which are composed of a number of smaller local authorities who combine for electricity supply purposes. The London and Home Counties Joint Electricity Authority is an outstanding example.

Before the last war, then, we had a large number of independent electricity suppliers, partly springing from private enterprise, partly from municipal far-sightedness, and some few Joint Boards. They were subject to control by the Board of Trade in matters of maximum price and safety, and to a certain extent in matters of voltage and electrical details in their systems of supply. But there was no national co-ordination of the industry. If the company operating in Blankborough was old-fashioned and inefficient, it was no one's business to do anything about it except the directors.

The 1914-1918 war, with its urgent necessities for immediate supplies of electric power, brought the need for a proper national outlook on this vital matter to the consciousness of the Government. In 1919 a new Act was passed which took sweeping steps to exercise a greater control over the whole industry. It established the Electricity Commissioners, who, as the Act stated, are the body through whom the Government ". . . promote, regulate, and supervise the supply of electricity." From the Board of Trade, the whole matter of electrical supplies passed into the hands of the Minister of Transport, and since the present war it has been again transferred, this time to the Minister of Fuel and Power, who exercises his authority through the Electricity Commissioners. A levy on the revenue of all undertakings pays for the Commissioners' costs, and they comprise five men, appointed by the Minister for their outstanding experience and knowledge of all matters appertaining to the generation, transmission, and employment of electrical energy.

The next important step occurred in 1926. A few years earlier the Government had appointed a committee, under Lord Weir, to consider the whole problem of electricity supply, and this committee had recommended the construction of a Grid system to be run by a new Statutory body to be known as the Central Electricity Board. The Act of 1926 embodied these proposals.

What Does the Grid Do?

In considering the question, "What does the Grid do?" we can take a very simple analogy. Imagine three cottages, each with a well and a pump. The first one has a very efficient well, and the water can be pumped easily. The third one has a poor well, which is inefficient and needs a great deal of labour to produce a small quantity of water. The second installation is mid-way between the two. Imagine further that the water—and this is where the analogy has to be stretched a little to make it fit—cannot be stored, but must be pumped as it is used.

Suppose now that an outside authority were to review the water position in our imaginary hamlet. The obvious thing to do is to supply all three cottages from the efficient well. But in case it breaks down, or has to be overhauled, you must also keep in being the second best, and so arrange matters that it can too be used. The third well can be abandoned, and the cottager can use his efforts in more profitable pursuits than painfully pumping from an inefficient source.

To accomplish this, you must first couple all three cottages together by pipes, so that each tap can draw from any well. You must then arrange that someone has the power to insist on the efficient well supplying all the water to the three cottages, and if he fails, or if on occasional days the total demand is too high for him, then the controller must bring in the second well. And he must also have power to direct the third man to close his well down, as he is not using his pumping energy to the best advantage in the general scheme, whereby all water is obtained in the most efficient manner, no matter by whom it is pumped.

If this can be accomplished, you have a state where every drop of water used by the three cottages is produced efficiently and, moreover, where each cottage has at least two independent sources of supply. In the total production of water, there is no waste of energy at all.

But, obviously, although each cottager might be able to be convinced, by argument, of the desirability of such a scheme, he would jib at the prospect of paying for it out of his own pocket, and unless there were an overriding authority with legal powers, the sharing of the production of water between the most efficient wells would not be equitably done, and would give rise to argument and difficulty.

Coming back to electricity, the Grid has performed almost exactly what the linking of the water-systems of the cottages was shown to do, in the simple example given above.

The outside authority, set up by the Government, was the Central Electricity Board. The equivalents of the three cottages are the whole of the statutory electricity undertakings in the country—about 600 in number. The pipes interconnecting the cottages are the symbols equivalent to the overhead wires and sub-stations of the National Grid. To pay for the construction, the C.E.B. was authorised to borrow £60,000,000, against a Treasury guarantee.

Eight Regional Schemes

The Central Electricity Board prepared eight regional schemes, for Central Scotland, South Scotland, North-west England and North Wales, North-east England, Mid-East England, Central England, South-West England and South Wales, and South-east and East England. In each of these schemes certain power stations were chosen as "selected stations," in which generation was to be concentrated. The less efficient, non-selected stations were not to be closed down immediately, but were not to be allowed to extend. The Board's powers included the duty of arranging and supervising the installation of new plant, which had to be allowed by the Electricity Commissioners on the Board's recommendation. Thus no new inefficient "wells" could be dug (to revert for a moment to our former analogy), and any further wells would have to be constructed so that they formed part of the plan of the independent authority for the most efficient supply of water to the whole body of consumers.

To link these "selected stations" together, the Grid was constructed. Taking a typical case, let us think of the town of Blankborough. It has a steam power station, owned by the municipal authority. It was classed, in the Electricity Scheme prepared by the Board, as a selected station. The Blankborough load has a maximum demand, in winter, of 20,000 kW. To supply this, there were installed in the power station three turbo-alternators, two rated at 7,500 kW., and one recent addition at 15,000 kW. The total plant was thus of 30,000 kW. capacity. At peak load time, the 15 MW. set and one of the 7.5's would be needed, giving 22.5 MW. of plant for 20 MW. of load. There would be 7.5 MW. of plant standing by in case of breakdown of either of the running sets. This would be idle capital, and since no chief engineer would allow his load to grow to such proportions that all his plant *had* to run at peak time to supply the demand, it follows that all over the country, in towns like Blankborough, there was idle plant, simply there in case of emergency. Even the simplest and smallest public supply could not be given without two sets for a load which only required one, in order to duplicate sources of supply against the failure of one of them, and also to permit maintenance to be carried out. The same reasoning, of course, applied to boilers, and to much other auxiliary plant.

If, however, in the next town, say, ten miles away, there was installed similar plant, of which a proportion also lay idle for the greater part of its life, one can see at once that an interconnecting cable between the two towns would enable the Blankborough spare plant to act as standby for the possibility of breakdown not only in its own undertaking, but in that of its neighbour, via the cable.

Reduction in Standby Plant

Instead of two idle machines, there need only be one. The remaining generator would be liberated for commercial use. In addition to gaining this advantage, the periods of light load, as in the middle of the night, could be supplied by using only one machine in one of the two stations, and since the efficiency of a set is higher (in general), the greater the load, it follows that this one machine, running perhaps nearly fully loaded, and supplying the other town through the cable, as well as its own load, would be running more efficiently than would be the case if two lightly-loaded sets were used.

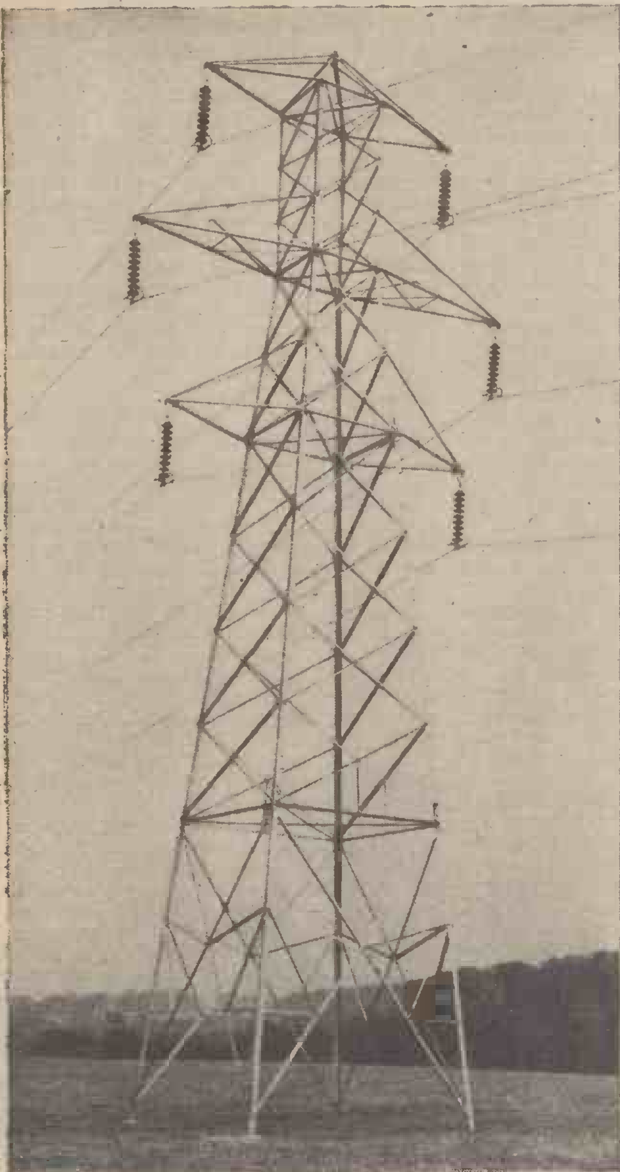
This reduction in standby plant, and the better utilisation of the plant as a whole, are two of the most important economies which the Grid has effected. As—with certain relatively unimportant exceptions—the whole of the generating plant of the country is connected together, it stands to reason that the standby plant can be reduced to a minimum, since a machine can act as standby for any other machine on its Grid ring, or on other rings, if the interconnectors are loaded suitably.

In order to give some slight further consideration of the methods by which the Grid ensures that the generation of all the electrical energy needed by the whole country at any instant is being generated only by the most efficient operators, let us return to Blankborough's power station.

The efficiency of the power station at Blankborough would be governed, in pre-Grid days, by the design of the plant, and by the skill and care of those who supervised its operation. It is possible to visualise that plant might be purchased which, for reasons of price, or for other considerations, is not of the most efficient kind. And ageing, with consequent loss of efficiency, especially by comparison with more modern designs, is a common factor. Again, individual skill and methods of operation vary. So one can easily imagine that there were wide variations in the over-all efficiencies with which power stations produced their final product. In pre-Grid days, Blankborough, we will suggest, was of an average figure in the efficiency

An essential part of every electricity supply scheme is the transformer, which enables economical high-voltage transmission lines to carry large blocks of power for great distances. This example is a 30,000 kVA. 132/33 kW. transformer, loaded for road transport to site.

(Photo by courtesy of the English Electric Company.)



HOW THE POWER IS TRANSMITTED. A 132,000-volt grid line, with two three-phase circuits.
(Photo by courtesy of British Insulated Cables, Ltd.)

ladder, and it was thus chosen as a selected station. The Grid was constructed in 1929–30–31, and by some date, say in 1931, the scheme was sufficiently advanced to go into commercial operation in the district to which Blankborough belonged.

From that date, the chief engineer at Blankborough was no longer the sole person who determined when his power station should run and what power it should generate. In fact, he lost a very great deal of his control.

Centralised Control

In the centre of each of the eight Grid areas is a control room. From it radiate private telephone channels to each of the power stations in the area. The control engineers, who are always on duty, know at any moment the total load on every undertaking on their system. It is their duty to arrange that sufficient generating plant, at whatever station it may be situated, is steaming to supply that load. When they anticipate a rise in load, they telephone the next most efficient station to those already running, and ask them to have, say, 10,000 kW. of plant ready to be on load in two hours. As the load drops off, they arrange to shut down set after set, one here and one there, until only the most efficient machines are left running, and those machines will be reasonably fully loaded. They will carry the whole of the district's night load.

The chief engineer at Blankborough, then, does not control the running of his plant. But he still owns it—or is the representative of the corporation, who are the real owners—and he still retains control over its efficient running. If it fails to be efficient, it will seldom be called on to run. He still engages and controls the staff, and he still is responsible for maintenance.

How is the load of Blankborough itself supplied?

The usual interconnection between a power station and the Grid takes the form of a grid transforming station, perhaps situated some little distance from the power station, where the standard grid voltage of 132,000 volts is transformed down, on duplicate transformers, to 11,000 volts, which is the main busbar distribution voltage at Blankborough. Cables operating at this voltage are laid between the Grid and the power station busbars. Into these busbars is fed the output of all the generators in the station, and from them also are taken the many feeds to the different parts of the town.

A Day's Cycle

Imagine a day's cycle, in winter, starting at midnight. The load is about 5,000 kW. The power station, not being one of the highly efficient kind which will be run by the Grid authorities for 24 hours a day, is, at this time, shut down. The busbars are supplied, via the cables from the Grid, from any of the most efficient stations which the Board have selected, on this particular night, to generate the area's night load. The nearest might be fifty miles away, the next sixty.

During the night, the load remains steady until about six in the morning, when it begins to rise. This rise, which has been forecast by the Grid control engineers, is met by the addition of more efficient plant in another of the distant "base-load" stations. A similar rise will be going on all over the country, and the Grid authorities will be arranging a programme of generating plant to be started up.

The Blankborough shift engineer has been informed, the night before, that he will be required to have 22,500 kW. "on the bars," that is, switched in and ready to deliver full load, by 7.45 a.m. This means that at about half-past six he makes preparations to start up his 15 MW. and his 7.5 MW. generators. The boilers, which have been banked all night, are brought to full pressure. At about 7 o'clock he runs up both sets, and a few minutes before the appointed time he rings control and informs them that he is ready. They ask him to put his plant on load, and he does this by synchronising both sets on to the busbars.

All this time the Blankborough load has been rapidly rising. But the Blankborough shift engineer pays very little attention to this fact, which would at one time have been his most vital and immediate concern. At the time when he switched in his sets, the Blankborough load may perhaps have been 18,000 kW. All this would have been, up to that moment, imported from the Grid, and thus flowing inwards down the interconnecting cable. Assuming he causes his sets to deliver full load at once, which is not generally quite true, the balance at once changes from import to export. He is delivering 22,500 kW. into the station busbars, and his own load absorbs 18,000, so he exports 4,500 kW.

This is going into the general Grid pool, to supply those undertakings whose generation equipment is either so inefficient that it is seldom run, or to those who have no generation department at all.

The Blankborough load rises, until at some time exact balance may be reached, in which there is no inward or outward flow at all. But this is no concern of the Blankborough engineer. It is determined by the C.E.B. Control. If the Blankborough load still further rises, then the flow is again inward, from the Grid.

At midday, the whole area load drops, and it may be that the C.E.B. anticipate that it will not rise to a figure high enough after lunch to justify as much plant being kept steaming. They may therefore ring Blankborough and tell them to shut down their 15 MW. machine at one o'clock. At this hour, then, the slight export from Blankborough may swing round to a fair-sized import from the Grid. During the afternoon the 15,000 kW. set will be kept warmed up, as it is actually being used as part of the standby plant for the whole Grid, but if the load does not exceed the anticipated figure forecast by the Grid engineers, it will not be needed again that day. At perhaps seven o'clock in the evening, the 7.5 MW. set will be shut down, and Blankborough will revert to total import.

The Grid scheme is constructed in a number of rings. From Blankborough Grid sub-station there will radiate a feeder to the north, and a feeder to the south, so that if one of them fails, there is always a supply available over the other. In many cases there are four or five Grid feeders radiating from one switching point, so that the various rings and the different areas into which the Grid is divided may interchange load.

Duplicated Supplies

Before the Grid, Blankborough had to rely entirely on its own power station. A simultaneous breakdown on two large machines, or a fire in the boiler house, or a busbar fault, would put out the whole of Blankborough's lights, perhaps for days or even weeks. Now, it has at least three sources of supply—its own plant, and the two Grid feeders. Many towns take supply from the Grid at two separate points, so that the final bottleneck, the common busbars at Blankborough power station, are no longer liable, in the remote event of their failure, to shut down the whole town. Failure of supply, except for a few moments, become virtually impossible with these arrangements. In wartime, this facility has obviously been invaluable. Throughout the most severe blitzes, electricity supply from the various central stations has seldom ceased for more than a few hours.

To transmit the large amounts of power over the vast distances involved, the Grid needs to use as high a voltage as possible, and 132,000 volts is the standard. The three-phase 50-cycle system is carried over the countryside on steel pylons, and at the end of 1944 there were 5,142 miles of these transmission lines, of which 3,614 operated at 132,000 volts. They connected together 348 switching and transforming stations, with an aggregate transformer capacity of 13,422,750 kVA. Up and down the country there were a total of 142 selected stations, with a total installed generating capacity of 10,984,656 kW. These figures are taken from the Board's seventeenth annual report, for 1944.

Control of Distribution

Turning now to the question "What amount of public control exists over the electricity supply in my town?," if it is a municipality the electricity department of the corporation are in direct control of the *distribution* of electricity. But if it is a company, then the distribution is in private hands. Both the corporation and the company are subject to the general supervision of the Electricity Commissioners, and their control grows tighter from time to time. They will not permit excessive rates of tariff, and they do not allow non-standard voltages to be used on new extensions. They inquire into the causes of breakdowns. They call for records of every possible technical detail to be sent to them at regular intervals.

But neither the municipality nor the company can control the price of the current as they receive it from the C.E.B. The "Grid tariff" is a figure based on the over-all cost of the generation of the whole of the units required in a district, by the most efficient plant only, with the Board's transmission and management costs added. The Board do not, of course, make a profit. The cost of generation at each station is paid by the C.E.B., subject to many safeguarding financial clauses of great complexity.

Rationalisation

And that is as far as Acts of Parliament have so far succeeded in rationalising the vital industry concerned with electric supply. When the current is received at Blankborough, the Board no longer have any control as to its distribution. They control, so to speak, the wholesaling of the product, and the retailing is left to each individual retailer to arrange and manage. He is subject to overriding supervision by the Electricity Commissioners.

Your electricity department has been relieved, through the operation of the Grid, of one worry. If you, as a manufacturer, decide to establish a factory in Blankborough, which will require 5,000 kW., in pre-Grid days one of the factors which might have influenced you against building your works in a particular area, such as Blankborough, was that the power station could not, with its existing plant, supply the whole of your load, especially at the time of its own peak. You would have had to wait for an extension to be built. This the corporation might be unwilling to do, as they might not feel justified in incurring the large expenditure necessary, to supply your factory alone.

Nowadays, all that is needed is for the chief engineer at Blankborough to write to the Board, and the (relatively small) additional load can be supplied straight away, from the Grid. This increase, with many others, is taken into account when the Board and the Commissioners plan the extensions they propose to ask the various undertakings to install in their generating stations during the coming years.

Differing Tariffs

The final question as to why your electricity costs more than does that of your friend in the next town is answered when we realise that no two distribution areas are alike. They both receive the energy at the same price, from the Grid, but one has a large rural area where there are miles of expensive overhead line between small hamlets with only a farm, a public house, and 10 cottages connected to the supply, and yielding only a revenue insufficient to maintain the lines and pay the capital charges. This town may have two tariffs, one for the expensive outer area, and a cheaper one for the urban consumer. But its total expenditure per unit sold may be high, and so its tariffs must be high. The chief engineer may have been left by his predecessors in a position where to extend meant a definite scrapping of a large number of non-standard mains and transformers, and the capital charges on the new gear have to be met.

Another town, by comparison, may have a small outer area, and a densely populated centre, with large factory loads at close intervals, each mile of cable, and each step-down transformer, earns a large return. It is thus enabled to distribute electricity cheaply, and the tariffs are correspondingly lower.

Many engineers envisage a National Distribution Board, to embrace the present Grid organisation, and also the whole of the distribution undertakings, on the lines of the Post Office. A uniform national electricity tariff, or tariffs, could then be promulgated.

The 1914-18 war laid the foundations of the national organisation of the electricity supply industry; it will be interesting to see the changes that come at the conclusion of the present conflict.

Clock Repairing and Adjusting—2

Striking Trains : Chiming Controls, and Calendar Mechanism

By WILLIAM G. PIKE, F.B.H.I.(Lond.)

(*Continued from page 230, April issue*)

FIG. 6 is an illustration of an Enfield 14-day hour and half-hour strike. A strike is the name used to distinguish a timepiece from a clock. In a strike, apart from all the extra mechanisms there is an extra train of wheels. This extra train is complete with its own motive power, except in the case of 30-hour English long cased clocks, where one weight drives both the timekeeping and striking trains.

At the end of the striking train, and positioned farthest from the mainspring, is a speed governor. This consists of an arbor with pinion attached, and upon the arbor are mounted two blades. These blades are held friction tight upon the arbor by a small spring. This governor, which is really an air-brake, is called a "fly." Some of these have centrifugal vanes which allow an outward movement as the speed increases; in this way some compensation is made for change of speed and load. In large and powerful clocks the "fly" is fitted with two adjustable blades mounted on a bar. To obtain the correct running speed these blades are turned inward or outward as desired. In Fig. 6 the "fly" is visible at top left of movement.

The number of wheels between the great wheel and the "fly" varies with different types of clock. In a 30-hour American clock there are only two; in eight-day English and other types there are three; in eight-day French and other Continental types there are four.

The fourth wheel is an extra train wheel. Clocks designed to go for a month or longer have additional wheels. The wheels of the striking train are called respectively warning wheel (next to the "fly"), intermediate

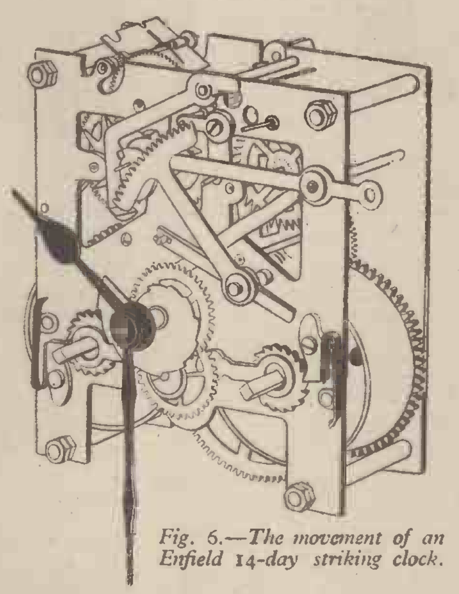


Fig. 6.—The movement of an Enfield 14-day striking clock.

wheel, and pin wheel. The warning wheel, as its name implies, allows the clock to warn about five minutes before striking; in other words, the striking train is partially released to allow the rack to fall to its correct position in readiness for gathering-up at the hour.

Gathering Pallet Wheel

The gathering pallet wheel has an extended arbor which carries the gathering pallet, which is a single curved tooth; when it revolves it gathers up the rack and finally arrests the striking. Fig. 7 shows three kinds of gathering pallet. In clocks which do not use the rack control there is no gathering pallet. This wheel, however, is still used to arrest the striking; in some clocks the wheel is fitted with a pin, in others a slotted disc is fitted to the arbor. The striking wheel is fitted with a number of short steel pins at right-angles to the plane of the wheel. These pins lift the striking lever which is either coupled to or attached direct to the hammer.

Both the striking and chiming of a clock has to be controlled, or else once it is set in motion it will continue until its particular mainspring has run itself down. This control can be divided into two groups; the two kinds are referred to as locking plate or rack striking. Locking plate striking is the earlier of the two, but both kinds are still widely used to-day. Modern chiming clocks utilise both locking plate and rack; the locking plate is used to control the chiming train and the rack is used to control the hour striking train.

As its name implies the locking plate is a circular plate or disc. Usually it is mounted on an elongated arbor of one of the wheels of the train, but quite often free to rotate on a fixed stud attached to the front or back plate. When mounted on a stud the locking plate has a toothed wheel fitted to the underside and is driven by a pinion attached to an elongated wheel arbor. To understand the action of the locking plate it is necessary to mention the locking arm which actually arrests the train. To control the hour striking of a clock the edge of the locking plate is divided into eleven slots, each slot being placed a

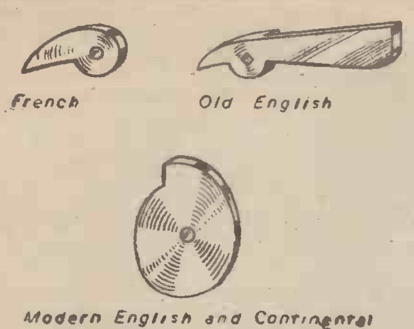


Fig. 7.—Three types of gathering pallet.

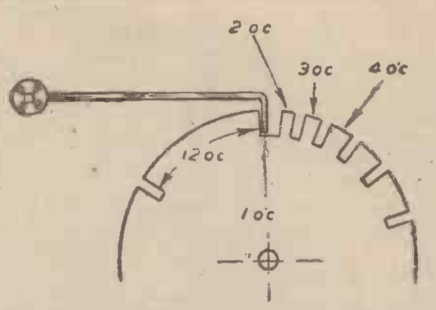


Fig. 8.—Locking plate and locking arm. The slot for 1 o'clock is about twice the size of the other slots.

little farther from the last. The eleven steps are therefore all of different length, the largest representing 12 o'clock, the next 11 o'clock and so on until 1 o'clock. This last position on the plate merely consists of an extra large slot, there being no step. Whilst the locking arm is resting on a step of the locking plate the train of wheels is free to run, but immediately the locking arm drops into one of the slots it arrests the train. A locking plate and locking arm are shown in Fig. 8.

Rack Chiming Control

Rack control is used occasionally for chiming as well as hour striking. The rack consists of a toothed segment usually pivoted on the front plate and held in position by a small spring called the rack tail spring. An hour rack has 12 teeth but a chiming or quarter rack only four. The toothed part of the rack is positioned just below the gathering pallet, and the number of teeth to be gathered up determines the number of strokes by the hammer. The number of teeth to be gathered up is determined by the distance the rack is allowed to fall before the rack tail comes into contact with the snail. The snail is the cam-shaped disc attached to the hour wheel. The snail has 12 steps, one for each hour. The lowest step represents 12 o'clock. In some high-class clocks the snail is not attached to the hour wheel, but is mounted upon a separate stud; it then has a 12-pointed star fixed to it and is referred to as the star wheel. The snail and rack are clearly illustrated in Fig. 6.

Rack Hook

Pivoted upon a stud just above the toothed part of the rack is the rack hook. This hook engages the teeth and prevents the rack from falling backwards as the gathering pallet gathers it up. The lifting piece is an important part of the striking mechanism, as this lever, which actually releases the striking or chiming train, is in direct contact with the hand mechanism. This two-armed lever lifts the rack hook, allows the rack to fall to its required position and by means of a small tongue arrests the warning wheel until the time for release. The lower arm of the lifting piece is raised by the cannon pinion or minute wheel. In some clocks the cannon pinion is fitted with one or more short pins, in others a two- or four-pointed star is fixed to the back of the cannon pinion. In English clocks one or more short pins is fitted to the minute wheel.

Chime Barrel

In Continental chiming clocks, which utilise the locking plate for control of the chiming train, an extra lever is provided for the release of the hour. This lever is called the hour warning lever. In English clocks there is no extra lever. When the quarter rack falls it comes into contact with and raises the hour warning lever which releases the rack hook. The chime barrel is usually similar to the cylinder of a musical box—a brass drum into which a number of short steel pins have been driven which in turning lift the various hammers. Modern chime barrels are often built up with a number of discs, spaced about ¼in. apart. In this type the pins are placed at right angles to the plane of the discs. In old English clocks the chime barrel, which is, of course, driven by the chime train of wheels, is placed within the main plates. Most modern chime clocks have a separate housing for the chime barrel fixed below the movement or attached to the back of the back plate. The barrel is driven by three external wheels shown in Fig. 9.

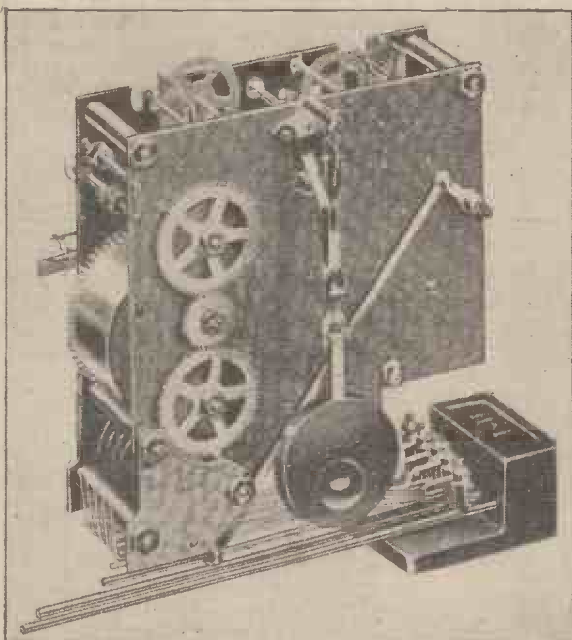


Fig. 9.—Movement of a modern chime clock.

Modern Chime Clocks

Antique English chime clocks have an hour striking hammer mounted near the hour striking train of wheels, and a separate bell or gong, but modern chime clocks use several of the chime hammers to strike the hour. Of the five-rod gongs fitted, four are for the quarters and one for the hour. The striking lever has a long pin at one end which lifts the three hammers striking the three lowest notes, thereby giving a chord instead of a single note. Practically every chime clock is now fitted with self-correcting chime mechanism which automatically corrects the chimes should they get out of correct sequence in relation to the hands. This consists of an extra cam and locking lever which is operated by the longest finger of the lifting star. (The mechanism will be more fully described in a later article.) A friction tight "chime-silent" lever is usually screwed to the front plate. When depressed this lever lifts the lifting piece and arrests the warning wheel.

Calendar Mechanism

Many antique clocks have calendar mechanism. Some are very simple and consist only of a thin toothed wheel rotating upon a stud at the back of the dial. Called the "day of month" wheel it has 60 teeth and a pin in the hour wheel moves it forward once every twelve hours. An alternate style is a flat metal ring about 6in. in diameter. Fig. 10 shows two kinds of calendar wheel. When a moon dial is fitted the clock dial is semicircular in shape at the top to permit this extra dial. A clock dial of this shape is called an arch dial. The most common method of operation is by means of a long arm with spring-controlled pawl lifted by the same pin that moves the day of month wheel. Many of the more antique clocks have very elaborate calendar work, alarm mechanism or tune-playing devices.

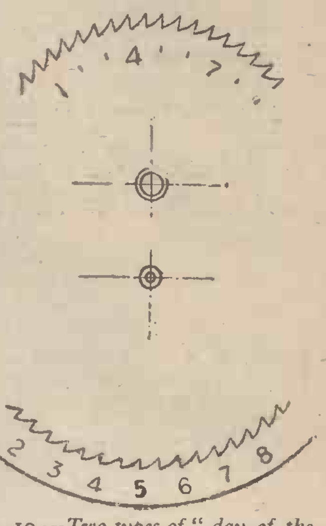


Fig. 10.—Two types of "day of the month" wheel. Each wheel has 60 teeth—2 teeth per day.

Although the following articles will deal with the repair of these mechanisms, close study of the clock before dismantling the movement will help to simplify any repair.

(*To be continued.*)

For Yachtsmen

A NEW invention, concerning which a patent in this country has recently been applied for, is of special interest to yachtsmen.

The object of this invention is to construct a yacht which is suitable for, or which combines pleasure cruising and racing.

It appears that when a sailing yacht is to be fitted so as to enable it also to be power driven, the necessary power unit or engine and the fuel tank are located in the cabin space. Such an arrangement considerably reduces the room available and likewise renders it unpleasant because of the fumes from the engine. This naturally does not add to the amenities of the vessel.

Hollow Keel

To obviate these disadvantages is the aim of the device in question. In this case the engine and the fuel tank and other accessories are placed in the keel or fin of the yacht.

The keel is made hollow so as to receive a power unit such as an internal combustion engine.

Diamonds from the Gold Coast

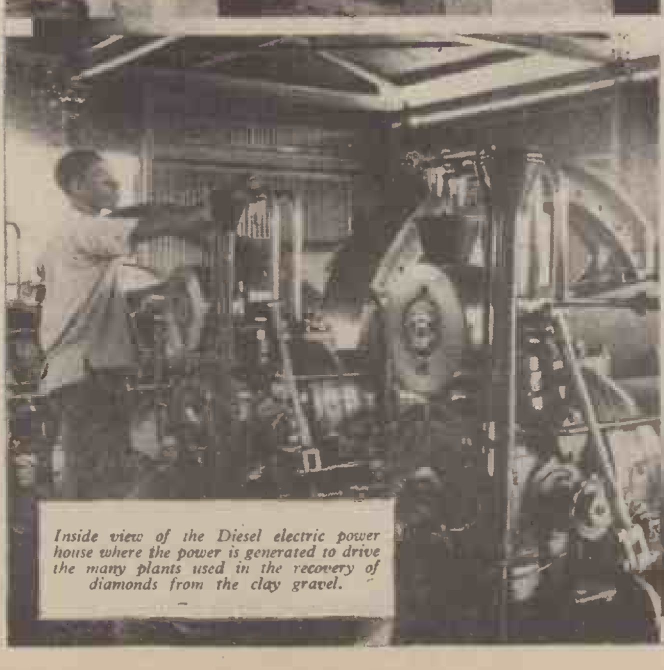
On the cutting edge of thousands of tools in British war factories there would be found a diamond from the Gold Coast, one of the four British Colonies in West Africa. Though the Gold Coast is better known for its cocoa and its gold (not forgetting its soldiers) diamonds were already becoming an important element in the country's economy before the war. Large deposits were located in 1919, and their exploitation began the following year. The stones obtained are small, and, although the total output to the end of March, 1937, was well over 11 million carats, the largest stone weighed less than three carats.

After the waste material has been removed from the diamonds they are weighed again by a European expert.

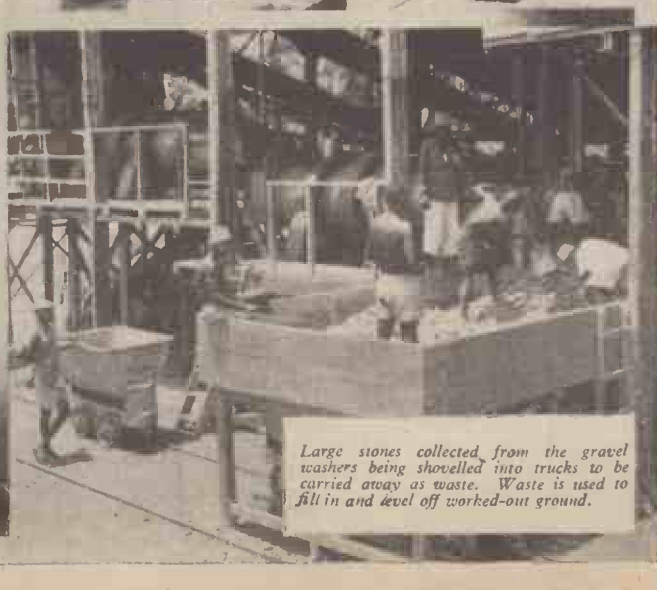
The grease table. The jig concentrates pass over this shaking grease-coated table assisted by flowing water. The diamonds have an affinity for grease and stick, whilst other minerals are carried along to the overflow.

Diamond-bearing clay gravel being tipped into the bottom of the conveyor belt at the recovery plant. On arrival at the top of the belt the clay gravel will receive a preliminary wash.

From the classification trommel the sizes pan concentrates are then passed to the jig house shown in this picture. Here the pan concentrates are subjected to up and down oscillations in water. The diamonds and other heavy minerals settle to the bottom.



Inside view of the Diesel electric power house where the power is generated to drive the many plants used in the recovery of diamonds from the clay gravel.



Large stones collected from the gravel washers being shovelled into trucks to be carried away as waste. Waste is used to fill in and level off worked-out ground.

The Food of the Future

Synthetic Nourishment: Its Pros, Cons, and Possibilities

SINCE the first beginnings of things Mankind (to say nothing of animalkind) has supported its existence on the products of the plant and the animal kingdoms. No creature can sustain life and activity for any length of time without an adequate supply of food, for food is to the animal body what fuel is to the power-producing machine, and it is for this reason that every living entity has to prey continually on other life forms in order to support its own individual existence.

But food is fickle. It has ever been so. One of its characteristics is to present itself

A well-known protein-gelatine, which is here seen swelling under water previous to its solution. It is the formidable problem of protein synthesis which bars the way to any big advance in the creation of artificial food.

to the world in alternate gluts and scarcities. It has never been easy to obtain. Often enough it is difficult to prepare. Most of its sources are wasteful. Many of them demand an enormous amount of labour for the production of a relatively small quantity of consumable material, and even with all its modern resources of production, transport, distribution and preservation, our present civilisation, after the scourge of a protracted war, finds itself faced with a probable severe shortage of many essential and semi-essential foodstuffs.

Good food is not only necessary for the effective and pleasurable sustenance of life, but it is also a source of much mental satisfaction to the healthy individual. Yet, philosophically considered, our present system of feeding is a most unsatisfactory business. If we take too great a quantity of food —good or otherwise—we let ourselves in, sooner or later, for a hundred and one ills of the body. If we do not consume food sufficient in quantity and of a minimum standard of quality we also attract all sorts of diseases to ourselves. We cannot store food very adequately because after prolonged storage the majority of foodstuffs not only lose their palatability, but usually deteriorate badly even if they do not become actually uneatable. There exist at the present day, for instance, samples of dried soups and of canned meat which are well over a hundred years old and are in fairly good condition. Probably they might be consumed without ill effects, but a diet of such material would have but little nutritional result.

The inherent unsatisfactoriness of the food position has give rise in many minds to thoughts regarding the ultimate possibility of our casting off completely our present utter dependence on Dame Nature and her queer and fickle ways for our food supplies and replacing her nutritional products

A liquid-air container for the experimental super-cooling of preserved foods.

with digestible materials of a purely synthetic origin.

Food from Carbon

Will such a state of affairs ever come about? one may ask. Will mankind ever be able to exist (and exist pleasantly and pleasurably, for that is a very essential condition of the contract) upon foods which have never seen a plant, a vegetable, or an animal, but which have been chemically created from a handful of elementary materials such as carbon, hydrogen, oxygen, nitrogen, together with traces of essential auxiliary materials like sodium, iron, chlorine, phosphorus, manganese, iodine, and sulphur?

That is the question, and, for us at our present stage of civilisation, it is a basic question which is impossible to answer.

It would, indeed, take a clever chemist or other scientist to imitate the succulent deliciousness of roast chicken and fresh green peas, or to create a gustatory rival to a juicy beefsteak. In fact, we may say that any such idealistic achievement would be well-nigh impossible.

The chemist, if he is going to strike out for human independence in this matter of foodstuffs must take the path leading to the discovery or creation of new nutritional materials, of novel types of food. He must not endeavour to imitate the old ones, for Nature's products are not usually imitable, although they may frequently be surpassed.

Of recent years our knowledge of foods and of nutrition has been very considerably advanced in consequence of the large amount of attention which has been paid to the subject. We know not only more about the chemical composition of foods than we ever did before, but we have also gained a good insight into the many mysteries concerning the fate of foods within our bodies. Then again, chemical science has also worked out much of the mechanism of those strange yet essential nutritional aids to which we have given the name "vitamins."

Vitamins, however, are not foods. They are only chemical aids to physical and mental well-being, and thus, although we can synthesise or create artificially on the manufacturing scale the very vitamins upon which our bodies seem so greatly to depend, this modern feat cannot be classed as one of actual food synthesis.

The modern age has witnessed the rise of the so-called food manufacturing industries, so called because, with one or two excep-

An analytical laboratory in which foodstuffs are tested.

tions, these commercial enterprises do *not* manufacture food. They merely cook, preserve, or otherwise prepare it. The actual manufacturers of our foodstuffs are still the members of the animal and the vegetable kingdoms.

Living Food-machine

Our friend the pig is about the most efficient food manufacturer we have. A pig is a machine which converts a miscellaneous assortment of scrap products into wholesome food. But, even so, the pig only returns to us as usable, consumable food about one-sixth of the material which it feeds on. The rest goes to waste.

The cow, however, is a much less efficient food-manufacturing machine than the pig. Although a growing calf may give in food about a twelfth of the material which it has eaten, its parent, the cow, only returns about 1 part in 30, whilst the common sheep is an even worse performer in this matter of food manufacture.

The hen, when in good condition, returns in the form of eggs about 1 part in 20 of its food intake, so that although an egg may be full of nourishment, it is, at the best, a rather expensive form of nourishment.

In the matter of milk production, a good dairy cow returns as milk about a sixth of the food which she ingests. Here, her efficiency as a food producer compares with that of the pig, but, from the viewpoint of pure economics the performance of either cannot be said to be in any way exalted.

Why cannot we cut adrift from the cow and manufacture milk in our own factories? After all, milk is, for the most part, a natural emulsion of fats in water containing a soluble form of calcium phosphate, some sugar, a quantity of protein matter, and a few other odds and ends.

There would be no difficulty in manufacturing an emulsion of the fats—provided that we could make the said fats in the first place—and we could procure calcium phosphate by the ton from our mineral resources. The trouble mainly concerns the proteins which milk contains, the casein material which is so essential to the nutritive properties of the milk. Unfortunately, these protein materials are all very complex in make-up, so much so that the chemist has, as yet, been unable to determine their composition.

The Problem of the Proteins

The complete elucidation of the long-standing problem of the proteins must be brought about before we can even hope to commence the artificial manufacture of milk. Apart from the fact that proteins contain nitrogen, and that they are seemingly composed of long chains and other molecular complexes of atomic groupings known as "amino-acids," we know little about the constitution of these very vital and necessary proteins. Serious scientific thinkers have at times expressed the opinion that it will take a hundred years or more of concentrated research to ferret out the true nature of even a small number of the natural proteins, to say nothing of working out methods of creating them artificially from simple basic materials. Hence it would seem likely that the present generation will not be able to feed itself on cowless milk, although it may continue to have its dried, canned and concentrated natural milks galore.

The protein difficulty at once rears itself whenever we begin to contemplate the synthesis of any natural food material of animal origin. Take the contents of an egg, for example. Much of it is composed of egg-white, or albumen. Now, this stuff, at first sight, appears to be simple enough. In reality, however, it is anything but simple. It is probably a complex mixture of different varieties of albumen. All albuminous materials are to be included in the protein class and, as such, are exceedingly complicated in chemical make-up. One doubts whether even trained researchers have yet dared to make an accurate guess of the intrinsic nature of the egg-white material which we call "albumen." The subject is, as yet, far too complicated. Chemistry is, at present, in the amino-acid or the unit stage of protein investigation. Chemists can string together several hundreds of these nitrogen-containing amino-acid units and form something like a simple artificial protein, but there the matter ends at present. Not until we can get over this formidable difficulty of protein investigation can we even hope to make artificially any human foodstuff pertaining to the nature of an animal product.

Nature's food supply—an English-grown cereal.

Carbohydrate Chemistry

In the opposite realm of the carbohydrates, chemistry has had much more success. The carbohydrates, as their name implies, are compounds of carbon, hydrogen and oxygen only. They are Nature's "three element" compounds, the majority of them being produced for us by the plant or vegetable kingdom. Cellulose, starch and sugar are typical carbohydrate compounds. Cellulose (wood pulp or paper, for instance) may be chemically treated by certain methods and changed into starch. Starch, in its turn may, without much difficulty, be converted into dextrose or glucose, which is a simple and very useful sugar. Thus it is true to say that sugar may be made from sawdust. Indeed, the Germans resorted to this process during the first great war, and, for all we know, they may have continued the process during the European war just ended.

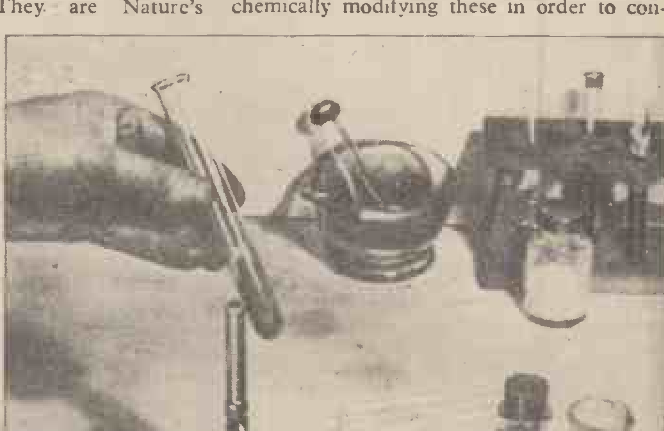
Although we can break down the very complex cellulose into the relatively simple sugars which we need for our nutriment, we cannot, as yet, proceed the other way and convert sugar into cellulose. Not, of course, that we have any actual need for so doing, but such chemical ability would give us a greater insight into the carbohydrate compounds and enable us to make or break them as we desired.

Sucrose Synthesised

Very recently, the laboratory-scale synthesis of sucrose, or cane sugar, has been announced. It is a crowning feat of many years of endeavour. To be able to manufacture sugar on the large scale (as distinct from merely extracting it from beet pulp or some other natural source) would result in the world being once and for all independent of all natural supplies, both in peace and in war time. The basic materials of sugar production are simple enough—carbon, oxygen and hydrogen. They are available in unlimited amounts. What we have to do, therefore, in this particular matter, is to revise and improve our theoretical and laboratory methods and to apply them to mass-scale production. The task is difficult enough, without a doubt, but it is one which will probably be solved in our lifetimes. If, therefore, such a feat could be achieved, one branch of synthetic foodstuff would be made secure. We should probably build up our sugars from carbon dioxide (carbonic acid gas) of which enormous amounts are produced daily among the world's industries.

Fats and oils come next. They are essential to us in one form or another and, at present, we derive them all from natural sources. With these materials, the difficulty of chemical synthesis is at a minimum. Many methods of artificially creating fats and fat-like substances are already known. The trouble is that natural fats and oils are very much cheaper than any present-day synthetic ones could hope to be. Which fact forces on us the conclusion that no matter how successful from a theoretical or even a practical point a synthetic food production method may be, if the process is not an economic one it will be, commercially speaking, useless.

At the present time, therefore, we content ourselves with collecting oils and greases from whales and from other sources, and in chemically modifying these in order to con-



Will inventions of the test-tube ever yield an effective substitute for Nature's cereals?

vert them into margarine. Such processes, wholly effective though they may be, may be classed as examples of food modification, but they do not constitute syntheses from basic materials.

Tablet Foodstuffs

There was a theory prevalent in Germany at the time of the 1914-18 war that a man could exist in good health on a minimum amount of highly concentrated nutritional material. So the Germans gave their soldiers, not packages of bullybeef such as we supplied to our men, but compressed tablets of concentrated meat and other extracts. These tablet-foodstuffs were prepared and compounded with great chemical accuracy, but they failed signally in their aim, mainly on account of the fact that their instigators omitted to comply with one of Nature's pressing requirements, that of a reasonably full stomach.

We are, whether we like it or not, physiologically designed and constituted to require at intervals a filled stomach. Nature demands that our nutritional material must be taken in bulk, none the less than in quality. We must have our roughage, too, otherwise the system rapidly becomes clogged with digestible food which is surplus to its requirements and which it is unable to dispose of.

For the above reason, no possible plan of supplying small amounts of highly concentrated synthetic foods or nutritional elements to the body at intervals by means of pills, tablets, or injections will ever suffice the needs of man. The food must be available in bulk, and it must be material, also, which brings pleasure to the eater of it. A life eked out on food pills and food tablets would not contain much joy even under the best of conditions. That is why all attempts at real food synthesis must of necessity present the artificial foodstuff material to us in its natural form, and in its natural bulk. Otherwise, such material will stand no chance of success under conditions of free choice.

Eating Coke

Another line of food research which has been touched on in recent years is that of enabling the human body to deal with food materials for which it was not originally designed. We cannot digest cellulose or coke or carbon and many other miscellaneous materials. But if we *could* swallow a few ounces of crushed carbon, suitably flavoured, and derive from it added energy and well-being, there is little doubt that we would, at times, do so, despite our preference for something more palatable and appetising.

The question is: can we, by any means, change our bodily constitutions so that we might be able to deal digestively with normally unpromising materials? It is a difficult question to answer at the present time, for research into the mechanism of the human body is at present proceeding apace, and there is no knowing the eventual results which it may bring.

Grass is not reckoned to be a very appetising or particularly digestible material for humans, since we are not constituted to avail ourselves of its nutritive protein. Yet a year or two ago a scientific individual lived on grass for a prolonged time and apparently waxed healthy on his spartan diet. He even went so far as to undertake a walking tour to the North of England, his "fuel" being chopped grass, salted to taste, together with a little sugar (by way of carbohydrate ration) and water.

Glycerine and stearin constituents of fats. Both can be made artificially, but the natural products are cheaper.

The experiments, which were recorded in the scientific press, showed that the average healthy human body possesses powers of good ingestion which we are not ordinarily aware of. Further experiments are proceeding in such nutritional studies, yet, of course, we have by no means got to the stage of eating coke and of making a dietetic success of it! And almost certainly, we never shall do so.

The Economic Factor

The simpler types of foods, such as sugars, starches, milks, oils, fats, together with numerous true flavours and essences, we ought economically to be able to create artificially after the necessary chemical problems and difficulties have one by one been surmounted. With such materials, it seems, given the necessary technical knowledge, all is a matter of economics. If, for instance, you can only turn out a synthetic sugar or an artificial fat from your factory at two or three times the price of the natural product, then nobody is going to buy your material, even though it be identical with the natural substance.

Synthetic food, to be anything of a success, must be cheaper than food from natural sources. That fact, of course, at once raises another train of difficulties.

But regarding the chances of making synthetic apples and oranges, bananas and beefsteaks, chicken-flesh and cereals, they must be reckoned as almost infinitesimal. We may, very probably, be able, at some distant time, to create chemically the nutritional essences of such food forms, but to make these materials themselves with all their characteristics of taste and flavour and texture most probably requires a skill which will never be Man's. Without any doubt, the food of the future will be a distinct advance on our present-day material. Its elements, such as sugar, starch, and possibly even protein matter, will be turned out artificially in large amounts, but unless some revolutionary scientific achievement is brought about, our natural food forms, despite their disadvantages, their periodical gluts and scarcities, will still constitute the most sought-after fuel for the sustenance and the driving of Life's human engines.

High-power Short-circuit Testing—3

How the Various Values Given by the Electro-magnetic Oscillograph are Recorded

By S. STATON

(*Continued from page 299, June issue*)

Phase to Phase and Phase to Neutral Voltages

ALL records of these voltages are obtained from single phase voltage transformers, four in all being used. One is connected across the generator terminals to give the applied and recovery value of phase to phase test voltage. The other three voltage transformers are connected to the generator side of the circuit breaker under test, and give phase to neutral voltage, or in other words, the voltage across the contacts of each phase of the circuit breaker. Reference to Fig. 4 (June issue) will make this clear.

Phase Short Circuit Currents

The short circuit currents in the red, yellow and blue phases are measured by non-inductive oil immersed shunts in series with the main test circuit. Calibrated leads are taken from these shunts to the current elements of the electro-magnetic oscillograph, which thus carry only a very small portion of the actual short circuit current.

Phase Watts

The short circuit phase power is recorded by including wattmeter elements in the electro-magnetic oscillograph. The elements consist of field coils, which are fed from potential transformers, and vibrator strips, which are fed from non-inductive shunts.

Fluid Pressure

Fluid pressure is the pressure of the gas and oil in the circuit-breaker tank. It is recorded by fixing a special device on the circuit-breaker tank, which consists of a thin metal diaphragm coupled to the armature of an electro-magnet. The coil of the electro-magnet is connected to a bridge circuit, which is normally balanced. The diaphragm and electro-magnet are fastened on the side of the circuit-breaker tank so that the oil in the tank is in contact with the diaphragm. Any rise in the pressure of the oil will deflect the diaphragm, which will move the armature and so vary the inductance of the magnetic circuit. This variation will cause a corresponding variation in the current, and thus the bridge circuit becomes unbalanced. The unbalanced current is recorded by the corresponding element of the electro-magnetic oscillograph, thus giving an accurate proportioned measure of the fluid pressure. Fig. 6 shows the diagram of this type of recorder.

Contact Travel

The contact travel is the distance moved by the circuit-breaker contacts during operation. A record of this movement is obtained by mechanically coupling the contact carrying bar to the sliding portion of a variable resistance. This resistance is connected in series with the electro-magnetic oscillograph vibrator to a suitable D.C. supply. Any movement of the circuit-breaker contacts causes a corresponding movement of the resistance slider, giving consequent variations in the current, and thus the deflection of the oscillograph element.

Closing and Trip Coil Currents

The closing and trip coils of the circuit breaker are each connected in series with a suitable shunt to a D.C. supply. Calibrated leads are connected between these shunts and the oscillograph elements, thus giving a record of the two currents. The trip coil current record gives the instant at which current was passed through the coil, also the "opening" time and "total break time." Likewise, the closing coil current record gives the instant at which the coil is energised and the "making time."

Timing Wave

A 50-cycle timing wave is included in the film record to enable any of the above records to be timed, the time interval between the peak of each cycle being 0.02 second for 50-cycles per second. It is recorded by merely connecting a 50-cycle supply to the oscillograph element. The wave is reproduced on the film as the latter moves along, thus giving a horizontal time axis.

Cathode-ray Oscillograph

The cathode-ray oscillograph gives a continuous record of the following:

(1) Recovery voltage in red, yellow and blue phases of the circuit breaker under test.
(2) Arc voltage in each phase as above.
(3) High frequency transient restriking voltage, also in each phase of the circuit breaker.

It is usual for this instrument to be arranged to record three voltages on a film. The film dimensions are as before, but in this case it is moved along at a much greater speed; such that one cycle of the voltage waves recorded spread over the whole 36in. length of the film. The records are obtained by taking tappings off the main testing circuit through capacity voltage dividers to the elements of the cathode-ray oscillograph. These tappings are shown in Fig. 4. A 50-cycle timing wave is recorded on this film in exactly the same way as for the electromagnetic oscillograph record.

Restriking Voltage Indicator

The restriking voltage recorded by the cathode-ray oscillograph during the actual short circuit test of a circuit breaker may, or may not, be the same as the inherent voltage indicator with the test circuit dead. The reason for this is that the actual interruption of the arc current may react on the test circuit with the result of modifying the inherent restriking voltage. From the above it will be understood that whilst the restriking voltage indicator gives a measure of the test circuit severity, the latter may be altered during an actual test. The restriking voltage indicator is an entirely specially developed piece of apparatus, and the various manufacturers of switchgear employ different methods of measuring. The firm with which the author is connected use a restriking voltage indicator consisting of:

(1) Current surge generating circuit.
(2) Time scanner.
(3) Amplifier.
(4) Cathode-ray tube.

Tests are made with the test circuit dead, by injecting current surges at the circuit breaker terminals.

The principle of its operation, together with an abundance of data on the subject of restriking voltage, may be found in the Journal of the I.E.E., Vol. 80, page 460.

Control and Observation

All testing operations are controlled by a control relay, situated in the control house. The control relay consists of a motor-driven drum on which is mounted the necessary contact segments. These segments can be adjusted so that they make contact with their respective contact fingers at a set time in relation to one another, as the drum revolves. All connections for the controlling of the various testing operations are made to the segments and contact fingers, and thus control is automatic. The films for recording the oscillographs are driven by the motor which drives the drum, whilst the camera shutter is controlled by one of the drum segments, hence, synchronisation of testing operations with film motion and the camera shutter is ensured.

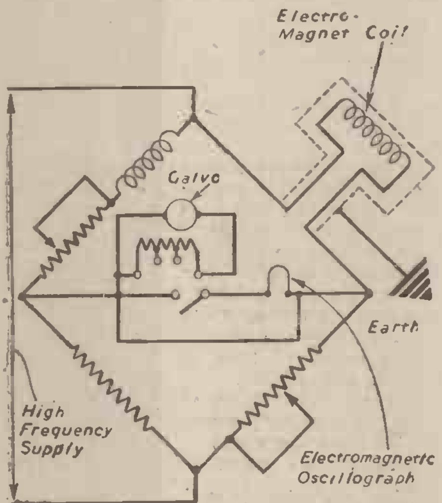


Fig. 6.—Circuit diagram for electromagnetic fluid pressure recorder.

It should be borne in mind that during testing operations, no persons are allowed in the generator house or the proximity of the testing cells for safety reasons. The control house is therefore situated at a secure distance from the testing cells and generator house. It is arranged to give full observation in security from the circuit breaker under test. The observation windows are along a corridor and face the testing cells and bays, all windows being fitted with armour plate glass. In addition to housing all control and recording apparatus, the control house usually includes the photographic dark rooms and printing equipment, also the station engineer's office and general office.

Advanced Observation Posts

It is often desirable for manufacturers' engineers to make closer observations of the circuit breaker under test than the general observation afforded by the control house windows. This is made possible by the provision of advanced concrete dugout posts situated about midway between the control house and test cells.

Facilities for Handling and Transport of Circuit Breakers

Circuit breakers are short-circuit tested inside heavy reinforced concrete test cells, and suitable equipment must be provided for handling and transporting them in and out of the latter. A small circuit breaker will weigh approximately 2 cwts., whilst a large one may well weigh up to 10 tons. Obviously the equipment must be capable and suitable to deal with the two extremes, and at the same time be simple and safe. It should be borne in mind that circuit breakers are costly apparatus, and their high voltage bushing insulators need special care and protection from any knocks, etc. The slightest knock is sufficient to cause complete failure of a bushing to withstand the high voltages for which it is designed and constructed.

These points in particular have to be taken into account when deciding the system of transporting and handling circuit breakers on the testing station.

The firm with which the author is connected, have a very good method of handling their circuit breakers for test. The testing station yard is laid out with a carefully planned set of standard 4in.-8½in. gauge railways lines, which are connected to the main line.

One of these yard railway tracks is laid into the end of the circuit breaker assembly bay, whilst off this line, branch lines are run to the repair and maintenance fitting shop of the station and the various test cells and bays. Low, flat-topped bogie trucks are used on these lines to run in and out of the various test cells, etc.

The bogie trucks consist of a ridged welded steel frame mounted on to the axles, on top of this frame are welded a number of standard rolled steel channels at suitable distances apart to form the top of the truck. A number of various size trucks are provided to carry from the smallest to the largest of circuit breakers.

Testing a Breaker

When a breaker is to be tested, it is lifted by the assembly bay crane and lowered on to a suitable truck as described above. It is then securely clamped to the truck top and wheeled to the testing cell, where the truck itself is chained to the floor, the connections can then be made to the circuit breaker for testing. If it is found necessary to carry out any repair work after certain tests, the circuit breaker can be readily wheeled to the maintenance fitting shop of the station; likewise, after testing operations are completed, the circuit breaker can be wheeled to the shipping bay and lifted off the truck.

The advantages of such a system are self explanatory, lifting by crane is cut to an absolute minimum, which, of course, cuts down the risk of damage in every way to a proportionate measure. No special heavy and costly lifting tackle is required in the testing cells, which otherwise would be awkward from the electrical clearance point of view. Damage to high voltage bushing is considerably reduced, since these are often damaged through being knocked by wire slings, etc.

In general, rapid and easy handling of the circuit breakers is effected, which is important when a large number of routine tests have to be carried out.

Oil Handling Equipment

The oil in a circuit breaker tank becomes very carbonised during short circuit testing, and it is, therefore, necessary that an adequate supply of clean transformer oil be available at any time it may be required. Suitable storage tanks are provided in a position well away from the testing cells, because of fire risk. A motor operated pump is used to pump the oil into the circuit breaker tank, the oil being carried through fixed pipes to a suitably located valve with respect to the test cells. From this fixed valve a flexible metallic hose is run to the circuit-breaker tank. The motor driving the pump is controlled by push buttons, giving "start," "stop," and "reverse" operation.

When the oil has become contaminated with carbon after test it is drained out of the circuit breaker tank into an underground tank. At various intervals, according to the demand, the contaminated oil is sucked out of the underground tank by an oil circulator and cleaner, and pumped back into the clean storage tanks ready for further use.

(To be continued)

What is Time?

A Discussion on this Ever-perplexing Problem

FOR once in a way, the reader beginning the perusal of this article may be pretty well assured that when he arrives at the end he will be very little wiser than he was at the commencement, since the subject with which it deals constitutes one of the most abstruse and gigantic problems which have ever presented themselves to the inquiring mind of man.

To call time a mere mystery is something akin to a gross understatement. Time, indeed, is practically the most colossal, the most perplexing, the most paradoxical, and the most inscrutable of the many first-rate conundrums which secret-loving Nature has to offer us.

If, throughout the entire gamut of Creation, there exists any greater and more completely perplexing natural mystery than that of Time it is, perhaps, the unutterably deep and fantastically complicated problem of the production of human consciousness, and of all that such a state implies through the agency of that strange chemical complex, the slimy, wobbly, jelly-like mass of material which we call the brain.

If consciousness is Creation's problem No. 1, Time comes almost certainly as No. 2 problem. And here it is interesting to note that Time, or, at least, its perception by us, has some connection with our higher consciousness. This is made clear by the fact that it is quite possible by means of drugs or by very carefully administered anæsthetics to so blunt the mechanism of consciousness that although that state may still persist, all perception of time or duration is abolished.

The same condition of affairs frequently reigns also (and can afterwards be recalled by an effort of memory) when we pass through that fleeting phase 'twixt waking and sleeping, that is to say, between normal consciousness and normal unconciousness.

A celestial clock. In addition to keeping accurate time, this clock (formerly in Weimar Museum), indicates the motions of the heavenly bodies and even predicts eclipses. It constitutes one of the most remarkable pieces of horological mechanism ever built.

By journeying into the depths of stardom we might be able to play strange tricks with time, or with its light records, as explained in this article. The above high-power telescopic view of a star-cloud region of the heavens enables us to realise in some measure the immensity of the regions through which we should have to travel.

Sensing Time

The perception of Time, therefore, the " sensation " as it were, which it causes us is concerned with our higher mental faculties and with those only. It is highly improbable that an oyster or an earthworm has any perception of Time because such creatures do not possess high mental faculties. A four-legged animal, a horse or a dog, for instance, may, on the other hand, have some sense of time or duration because in all such animals there are present the beginnings of the higher faculties which we ourselves enjoy.

The subject of our actual sensing or perception of time, however, gives us very little help when we begin to investigate scientifically the real nature of Time.

If we grasp a red-hot iron bar, the inevitable result in no way indicates to us the true nature of heat. It only informs us in a practical manner of one of heat's baneful effects. In the same way, if, being watchless, as many of us are in these wartime days, we manage to miss the last bus or train home at night, we experience an apparent effect of Time which, in our circumstances, is harmful, or, at least, inconvenient to us. We say that the Time has passed quickly or that it has flown, but any such statement really implies very little to the scientifically-minded inquirer, for it gives him no idea of the inner nature of the *thing* which has flown or of the precise manner of its assumed flight.

From considerations such as these there are many thinkers who have come to the conclusion that Time is merely one big illusion and that it has no real, genuine existence.

Such opinions, however, only beg the question, for have there not been philosophers who have, in their own minds, seriously come to the conclusion that everything external to us which we can grasp or appreciate with our senses is illusory, and devoid of true existence? So that merely to say that Time has no existence, that it is non-existent in a scientific or philosophical sense helps us little in our endeavours to ferret out clues to its real nature.

Time's Passing

We speak, as before mentioned, of the " passage of time " and of " time racing on," to say nothing of the familiar and hackneyed *tempus fugit*. Do all such expressions mean that Time has *dynamic* properties, i.e., those of movement? If so, time must be some *thing* because it is perfectly obvious that you cannot have movement without a *thing* to undertake the movement.

However, a small amount of reflection shows us at once that all statements concerning the so-called passage of time must be incorrect in just the same way as are our allusions to the passage of the sun across our daytime skies. Relatively speaking, the sun stands still; it is the earth which moves.

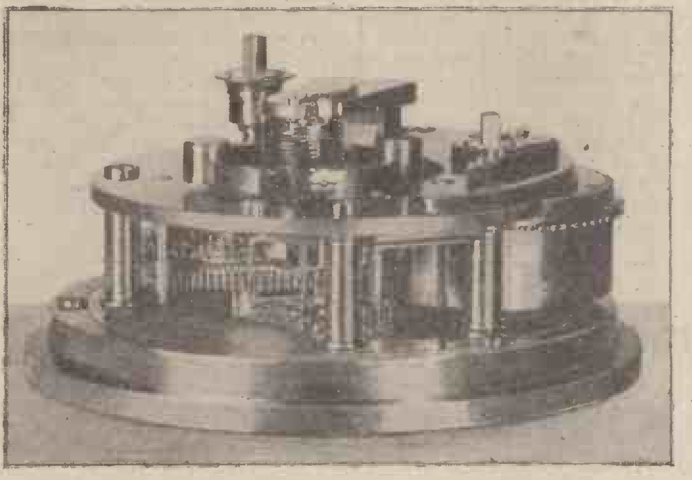
And, in precisely the same manner, too, in relation to the assumed " passage of time," it is we who move along Time or through Time and, in doing so, create for ourselves the common illusion of Time's passing by us.

Time, therefore, if it has any tangible existence apart from other things, must be *static* or stationary, not dynamic or endowed with movement. It is *we* who perforce do the moving.

Our next question regarding Time is this: has it any real existence apart from our consciousness or apart from our universe of material things?

Is it possible, for instance, for "empty time" to exist? That is to say, can we conceive, say, in some unfathomably remote area of stellar space far beyond the range of even our most powerful telescope, a region which is endowed with perpetual stillness, which is devoid of all forms of matter, energy or energy-radiations, a region desolate, void and utterly empty? Can such an area have any true existence in Time? Apparently it can, on first reflection, but when we consider the utter changelessness of this hypothetical region, many doubts must at once arise about Time's dwelling there, for Time and changelessness do not agree.

In many ways, therefore, it would seem that time is interrelated with or dependent upon matter and space because we cannot have a "timefulness" of *nothing*, for "nothing" implies non-existence. Hence we must associate Time with created things or entities, material or otherwise.



Man's more accurate time-measurer—the movement of a modern chronometer.

The Fourth Dimension

To many inquiring minds, it has seemed that Time is actually a dimension, and that it is a dimension along which we and all material things move at a regular pace. Think, for instance, of a solid object such as a bar of metal. Such an object obviously exists in three dimensions, for it has length, breadth and thickness. But the metal bar has another type of existence superadded to its lineal dimensions. It exists in Time, and this is so because we cannot by any stretch of the imagination conceive an *instantaneous* metal bar, one which has no duration at all.

On these reasonings, many scientific people have supposed that Time is a fourth dimension which is the attribute of all material things, for just as all objects must have length, breadth and thickness, so, also, must they have the added attribute or "dimension" of time if their existence is to be in any way apparent to us.

Time, therefore, for these thinkers, is an actual fourth dimension or path along which all things are impelled at an apparently fixed and unalterable rate.

There is, undoubtedly, some truth in this aspect of the time problem. Nevertheless, such notions fail completely to give us any real idea of the nature of this "time dimension" to which they refer. Length, breadth and thickness are all distance measurements. They are not material things or forms of energy or anything like that.

Time is Distance

And so, too, must be Time. It cannot be a form of energy. It cannot be even sub-material. Neither can it be a wave phenomenon. From our worldly point of view, we may define it as a distance measurement just as length, breadth and thickness are distance measurements, Time being the distance measurement between one event and another.

We cannot point to or even imagine a chunk of Time any more than we can conceive a lump of length or a barrelful of breadth. And when we are considering material things and the universe of creation, we cannot imagine a state which is lengthless, breadthless and depthless, for it is one of the properties of material things that they all possess these three linear dimensions or distances: length, breadth and thickness.

The material, physical world is manifestly one of continual change. The earth revolves around the sun, the electrons of an atom revolve around their central nucleus. Man and animals come into this world. They live, die and decay.

Now, all these processes are not effected instantaneously. They all have duration. They all consist of series of events. And the distance between one event and another manifests itself to us as Time.

That, in short, constitutes the practical aspect of Time.

Is Time Eternal?

Will time ever end? Such a question is often asked. Yet, strangely enough, few inquire whether lineal distance will ever end.

Suppose, for example, you were asked whether the distance between London and Manchester will ever end, your reasoned answer would be "Yes—when Manchester and London end."

Lineal distance is dependent upon object and object, place and place, or, to be more accurate still, it is dependent between the existence of point and point in space. Thus, if you abolish space, you automatically eliminate distance, for there can be no distance without space.

In the same manner, if you abolish material things, including space, then you automatically annihilate Time because space and matter bring about movement and change, and Time, or at least one aspect of it, is the measure of movement and change.

And here we come to the question of Eternity. Now, eternity is not quite so difficult to conceive in the mind as one is apt to think it is. Eternity cannot be a mere unending succession of time units. It is not an infinity of time. Rather, it is an *absence* of time. A state of existence in which time is absent *must* be an eternal one. It must be a condition of perpetual "now-ness," there being no past and no future, but an everlasting "present." Clearly such a state or condition must be entirely dissociated from the material world as we know it, for the material world cannot operate at all without Time.

Time's Termination

It is clear, therefore, that if the material world or universe is ever run down or dissolved into an all-pervading nothingness, as some astronomers and physicists (to say nothing of the theologians) predict, then Time also will come to an end. There will be no more Time.

If time, given the above circumstances, will so obviously terminate, we may be well excused for asking whether it has ever had a beginning? To this conundrum, the answer seems also to be in the affirmative, for no matter whether our universe has been created suddenly or has slowly evolved from a single cause, a state must have existed before the sudden creation took place or the cause began to operate. So far as we can see therefore, time, like matter, arose out of the black chasm of physical nothingness.

Time, therefore, probably did *begin*, just as heat and light began. And just as heat and light will end, so, also, must Time. The unrest and the dynamic nature of our present universe necessitates the phenomenon of Time. Hence, at the ultimate transition of changing to unchanging existence, Time will automatically vanish, for the circumstances under which it exists will then be no more.

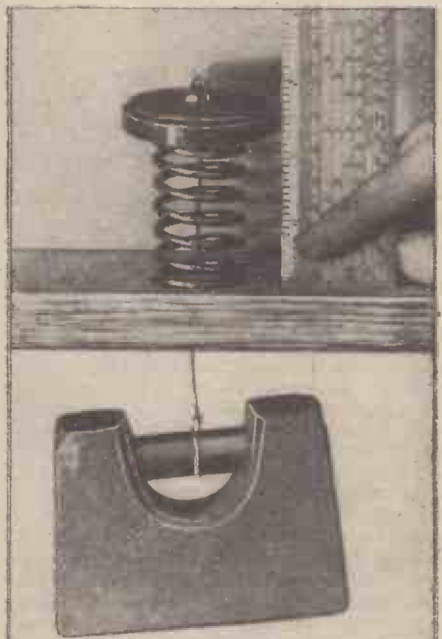
Although we cannot prevent the continuance of change (or the "passage" of time as we commonly put it) we can make records of time at any given stage of its "passage." What, for example, is a photograph other than an accurate time record? The photograph records an event or a happening which took place at a definite time instant, and, by means of the reflection of light rays, it brings back to us the state of affairs which prevailed in a given space or area at that given time instant.

Time, space, matter and motion seem in some strange way to be intimately related, and the record, or, as we might say, the trace of time, can be very curiously affected by motion, as we shall now see.

Space Rocket

Let us, in our imaginations, build for ourselves a space rocket capable of travelling at any imaginable speed. We embark in our space rocket for an experimental tour into the confines of the universe, taking with us, besides food, heating equipment, oxygen apparatus, etc., and an enormously powerful, automatic focusing telescope. Before we set off we adjust our telescope so that it continually projects a screen image of some selected area of the earth.

The rocket crew being all aboard, we set off gently from the surface of our planet, and for the first few million miles we crawl along at a speed of only a thousand or so miles a second. On our telescopic screen we see events on the earth, or on our selected area



A lineal measurement during a compression experiment. Here, distance is being measured from one spot to another. In an analogous manner, "duration" is time-measurement—from event to event.

of it, in very much the same way as they are happening at that time.

We instruct the rocket pilot to "step on it." He does so. Very soon we are travelling at the speed of light, which is approximately 186,000 miles a second. Just before attaining this rocket velocity we glance at our telescopic screen, and, to our horror, we chance to witness a tragedy being enacted on earth. A man is murdering his wife. We see him, knife in hand, about to plunge it into her body. But, strangely enough, as we fly away from the earth at exactly light's velocity the cruel murderer never seems to complete his wicked task. Our telescopic picture is "held" like a "still" in a cinema drama. We travel outwards for days, for weeks and even for months and years still keeping very precisely in step with the speed of light, yet the picture still persists. The man is still murdering his wife. He never finishes the job so far as our telescopic screen is concerned.

Record of a Tragedy

Why is this? Well, obviously when any action takes place on the earth's surface the light rays which proceed from it travel outwards into space with an absolutely constant velocity of 186,000 miles per second, and if, by means of our imaginary space rocket, we travel abreast with those light rays and keep up with them in velocity, then we shall continually witness the scene or record which those light rays carry with them. Thus we may travel for years at the speed of light in our space rocket, and have continually on our telescopic screen the spectacle of the man murdering his wife because we are ourselves actually keeping in step with those light rays, whereas, far away from us on the earth, the man may have been hanged for his crime years ago.

Suppose, however, that instead of travelling with the speed of light we bring additional power into operation in our space rocket, and so increase its rate of travel that our rate of progress through space becomes actually greater than the velocity of light?

Inverting Time

In these circumstances, an extraordinary state of affairs would take place. We should, in a way, be able to invert time and to witness the past, or, at least, a moving record of it, for, by travelling out into space faster than light we should be able to overtake light rays which had left our earth before we had embarked from it. And, consequently, the faster we travelled in excess of the speed of light the more long-departed light rays from the earth would we overtake. Hence, on our automatic telescopic screen we would witness a sort of cavalcade of past history taking place on the earth, or, on our selected area of the earth. By suddenly decreasing our rocket speed to that of light we should be able to "hold" any required screen picture for as long as we required. Thus, we should, given these fantastic means, be able to examine at leisure any stage of the earth's historical record in which we were particularly interested. We could, for example, witness any selected moment of the Battle of Waterloo for hours together if we so had the mind.

Similarly, by decreasing the speed of our space rocket below that of the speed of light, past events would recede from our screen view and the apparent future would gradually build itself up, for, under those circumstances the light rays projected from earthly scenes would gradually overtake our travelling rocket.

Thus, whilst travelling freely in our space ship, past and future would have apparently little meaning, for, by altering our speed we should be able to mix them up to our hearts' content. We should literally be "playing with time."

Time, therefore, although its real positive nature eludes us, is a relative sort of thing. It cannot exist by itself. It depends on the existence of matter, and, very likely, on the presence of space. Certainly, also, its manifestations are greatly modified by motion through space.

It looks, therefore, as if Time, Matter, Space and Motion are all intimately associated, for we are never able to experience any one of these entities separately and independently of the others.

Time, apparently, began. So, also, does it seem likely to end. But, seemingly, it will be the last of all material attributes to end.

"*Tempus edax rerum*" (time consumes all things) said the old Latins. They were right. It is only the unchangeable entities which can withstand Time's continual corrosion.

Rocket Propulsion

Power Rockets : Stability Trials and Details of Alighting Methods : Range Sighting

By K. W. GATLAND

(*Continued from page 316, June issue*)

FURTHER to the development of liquid fueled rocket units, the American Rocket Society has carried out numerous exacting tests of powder charge rockets; principally in order to gain practical experience of stabilising methods and the function of alighting mechanisms.

Powder Rocket Trials in 1935

The experiments which P. van Dresser and A. Africano conducted near Danburg, Connecticut, in 1935, have thrown much light on the relative effects on stability by varying the location of the centre of thrust.

The initial flight tests concerned a projectile of elementary form having the motor at the extreme rear, and this model also served to test a simple parachute release gear, the 'chute compartment being placed at the rocket "head" and joined to the charge casing by a length of dowel. Four small guide fins were fitted at the rear.

A second rocket was somewhat more elaborate, the power charge being contained within an aluminium body shell. It had a fully loaded weight of 3½ lb., of which 1¼ lb. constituted the rocket charge. There was provision for modifying the centre of thrust from the nose to the centre of mass and the tail, and under the changed conditions the weight distribution was kept constant by the simple procedure of moving a pair of ring weights along the outer shell. The idea of altering the position of the power element was to gain comparative data on the flight stability under these varying conditions.

On test, however, the rocket proved a complete failure. It was found that the effective thrust was almost halved when firing took place through the shell, and with the motor mounted in any position other than at the tail the efflux melted the aluminium of the body tube.

Tests of the simple tail-drive rocket gave far more conclusive results, and about 12 free-flights were made in conjunction with a 10ft. catapult apparatus.

It was unfortunate that, through bad co-ordination of timing in the release of the catapult and the ignition of the powder charge, the rocket was often fired from the rack not under the most optimum conditions, with the result that the performance was appreciably less than the calculated figure (as derived from the available thrust impulse and mass). In the majority of tests the altitudes reached varied between 200 and 250ft., but in one particular flight, when the timing was exactly right, a height of over 400ft. was attained. The rocket showed itself quite stable, and ascended on a trajectory which, in the majority of flights, did not deviate more than 20 or 30ft. from the vertical.

Parachute Release

The most useful result achieved, however, was from the tests of the alighting gear. The parachute in this particular model was of silk, 32in. in diameter, with a 2in. vent hole in the centre. There was also a small pilot 'chute of 10in. square, and this was attached to the top of the main supporting canopy by four shrouds secured equally around the vent.

When packed ready for use, the main shroud line was coiled beneath the 'chute pack and fastened to a bolt in the bottom of a tubular container situated at the "head" of the rocket. The pilot parachute was loosely packed at the top, and a ballistic shaped aluminium nosing was then fitted, not too tightly, over the compartment.

The device was so designed that the parachute would not release when the rocket was accelerating or travelling in a vertical ascent. When the projectile reached the apex of its trajectory, however, and turned over under the slowing influence of gravity, the lateral air resistance developed during its fall served to blow off the light nosing and thereby expose the pilot 'chute. This was readily caught by the air flow, so pulling out the main parachute from its container.

In order that the device should be sensitive in operation, two small vanes were fitted externally—at the rocket "head"—and these served to increase the lateral resistance.

This method of release is, of course, suitable only for light rockets, and in the tests reviewed the device functioned perfectly in practically every instance.

While on this subject of alighting mechanisms, it is as well to trace briefly their development. The parachute has, of course, long been used for display purposes; the idea was probably first conceived by the Chinese pioneers of pyrotechnics early in the Christian era. The rocket star-shell, for instance, uses a number of small parachutes from which are suspended coloured display "fires" and this principle was adapted in the 1914-18 war, when the "flaming onion," or magnesium flare, first came to be used extensively.

Professor Goddard is credited with the initial application of the parachute in liquid fueled rockets, and his first successful experiment took place on July 17th, 1929, when a rocket, complete with a camera and barometer, was safely wafted to the ground. In more recent work, he is said to have perfected a parachute release gear of faultless operation.

The German experimenters employed parachutes in their early powder rockets—particularly the mail-carrying versions—and the Verein für Raumschiffahrt E.V. fitted them to the "Repulsor" liquid-fueled types, as also did Johannes Winkler in his liquid fuel rocket of 1932.

Some of these earlier rockets simply had a slow burning fuse to function the release gear while others incorporated a clockwork "photographic" timer. The pressure within the propellant tanks has, too, been employed as the release medium, effecting operation through a spring-loaded plunger when the fuel is consumed and the feed pressure has dropped to zero.

In the more recent and larger type rockets, the parachute release is effected by the firing of a small powder charge, similar to the method employed by J. H. Wyld in his 1939 sounding rocket. (PRACTICAL MECHANICS, June, 1945, page 316.)

Other devices recently developed are functioned by air pressure, in the operation of a trip mechanism by a barometric pointer. Release is arranged to take place at a height previously determined from the performance calculations, the trip device either ejecting a pilot 'chute through the release of a compressed spring, or causing the explosion of a small charge.

Yet other release devices have been advocated which would work under rapid negative acceleration—at the time when a rocket which had just ceased firing was slowed up by atmospheric resistance. This factor, coupled with the rocket's curving trajectory at the flight apex, it has been suggested, would cause any free body in the rocket to be forced upwards, and so enable the function of a pendulous device, or some form of escapement mechanism, in conjunction with a spring or "shot" ejecting gear.

Tiling "Flying Rocket"

Finally, in this short summary of alightment apparatus, the patented design of Reinhold Tiling (U.S. Patent 1,880,586, Tiling, Osnabruck, Germany, 1932) cannot go without mention.

The method as fully outlined in Tiling's specification does not involve the parachute, but makes use of stabilising fins which, at the end of firing, hinge at a set angle of incidence, to form supporting blades. By this means, the rocket is brought to the ground as a gyro-plane.

The Tiling "flying rocket" (Fig. 25), as the device is termed, is of form simply a finned rocket with the propellant charge contained conventionally within the body shell, having provision for mail in the nose. Equally spaced around the shell are fitted four stabilising fins which project some distance from the rear, and each of these are so built to hinge outwards from a point just aft of the body.

Having served their initial purpose of maintaining the rocket in stabilised flight throughout the duration of combustion and propulsive momentum, the free part of the fins are automatically brought almost horizontal (relative to the vertical body axis), at the same time setting a slight positive incidence. The rocket is thus wafted to the ground by the reaction of air on the supporting "planes," which causes rotation about the body axis.

The Tiling specification suggests also the provision of four auxiliary rocket units fitted to discharge tangentially from the body. These are intended to become operative shortly before the rocket reaches the ground, and have the effect of creating a lifting force opposing the free fall due to the "powered" spinning of the rocket.

Whether or not Tiling ever put his "flying rocket" to actual tests is uncertain. Certainly he built, and demonstrated with no small success, several "winged rockets" of particularly unique design, but they differed greatly from the patented form. In the tested version there were four long fins; but these were rigid and did not fold. Instead, two other fins were fitted which pivoted from near the after part of the rocket body, and were folded back snugly beneath the horizontal stabilising surfaces during ascent. When firing and upward momentum had ceased, they automatically snapped open, thereby transforming the rocket into a glider.

Why Tiling should have employed this rather cumbersome and heavy arrangement in preference to the gyro type "flying rocket" is not clear. It is true, nevertheless, that the "winged" version had a creditable performance, often rising above 2,500ft.

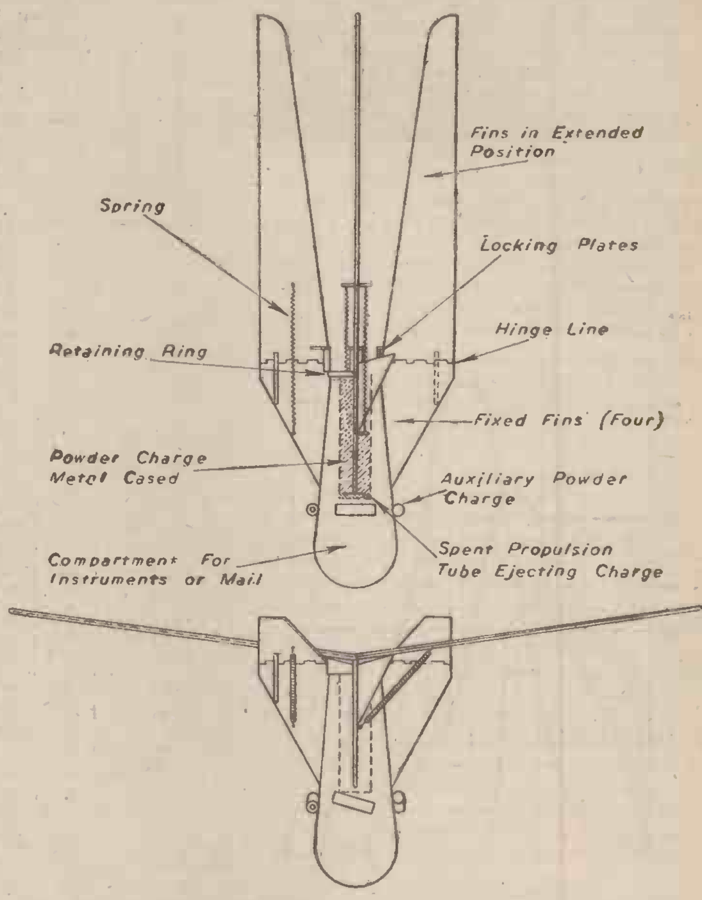


Fig. 25. Diagram of the Tiling "Flying Rocket," showing the two fin positions. Firing of the ejecting device forces out the propellant charge with retaining ring. This action deflects the locking plates, and the stabiliser fins automatically collapse to form "supporting planes."

Further Stability Trials

A further series of powder rocket trials took place at Pawling, N.Y., in October, 1937, under the auspices of the American Rocket Society Experimental Committee. Again, stability formed the subject of the experiments, which were centred toward searching out flight phenonema both during propulsion under power and momentum, for various conditions of the centre of thrust, the centre of gravity and the centre of lateral area.

The rocket bodies were constructed by H. F. Pierce, simply of balsa wood and cardboard tubing; being designed from various suggestions put forward by members of the Society. Commercially obtained charges of 12oz. loaded weight (comprising 6oz. powder), served as the propelling element, each rocket having a single charge which fitted into a central tube in the body.

Firing took place from a special launching rack, the rocket under test being attached to a small trolley which ascended the apparatus under thrust along a single guide rail. Ignition was either performed electrically or through a touch fuse. Each flight was ciné photographed in order that a subsequent study of trajectories could be made at leisure.

Of the seven rockets tested, two were outstanding both in respect to the altitude reached and their flight stability, as the accompanying table (Fig. 26) shows. It will be noticed that both types were the lightest in weight, thereby making more effective the impulse of the charge and so producing increased rate of acceleration. Another point of significance is that the centre of propulsion was forward to the centre of gravity and the centre of lateral area.

Experiments at Mountainville, N.J.

Following up the stability question, the Experimental Committee of the American Rocket Society carried out further trials of small-scale powder rockets in September, 1939, from a prepared test site at Mountainville, N.J.

The models tested were based on the results of the earlier Society experimentation at Pawling, and, as then, balsa and cardboard were used in construction. The launching apparatus bore much resemblance to the single-rail type which had proved itself in the former trials.

It is of interest to point out that, in this, and the majority of free-flight experiments previously discussed, the altitude figure was derived from the use of special sighting instruments developed on the principle of the surveyor's theodolite. The system requires two remote sighting locations spaced at a known distance. In the trials under review, this length was 1,100ft. on a straight line 50ft. west of the launching point. The location "A" was 800ft. to the south, and location "B" 300ft. to the north. The altitude is calculated in accordance with the simple formula:

$$H = \frac{b}{\cot A \quad \cot B}$$

where H is the altitude in feet, b is the base line of the two sighting locations in feet, cot A is the observed angle from location "A," and cot B is the observed angle from location "B."

According to A. Africano, who participated in the test sighting, the Society instruments were operated as follows: When the rocket, seen through the eyepiece and cross hairs, was observed to reach its maximum altitude, a small indicator carried along in one direction by the upward motion remained in place at this point and the angle could then be read leisurely on a graduated quadrant, and noted. This method gives the altitude of a horizontal line formed by the intersection of two planes rotating about shafts set parallel to each other. While it does not locate the point definitely in space, as in the method used at Staten Island in 1934, where two vertical and two horizontal angles were measured, it is sufficient for present purposes. The instruments were later adapted for an automatic angle and time recorder with which it is possible to calculate the vertical acceleration and velocity in addition to the upward range.

To return to the rockets themselves, the propulsive charges were obtained commercially, and being the ordinary display rocket type their weight and thrust characteristics were known only approximately. In consequence, the results achieved in free flight were, in many ways, inconclusive.

The rocket charges used in these particular

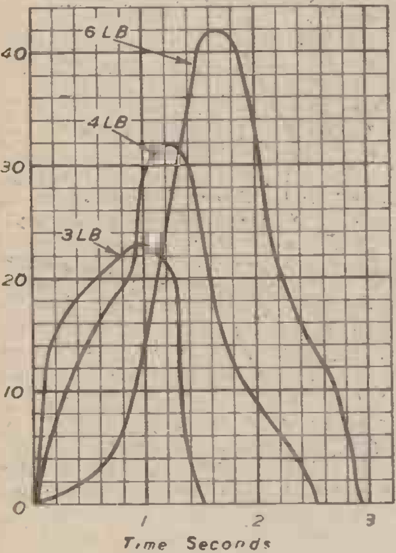


Fig. 27.—Thrust curves derived from proving stand tests of black powder rocket charges manufactured by the U.S. Unexcelled Manufacturing Corporation.

Model No.	Maximum Altitude, feet.	Time of Flight, seconds.	Total weight of Model, ounces.	Charge size, comml. "lb."	Body length, inches.	Maximum body diameter, inches.	Distance, nose to centre of gravity.	Distance, nose to centre of area.	No. of fins.	GENERAL REMARKS.
5	403	5 (up)	11.2	2	12.0	1.50	—	—	1 (Stick)	Lost in clouds.
6	—	—	5.6	2	12.0	1.75	7.625	11.125	4	Exploded over rack.
7	25	13	6.0	2	12.0	1.50 (Sq.)	7.75	10.50	4	Horizontal flight—400ft.
8	650	—	6.0	2	11.375	1.50	7.50	9.75	4	Better result expected.
9	56	—	9.0	2	14.75	1.25	9.625	11.50	4	Exploded over rack.
10	86	2.5	11.2	4	15.0	2.0 (Sq.)	9.50	10.50	4	Looped.
11	150	6	10.7	4	13.75	2.0	7.875	9.25	4	Horizontal, then looped.
12	620	12	18.7	4	17.875	1.875	12.125	15.50	2 (Sticks)	Cap ejected at flight apex.
13	235	8	25.0	4	28.125	1.75	18.125	19.125	4	Weighted model.
14	—	—	20.5	4	28.125	1.75	18.625	19.125	4	Caught in rack.
15	196	9	24.0	4	17.0	1.875	15.875	17.75	2	Excess frontal area (9 sq. ins.).
16	503	6 (up)	16.0	4	18.25	1.875	12.0	—	3	Lost in clouds.
17	725	19	34.0	6	23.625	2.375	16.25	16.0	4	Second best performance.
18	524	10	22.0	4	12.5	4.0	8.5	—	3	Over Observer "B's" zenith.
19	206	7	—	—	—	—	—	—	4	Exploded in flight.
20	75	6	37.0	6	30.5	4.0 (Sq.)	22.0	—	4	Excess frontal area (16 sq. ins.).
21	174	8.5	14.0	4	16.0	1.875	10.5	14.75	4	Fins broke off in flight.
22	145	10	12.0	4	13.5	1.875	8.25	11.50	3	Horizontal flight.
23	531	7 (up)	12.5	4	13.25	1.875	8.125	11.50	3	Swung into wind.
24	125	6	17.0	4	14.875	2.875	8.50	9.50	3	Launched late.
25	582	15	14.0	4	26.75	1.875	18.75	16.25	4	Fin area at extreme rear.
26	66	4	13.5	4	12.625	1.875	7.875	—	4	Looped (fin area at nose).
27	1930	24	39.0	6.2	25.25	2.375	18.50	21.50	8	Shows efficiency of two-step principle.
27	2nd step alone		9.0	2	12.75	2.375	7.75	8.0	4	

Fig. 28.—Table of results of 23 individual firings.

Model No.	1	2	3	4	5	6	7
After protype design of	Pierce	2 Step	Africano	Goodman	Wyld	Shesta	Repulsor
Distance from nose of rocket to centre of propulsion, inches..	15.9	28.0	8.0	14.0	39.0	59.0	14.0
Distance from nose of rocket to centre of gravity, inches ..	19.0	28.0	15.0	39.0	33.0	43.0	24.0
Distance from nose of rocket to centre of area, inches.. ..	22.0	28.0	19.0	50.0	25.0	35.0	22.0
Overall length of body, inches..	44.0	68.0	33.0	94.0	49.0	68.9	48.0
Initial weight of rocket, lbs. ..	1.19	2.27	1.19	2.16	1.85	1.72	2.28
Maximum altitude, feet (approximate)..	1,500	600	1,500	400	200	300	100
Time of ascent, seconds ..	7	5	5	5	4	4	3
Time of descent, seconds ..	3	4	3	4	4	3	2

Fig. 26.—Table of results of tests.

tests were designated by the manufacturer 2lb., 4lb. and 6lb., but their actual weight was considerably less. Writing in *Astronautics* (November, 1939), Mr. A. Africano, who conducted a private investigation of the values attainable from these size commercial charges, states that the 6lb. type shows an increase of thrust from 0 to about 40 lb. along a smooth curve in about one second, and he points out that the form of the reaction curve would, in all probability, prove to be similar for the other sizes. Mr. Africano reports the weight of powder in the 6lb. size as approximately 12 oz. The maximum thrust of the 4lb. charge which contains 4.8 oz. of powder, he gives as about 20lb., and the duration of reaction one second. The powder weight of the 2lb. charge is stated to be 2 oz., but no figure for thrust is available.

Some two years later the Experimental Committee carried out tests of similar commercial charges of the 3lb., 4lb. and 6lb. size, and their conclusions are set out graphically in Fig. 27.

The designations of these charges follow the usual practice of pyrotechnics in that a lead shot of diameter equal to the charge represents the weight. The *actual* weight of the 3lb. charge is 0.6875lb., of which 0.250lb. is black gunpowder, the containing cylinder being 11.0ins. long by 1 11/16ins. diameter, with a nozzle diameter of 7/16in. Concerning the 4lb. type, the true weight is 0.906lb., of which 0.406lb. constitutes powder. This size has a case of 12.0ins. by 1 7/8ins., and a nozzle diameter of 3/8in. The last size investigated, the 6lb. charge, has a weight of 1.5 lb., of which 0.656 lb. is powder. It is 13ins. long by 2 1/8ins. diameter and has a nozzle orifice of 3/8in.

Firing Results

In the above table (Fig. 28) is shown, for easy comparison, the results of the 23 individual firings. Of these, rocket No. 27 is of particular interest, being of the two-step type. It consisted of two distinct sections, each a self-contained propulsion element—the main component having a 6lb. charge of commercial origin and the other a similar 2lb. charge. In this type the two sections are connected, and the larger fired first. Having consumed its fuel in raising the small component, a connecting fuse fires the latter, which automatically disengages and accelerates away from the expended "parent" rocket.

Another unusual type, rocket No. 26, had fins fitted forward of the centre of mass, but this model proved markedly unstable on test.

Other rockets, Nos. 6 to 11 and 21 to 27, were lightened by the removal of part of the charge casing, and to this is attributed the explosions of models 6 and 9.

(To be continued.)

What Do You Think?

A Talk on Observation, "Jets," Rockets, and Small Things of Importance

By Prof. A. M. LOW

I AM rather nervous of our Editor, for it is true that I have never yet asked a question to which he could not give a reasoned reply. Now *I* think—and I am told I can say what I like—that the reason for this alarming state of affairs is mainly skill in observation. I believe that this word covers all happiness, education and knowledge. I will be blunt and say that, in my opinion, most people walk through life—or run nowadays—with their noses to the ground like cabbages. Cabbages do have noses in the sense that they are very responsive to gaseous atmosphere.

To-day (I will get to the point in a moment) education has reached a stage where we often read pages of mathematics written for the one purpose of giving complication to the few simple things we know. The "facts" of which we can be certain are so few that we are still little better than savages. If you doubt this statement please note that a large number of children are born with such noticeable tails as to require surgical treatment; while you, and myself also no doubt, have throats which correspond with painful accuracy to those of our ancestors, the fish.

I am quite sure that the drawing of endless curves and the memorising of unlimited data, called facts because they have not yet been proved to be untrue, can in no way replace observation. That is what *I* think.

Who Invented "Jets"?

Take "jets" as an example. I read that they are new and that they are old. That they were invented in England, and that they were invented in Italy. None of this is true. For millions of years fish have used the reaction principle in a most skilful manner, and in many tropical pools these creatures can be seen swimming backwards and forwards by means of water sucked in or driven out.

Hundreds of years ago, when I was a boy, we used to make power-boats on a very similar principle by fixing a metal U-tube in a piece of wood and heating the curved part by a spirit lamp. These little models were jet boats. The hot water was blown out, and the steam condensed by the surrounding cold water which thereupon rushed in to be blown out again so that the boat quivered to the touch as it dashed quickly round the local pond.

Internal Combustion Engines

The remarkable part of all internal combustion engines of every kind is that most of them are totally unsuited to their job. The motor-car is only satisfactory because its fuel is clean and well distributed. In fact, it is crazy. We want to get as much cold mixture into an engine and turn it as rapidly as possible into gas, because the only criterion of efficiency is the weight of mixture in and out of the cylinder per minute. That is one kind of efficiency. To secure all the others, such as comfort, silence and convenience, we dare not turn the petrol into a gas or the combustion chamber overheats. We want to compress it and make it burn quickly and efficiently, but we must let it combust very slowly if the whole of the power is not to be wasted in gears.

We would also like the heat to be turned into mechanical work, so, logically, the cylinder should be exceedingly hot. Do this and the incoming gases are overheated. The solution is gloriously simple. We buy an expensive radiator, and deliberately waste 30 per cent. of the heat and fit a costly exhaust system to make sure of getting rid of another 40 per cent. Frightfully scientific is it not?

The Flying Bomb

The flying bomb is a clever device because of its control, its turbine-fed mixture regulation, its gyroscopes and its direction indicator. But its engine, using a poor compression ratio and allowing the gas of combustion to drive into the atmosphere so that equal and opposite reaction to this putting off of weight drives the machine forward, is by no means marvellous. Fuel consumption must be appalling. What *is* exciting is the rocket, and in this case the reason is not only that of its skilful control. It is because for the first time a fuel is being used which is complete in itself, carrying its own oxygen for combustion. Allowing for the need for the machine to travel when there is no atmosphere before it can move efficiently it suggests the possibility of all kinds of queer progress.

You may say that rocket posts, high-speed travel to America, and control by radio are more or less obvious, but what appeals to me is that peak horse-power may be in the neighbourhood of 500,000 or more. When I am told sarcastically that this only lasts for a minute or so, I point out that if you could reduce the horse-power to 20 the time would proportionately increase, and I see no reason why something of this kind should not eventually be accomplished.

Anyone who troubles to think must agree that the modern reciprocating engine is chiefly interesting for its triumph over difficulties. Thermally it is horrible; mechanically it is worse still. Who in their right minds would want to take a few dozen relatively heavy pistons and throw them backwards and forwards many times a second? The engine is expected to do this, and more, and is further asked to function reliably with a temperature in its stomach very nearly high enough to liquefy steel.

Reaction Machines

It looks to me as if reaction machines, if you will forgive my colloquialism, are one day destined to make speeds of a few thousand miles per hour quite common. It may happen that in the far future old ladies will mistake Africa for England instead of Golders Green for Hampstead Heath. And we shall know that men wearing white ducks and solar topees are not mad because they cross Hyde Park on Christmas Day. They are, of course, spending Sunday afternoon in Africa.

No! I am right. Popeye had the idea of reaction and relativity most accurately. You may remember that after a helping of spinach he would commonly pick up an aeroplane by what vulgar people call the "prop" and spin the whole kite round it instead of the other way about. It should indeed be a source of satisfaction to know, when we start a car and let in the clutch, that it is the engine which revolves and not the car. Relatively speaking there is very little difference.

Nor is this point so foolish. One of the great causes of airscrew inefficiency used to be that of flutter. The engine fires, we hope, and at each kick the tips of the blades are left behind. As these blades are springy, a high-speed cinematograph may show that the end is vibrating like a comic picture of a dog's tail, and some wonderful statistics were once compiled to show that 15 per cent. of total horse-power could be lost in this fashion.

Very Small Things

I should hate you to say that these are very small things and therefore of no interest. Just the other way about. Before long our world will be moved, controlled and organised by the everlasting dance of atoms with their electronic chorus. I once took the trouble to work out the amount by which the middle span of Sydney bridge bent when a butterfly landed upon it. Quite a simple calculation but enough, I think, to remind us that very few of the things which we ordinarily see are so interesting as the very small. Half the marvels of life must have been totally untrue to those who had only their unaided eyes, and much more than half modern science is devoted to the discovery of instruments by which our senses can be *apparently* improved.

It will have occurred to you that the cinematograph and television both rely upon the extraordinary badness of our eyes from the aspect of a maker of optical instruments. Who would buy a microscope which had lenses so far from the spherical that a point of light appeared to have streamers rushing from its centre? Yet it is to this fault that a star owes its traditional form. Would anyone consider a lens and its appurtenances which were so slow in response that the image formed takes a fifth of a second before it died away? It would be a poor advertisement for a manufacturer of photo-electric cells if this was his standard of efficiency. Now, come to the cinema where, incidentally, you sit half the time in pitch darkness while the film moves. Yet you are quite willing to pay the full price. If your eyes had no retentivity you could never enjoy Donald Duck, and if the last picture came on again before the next took its place, the projection would be worse than those of the earliest biograph.

A Poser

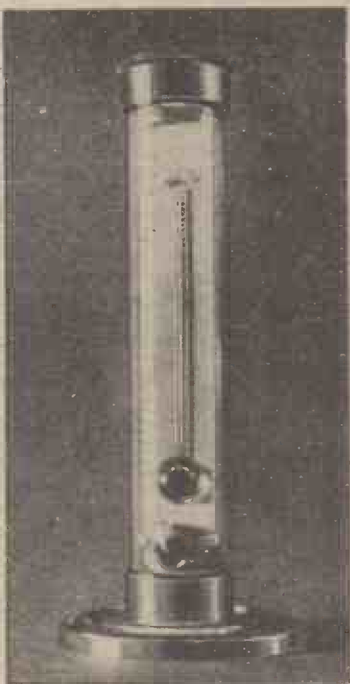
So you will agree that the world is an interesting place. It is quite impossible to be bored. That is what *I* think. But if you must trouble yourself with unnecessary figures, and if you insist occasionally upon confusing smartness with intellect, I will give you a problem. . . . A man had a dog which used to run to its master when he left the office, take his hat, stick and gloves, etc., and dash home. The dog ran at 10 m.p.h. and the man walked at 4 miles per hour. One day man and dog left office and house at the same time; the dog running faster than the man, met his master not far from the city, took the gloves and was, of course, much more than half way from its home. The dog came back, took master's stick, and tore off home, returning again to meet his owner, who was by that time a little nearer his house. This went on incessantly for an hour, each time the dog dashing backwards and forwards between home and its master, who upon every occasion was a little closer to his house. Even at the garden gate the same thing happened, the dog rushing backwards and forwards until at last both reached home together. During all the dog's trips what was the total distance covered? *Quick now!*

Masters of Mechanics—104

Gabriel Fahrenheit

The Introduction of the Mercury Thermometer

GABRIEL FAHRENHEIT, celebrated thermometer constructor, was a German. Perhaps he was a sensible German, because he lived most of his life in Holland and spent a number of years in England. At any rate, although the details of his personality have vanished from the world's memory, his name, in consequence of his thermometric activities, has been wellnigh immortalised and, in many countries, has become almost a household word.



A pre-Fahrenheit spirit thermometer made in Italy about 1660. This instrument, preserved at Cambridge, is one of the world's earliest thermometers.

Although Fahrenheit played the role of a mechanic and an instrument-maker, although, indeed, he even had leanings towards the primitive engineering science which was current in his days, he would best be described as a working physicist, for he made the science of thermometry and, to a lesser extent, that of meteorology, the principal study of his life. It is, of course, clearly in connection with his thermometric associations that his name and some record of his activities have been preserved.

Before Fahrenheit's time, the primitive spirit thermometer had been an instrument of little practical use. It had not even been calibrated. Nor had the more accurate and reliable mercury thermometer come into use, although the idea of a thermometer containing the highly expansible mercury had previously been mooted.

The first thermometer containing alcohol or, as it was then known, "spirit of wine," was the invention of a Frenchman named Rey, who first devised the instrument in or about the year 1632. Hence, this, the first liquid thermometer, had not been known very long when Gabriel Daniel Fahrenheit, to give him his full name, introduced himself to the world in the City of Danzig on May 14th, 1686. He came of a fairly affluent family, his father being a well-known Danzig merchant.

It appears that young Fahrenheit went to a good school and received in full the recognised education of the day. His parents had destined him for the shipping trade from his early boyhood, and it was into this family occupation that the lad Gabriel was entered not long after he had reached his teens.

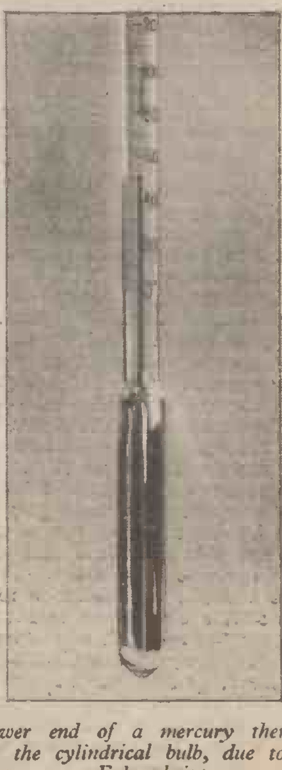
Commercial Career

At this time, so far as we can ascertain, Fahrenheit had no notion of taking up a scientific career, such as it was in those days. He became energetically interested in "trade," and shortly after he went to Amsterdam, Holland's noted port and trading centre, to train as one of the merchants and shippers of the day.

Here the historical record of Fahrenheit's early career becomes somewhat blurred because certain details are lacking which would supply positive evidence as regards his early activities in Amsterdam. One story has it that Fahrenheit set up actively in business at Amsterdam and that, after a few years' trading, he failed badly, barely managing to escape bankruptcy, whereupon he conveniently conceived a taste for scientific pursuits and promptly set himself up again as a maker of "philosophical" instruments.

Another, and, almost certainly, a more accurate record asserts that Gabriel Fahrenheit was always interested in the physics and chemistry of his day and that, after a few years of "trade" in Amsterdam, he took an intense dislike to a purely commercial life and, as a result, threw the whole business up voluntarily and gradually got together the nucleus of an instrument-manufacturing shop.

About this time of personal unsettlement, Fahrenheit seems to have been affected with some degree of wanderlust, for he travelled pretty extensively through Holland, Denmark and Sweden, and he also made his first visit to London. Being an educated man, who could read, write and converse in Latin, the scientific language of the period, Fahrenheit seems to have had little difficulty in becoming intimate with the scientific characters of the period. He was well known to our own Royal Society, in London, to whose *Philosophical Transactions* he afterwards contributed five scientific papers in Latin. He was particularly friendly with Olaf Römer, the Danish astronomer, whom he visited in Copenhagen and, with him, during the exceptionally cold winter of 1709, took careful records of temperatures.



The lower end of a mercury thermometer, showing the cylindrical bulb, due to Gabriel Fahrenheit.

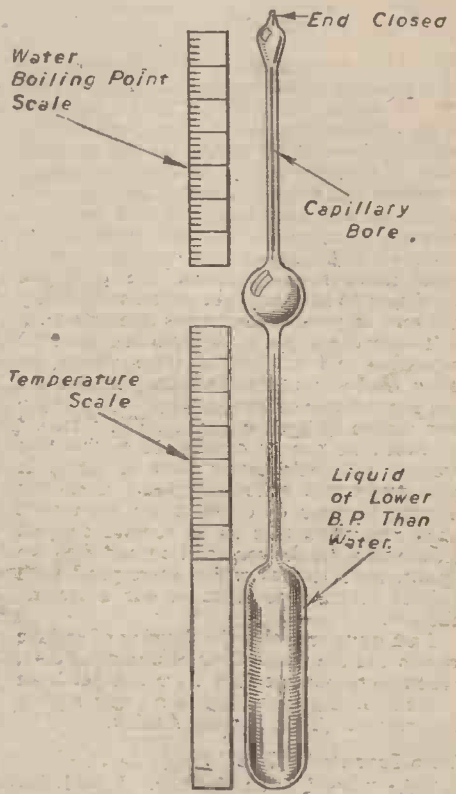


Fig. 1.—Fahrenheit's "Hyposometer" for the estimation of water boiling-points under varying atmospheric pressures.

Whether, during Fahrenheit's pre-thermometer days, the instrument business at Amsterdam was sufficiently thriving to maintain him we do not know. Probably there was no need for it to amass much wealth, for Fahrenheit, at this time a somewhat indefatigable worker, appears to have given more attention to original physical investigations than to the routine claims of his business.

Temperature Measurement

He had become very interested in temperature measurement. As time went by, he recognised more and more clearly the paramount importance of having some thermometric standard, and of being able to construct thermometers which would accurately keep to such a standard.

The first liquid thermometer containing alcohol or spirit was, as we have previously seen, a French invention dating from about the year 1632. As a matter of fact, the first of Rey's thermometers utilised ordinary red wine as the heat or temperature-indicating liquid. It underwent rapid improvement under other hands, and about ten or a dozen years later, a noted Jesuit scientist, Athanasius Kircher, actually proposed the use of mercury for thermometer making, a project, however, which he did not carry out.

The Mercury Thermometer

The first maker of a mercury thermometer is quite unknown at the present day. There

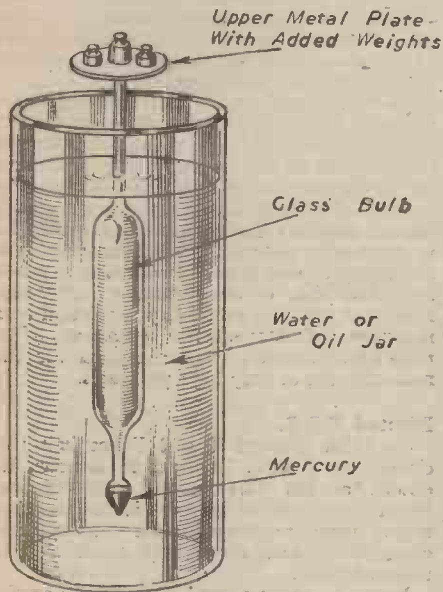
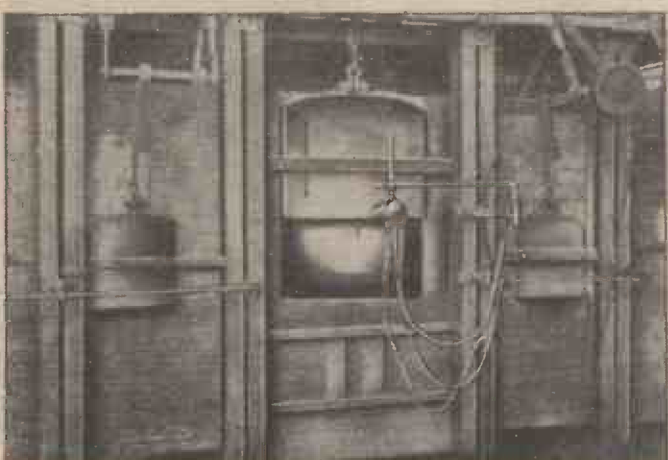


Fig. 2.—Fahrenheit's hydrometer for the measurement of specific gravities of liquids.

are two or three claimants for that honour. According to some, it was Fahrenheit's friend, the astronomer Römer (or Roemer), first measurer of the velocity of light, who successfully made a mercury temperature-measuring instrument. Another story has it that Edmund Halley, of Halley's comet fame, made a thermometer based on mercury, whilst a third contention is that as far back as 1675 the Italian Academy of Science had produced a mercury thermometer.

These contentions, however, do not concern us, since it is quite clear that although Fahrenheit was not the first originator of the mercury thermometer, he was the first practical constructor of it. Moreover, he was the first man to calibrate a thermometer, that is to say, to give it a regular indicating scale having fixed points of temperature, all previous thermometers having been quite devoid of any constant system of scaling.



The modern form of high-temperature furnace thermometer. It is fixed in front of the furnace door and records the radiated heat from the furnace.

It will readily be understood that after a serviceable scale had been applied to the thermometer by Fahrenheit, its use as a practical everyday instrument went up by leaps and bounds, for a thermometer with a scale is often a highly indispensable instrument, whilst one minus a scale is about as useful as an automobile without a steering wheel.

From what we can discover in the available records, Fahrenheit first became really scientifically interested in thermometer construction and improvement in consequence of being struck by the previous observation of one Guillaume Amontons (1663-1705) that water always boils at one definite point, as measured by the older forms of thermometer. Fahrenheit became curious to ascertain whether other liquids besides water would show fixed boiling points. He put a number of liquids to practical test and found that in every case a constant boiling-point was indicated.

Later, he went a little further, and made the important observation that the boiling-points of liquids are appreciably altered by changes in atmospheric pressure. A liquid's boiling-point, therefore, is a sort of fixed balance between its temperature and the pressure to which it is subjected.

At first Fahrenheit made his thermometers with "spirits of wine" (i.e., alcohol). This was about the year 1718, but in 1720 he completed his first mercury thermometer, an instrument which had almost the same appearance as our present-day one. Fahrenheit made the bulb of his thermometer cylindrical instead of spherical, as previous thermometer constructors had done, for he claimed that better and quicker heat-transfer to and from the mercury or alcohol is obtained with a cylindrical bulb. Such a style of construction has been followed ever since in the best designs.

Fahrenheit's Success

To some extent the success of Fahrenheit's thermometers was due not only to their design, but also to his method of cleaning the mercury which he used. He noted that dirty or contaminated mercury will stick to glass and leave "tails" on it, whereas perfectly clean, lustrous and bright mercury slides up and down a glass tube with the minimum of friction.

In the previously-mentioned Latin papers published in the Royal Society's *Philosophical Transactions*, Fahrenheit revealed, for the first time, his detail process of making thermometers.

He perceived clearly that some sort of a scale was vitally essential for thermometer usage. The question which at first perturbed him was what kind of thermometer scale to use. For his first thermometers, of both the mercury and the alcohol or spirit type, he "invented" two fixed points, the lower one constituting the average temperature of an ice-salt-water mixture and the higher one comprising the blood temperature of the human body. Between these two points, Fahrenheit divided his thermometer stem into 96 equal steps. He had the notion that the temperature of his ice-salt-water freezing mixture was the coldest cold which could possibly exist.

Absolute Zero

It is interesting to note here that Fahrenheit had some idea of what we now term "Absolute Zero," that is to say, of a final state of coldness at which a body is entirely devoid of heat. We now know this ideal state of "heatlessness" to coincide with a temperature of minus 273 deg. Centigrade, but Fahrenheit, with the limited amount of experimental information available at his time, took his "absolute" to be the temperature of his ice-salt-water mixture. This, therefore, was his *zero* on his thermometer scale.

In his next batch of thermometers he added

Fahrenheit observed the influence of atmospheric pressure on the boiling point of liquids. Here is a contemporary illustration depicting a demonstration of the effect of atmospheric pressure in holding together the two halves of a metal globe which has been exhausted of air. Despite loading with heavy weights, the lower half of the globe cannot be pulled away from the upper half, although if air were admitted to the globe its lower half would fall away at once.

a third point on the scale, i.e., that which coincided with the temperature of melting ice. He found that the distance between the mercury level at his zero temperature and at the temperature of melting ice could be divided into thirty-two equal parts. Nothing, therefore, was easier than to mark the freezing-point of water (or the melting-point of ice) "32" on his scale.

Between the freezing-point and the boiling-point of water, the mercury column was found to expand by a length which could be divided into 180 equal parts. Hence $180+32=212$ was fixed by Fahrenheit as the boiling-point of water, the scale, of course, being decidedly arbitrary but, nevertheless, having some experimental basis for its calculation.

Says Fahrenheit in one of his later papers in the London *Philosophical Transactions*: "Later, I recognised through various observations and experiments that this point, i.e., *the boiling-point of water*, is fixed for one and the same weight of the atmosphere, but that for different weights of the atmosphere, it may vary either way."

Alteration of Boiling-point.

In other words, boiling-points vary with the pressure to which the liquids are subjected. Fahrenheit had the scientific sense to see that his fixed standard of 212 divisions or degrees only applied to water under normal atmospheric pressure. Alter the pressure, and the boiling-point at once changes, the higher the pressure, the higher the boiling-point, and, conversely, the lower the pressure, the lower the boiling-point. It is, of course, just for this reason that, given a much reduced pressure, water and other liquids may be caused to boil at astonishingly low temperatures.

It is a curious fact that Fahrenheit never had the clearness of perception to realise that two fixed points on his thermometer scale, to wit, the freezing-point of water as 0 deg. and the boiling-point of water as 100 deg., would constitute a much more convenient and simpler arrangement of temperature scaling than his cumbrous scale of 212 divisions. Had Fahrenheit lived longer he might, perhaps, have come to this conclusion, but as things were, the 0-100 deg. thermometer scaling had to wait a number of years before it was first practically introduced in the form of the nowadays well-known "scientific" *centigrade* temperature scale which, in view of its greater simplicity, is used in all laboratories and scientific institutions the world over.

It is rather strange that only the English and the Dutch at first appreciated Fahrenheit's thermometers, the Dutch, perhaps, because the new thermometers were Amsterdam products, and our own countrymen because the Royal Society had taken them more or less under its august ægis.

France adopted another thermometer scale due to Réamur, whilst other European countries seem to have been satisfied with "local" scales of their own. The present-day "Centigrade" thermometer was originally due to Andreas Celsius in 1742. But this worker, curiously enough, marked the boiling-point of water as 0 deg. (zero) and its freezing-point as 100 deg., thereby giving a strangely inverted scale. Our present Centigrade thermometer scale was introduced some eight years later by an associate of Celsius named Marten Strömer.

The Hyposometer

Coming back to Gabriel Fahrenheit, however, it is interesting to note that he was responsible for other devices besides temperature-measuring instruments. He invented, for instance, a "hyposometer," which constituted an instrument similar to that shown in the accompanying diagram, Fig. 1. The Fahrenheit hyposometer comprised a cylindrical glass tube terminating in a short narrow tube leading to a glass bulb, upon which latter was surmounted another length of narrow glass tube having a very fine bore and being topped with an upper glass bulb.

The lower glass tube was filled with a liquid and allowed to remain for a few hours at normal temperatures, during which time the liquid rose to a position in the narrow tube below the first glass bulb. This position of the liquid indicated its temperature on a lower scale.

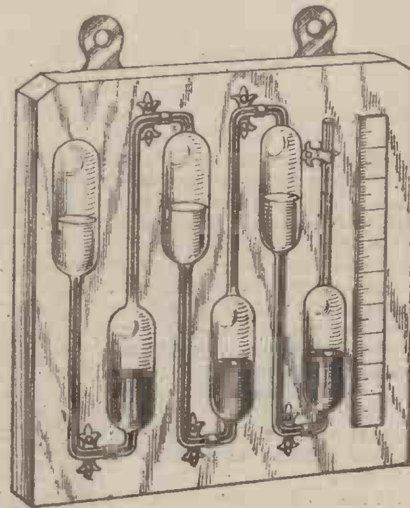


Fig. 3.—Fahrenheit's barometer—a scientific curiosity.

The device was then placed in boiling water, whereupon the liquid, by its expansion, rose in the tube, filled the lower glass bulb and entered the upper capillary tube. Its height in this latter tube (which was measured on another scale) served as a measure of the exact temperature at which the water boiled under the existing atmospheric pressure.

Fahrenheit was also responsible for the design of a special form of hydrometer (Fig. 2), comprising a mercury-weighted glass tube having an upper metal plate on which additional weights were placed until the hydrometer became immersed in the liquid up to a predetermined mark. This form of "variable immersion" hydrometer in the modification due to Nicholson is still in use in modern times.

Fahrenheit's Barometer

A more interesting device of Fahrenheit's was his barometer, which formed an ingenious attempt to get rid of the long and unwieldy nature of the more usual tube barometer.

The Fahrenheit barometer consisted of a series of glass bulbs and tubes secured to a wooden frame (Fig. 3). Virtually, it was a tube bent several times, the lower portions of which contained mercury and the higher parts coloured water. The terminating end of the tube system was open to the atmosphere and a scale was fixed alongside of it.

In this form of barometer, the atmospheric pressure was balanced by the sum of the differences of level of the columns of mercury less the sum of the corresponding differences of the columns of water. Thus, by using a number of bent glass tubes, the height of the normal mercury barometric column may be very greatly reduced. Unfortunately, the sensitivity of this type of instrument is much less than that of the ordinary barometer. Hence, it was not practically successful as a measurer of atmospheric pressure. Its principle, however, has been used for the measurement of very high pressures.

Elected F.R.S.

In 1724, Gabriel Daniel Fahrenheit was elected an F.R.S., London, in honour, no doubt, of his thermometer constructions. From henceforward he went in for what we might term mass-production thermometer construction and, apparently, made a good thing out of it.

Later, he spent a good deal of time on the design of a machine for land draining, a project which was to be applied in the extremely low-lying parts of Holland. The details of this invention are, however, missing, for the machine was never completed and put to practical test, the reason being the death of its inventor, which occurred in Holland on September 16th, 1736.

Little notice was taken of Fahrenheit's decease. Indeed, there is some doubt as to the actual date of that event, one narrative ascribing it to the year 1740 instead of 1736.

But his memory has lived on, and despite the admitted imperfections of his thermometer scale, it seems that we are likely to retain it for many years to come.

A Tyre "Hospital"

THE accompanying illustration shows a corner in one of Britain's factories which has devoted energy and ingenuity to the wartime task of rubber conservation on a large scale, and is now slowly turning to the peace-time job of repairing tyres for commercial and private vehicles, as well as providing the additional output which the increase in public transport necessitates. Man (and woman) power is saved by an overhead conveyer system which discharges tyres at pre-selected points throughout the factory. Seven thousand tyres per week are received here, first for inspection, then for classification according to treatment required, and finally for repair.

Unsuitable tyres are scrapped and the rubber content is reclaimed.

What happens when the tyres reach the factory is this: After examination, tyres accepted for reconditioning are prepared for their new treads. With the use of precision machines, the existing tread surface is rasped down or, in case of need, stripped to the fabric. These raspings are saved for reclamation purposes. Should any major defects be detected at this stage, the tyres are passed to the repair shop. Again on machines, the rasped tyres are brushed clean, then solutioned and dried in ovens. The new rubber tread stock is applied by machinery in the "building-up" shop. Tyres are then conveyed to the moulding shop, where the new rubber stock is vulcanised to the carcase in regulated steam-heated moulds engraved with a familiar non-skid tread pattern.

In the repair shop of the tyre "hospital."

NEW SERIES

The Annals of Electricity—5

Frictional Electricity and the First Electrical Machines

IF, in a darkened room, you shake up a little dry mercury in a perfectly dry glass tube, you will probably witness some momentary miniature flashes of luminescence within the tube. And if, by any chance, you have an air pump available to extract the air from the tube before commencing the experiment, the luminous effect will be much more pronounced.

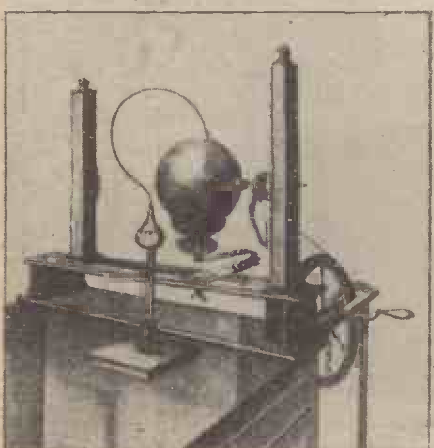
This peculiar phenomenon must have been noticed soon after the invention of the barometer, but, so far as we can trace, the luminescence was first recorded in the year 1675 by an individual named Picard.

The luminous effect is, of course, an electrical one, due to the friction of the metallic mercury with the inner walls of the glass tube, and it is of some interest because it happens to constitute one of the early experimental observations from which the science of electricity took its rise.

The contemporary explanation of the luminous effect was that it was caused by the presence of a special phosphorescent material in the mercury which, when agitated, gave forth flashes of light. Quite a controversy raged on the matter for a number of years, but the dispute was at last settled by an Englishman, Francis Hauksbee, one of the early Fellows of the Royal Society, who, in consequence of a number of experiments which he made, established the fact that the said luminescence is of frictional origin.

The Magdeburg Experiment

But before noticing the experimental work of Hauksbee any further, let us, for a moment, retrace our steps along the avenue of electrical discovery to the time of a certain very picturesque figure in the history of science, to wit, one Otto von Guericke, who was flourishing in the German town of Magdeburg around the middle of the seventeenth century. The worthy Otto was a confirmed adherent of science and experiment. He had, indeed, a taste for the spectacular in the experimental line, as witness, for instance, his famous experiment (1651) of the "Magdeburg Hemispheres," in which two copper hemispheres or half-globes were joined together and the air pumped out from the space enclosed by them. Each hemisphere was fastened to a team of 15 horses. The two horse teams pulled in opposite directions,



Dr. Priestley's electrical machine. It comprised a rapidly revolving glass globe making frictional contact with a lower spring-applied pad.

yet the two half-globes were not able to be separated. Nevertheless, when air was admitted into them again, they readily fell apart.

It was this famous Otto von Guericke,

The famous Otto von Guericke (1602-86), inventor of the air-pump and other scientific devices. He constructed the first electrical machine, consisting of a ball of sulphur rotated by hand. This illustration is taken from the frontispiece of one of his books.

who gave to the world the first known or recorded electrical machine.

The reader who has followed this series of articles may recollect that William Gilbert,

Francis Hauksbee's electrical machine in which the frictional electricity was generated within a partial vacuum.

the Court Physician of Queen Elizabeth's time, had divided all substances up into two classes—electrics and non-electrics, the "electrics" being those substances which generate an electrical attractive power when they are rubbed.

Whether Otto von Guericke, some 50 years after Gilbert's time, got his ideas from Gilbert's writings we do not know, but certain it is that von Guericke was the first to conceive the idea of making a ball or a sphere of an "electric" substance and by revolving it rapidly in a lathe-like device to collect frictional electricity from it by means of a suitable rubbing surface.

Von Guericke chose sulphur (one of Gilbert's "electrics") for his rotating sphere. He poured molten sulphur into a round glass bottle or flask, and, after the sulphur had solidified, he gently broke the bottle and extracted the sulphur ball. This he rapidly rotated on a hand-turned machine, using his free hand to make contact with the revolving sphere. In this way, he managed to draw sparks from the sulphur. When the machine was turned in a darkened room, Guericke noticed a feeble luminosity flickering around the contact area of his hand with the sulphur.

Strictly speaking, this was the first artificial electric illumination which the world had yet seen in continuous generation.

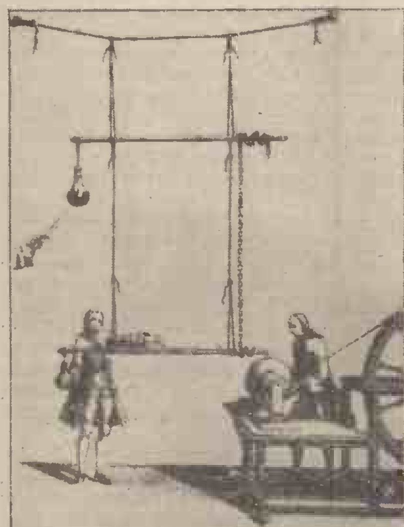
A few years after Guericke's experiment, Sir Isaac Newton, in London, repeated it. Newton, however, used a glass globe instead of a sulphur one, and got better results.

Francis Hauksbee

That is as far as electric development went until the aforementioned Francis Hauksbee came on the scene. Who Hauksbee was, where he came from, where he was born and when he died, are points of information which historians of science are still seeking. In fact, apart from Hauksbee's Fellowship of and association with the Royal Society and his published experimental work, there is practically nothing whatever known about him.

Whoever Hauksbee was, he must have been something of a genius. He seems to have stood at a focal point of electrical discovery and, by his work, to have given clues and indications to other inquiring minds which took up the trail of electrical discovery.

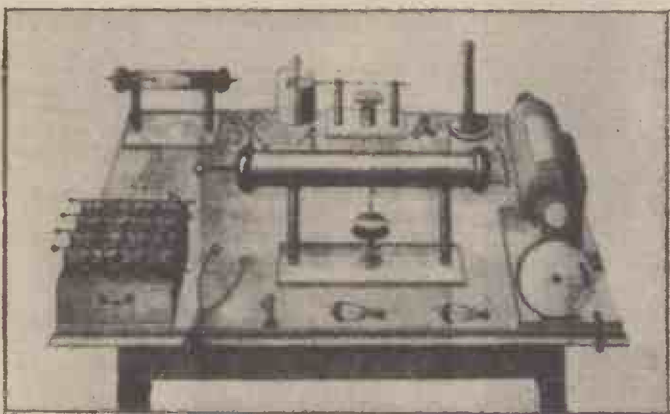
Hauksbee, we have already seen, explained the strange luminescence of shaken mercury in a tube. But he did far more than that. He contrived a frictional machine in which a glass sphere was rotated within an enclosing sphere exhausted of air. The inner sphere was revolved in contact with a dry woollen pad, and Hauksbee demonstrated to the members of the Royal Society the continuous production of "electric luminescence"



Charging a Leyden jar by means of a large frictional machine. (From an 18th century print.)

as long as the inner sphere was kept rotating and, also, as long as the outer glass sphere was maintained in a state of partial vacuum. Immediately, however, air was admitted into the outer receiver, the luminescence ceased, or, at least, diminished to barely appreciable proportions.

Francis Hauksbee, therefore, may be regarded as the inventor of the first practicable glass frictional electrical machine, for although Newton had previously used a glass sphere, thus advancing on Otto von Guericke's sulphur ball, he had only really dabbled in the subject, and had not made any important contribution thereto. Hauksbee, in fact, experimented with frictional electricity produced by frictional contact of materials in a vacuum along the lines above mentioned, and he also devised a non-vacuum electrical machine consisting of a rotating glass sphere, yet, in spite of his successes in this direction, it is an amazing fact that his electrical machines were taken little notice of in this country or abroad. Experimenters still went on generating their frictional charges of electricity by the slow, laborious and exceedingly unsatisfactory method of rubbing by hand a silken pad along a glass tube, as witness, for example, the exploits of Stephen Gray, the Charterhouse experimenter (*See article No. 3 of this series*) who made his fundamental discovery of electrical conduction and insulation by means of the rubbed tube method alone.



An electrical experimenter's bench of the mid-18th century. Note the cylinder frictional machine on the right. (From a contemporary print.)

The Suspended Boy

Assuming that Francis Hauksbee died about the year 1713, it can be stated that nearly thirty years elapsed before anyone else took it into his head to construct an electrical machine. It was only about 1743 that Hausen, a German experimenter and mechanic, of Leipzig, devised and popularised an electrical machine which was fundamentally built on the lines of the Hauksbee model.

Hausen's electrical machine comprised a glass globe which was rotated by means of a belt which passed around the circumference of a very large wooden wheel mounted in a strong frame, and provided with a substantial turning handle. This experimenter, like von Guericke of old, had a taste for the spectacular. He suspended a servant boy from the ceiling of his apartment by means of strong plaited silk lines. The lad was suspended horizontally so that the toes of one of his feet made contact with the rapidly revolving glass sphere. As a result, Hausen had the delight of drawing electric sparks from the lad's nose!

Another German compatriot, one F. M. Bose, made a similar electrical machine, with which he performed almost equally similar experiments, but Bose dispensed with the assistance of the serving lad, and used suspended iron tubes instead. He got the same spark-producing result.

Multi-frictional Machines

Then, as if to go one better, another experimenter of Leipzig, J. H. Winkler by name, devised and constructed a sort of multiple frictional machine in which three or four glass spheres were simultaneously rotated against frictional contacts instead of only one globe, thus producing a greater "kick" than the single-sphere machines. For a contacting material, Winkler used soft leather pads or cushions dusted with chalk. These increased the frictional effect, and so heightened the intensity of the electrical charges which were forthcoming.

Winkler seems to have made his electrical machines on a semi-commercial basis, for, in Germany, these frictional machines were becoming fashionable among wealthy amateurs. The fashion, too, spread to England, whose society circles at that time were becoming increasingly Germanised in view of the Hanoverian monarch who was then reigning in Britain. Consequently, a number of the German machines found their way over to our country for the delectation of not a few would-be amateur scientists of the period. Winkler must have "cashed in" to some considerable extent with his electrical machines, which were certainly strong and well made. He brought out a non-spherical electrifier, also. This comprised a glass tube alongwhich oscillated with a piston-like motion a leather rubbing pad, the mechanism being treadle operated. After this, he devised a machine for whirling an ordinary drinking tumbler on its axis against a frictional pad. There was no end to Winkler's practical constructive ability in the matter of his electrical machines.

But British experimenters and constructors were now arising. The pioneering experiments of Benjamin Franklin had placed electricity on the map, as it were. Electricity was beginning to have a good public.

A multiplicity of electrical machines of various patterns and sizes were devised and constructed in England. They all, of course, operated on the same plan, namely, the friction of a suitable contacting material upon a glass globe or cylinder. Many were the devisers of such machines; many, too, were the operators and experimenters, but few were the theorists who endeavoured to advance the knowledge of electrical science.

Dr. Priestley

One of the most interesting of these experimenters was a voluble, energetic and learned dissenting clergyman, the Reverend Joseph Priestley, a Yorkshireman. When he was not writing philosophical pamphlets or annoying people with his novel theological views, he was experimenting in chemistry, discovering oxygen, writing histories of Light, Electricity and other learned works.

Priestley shines as one of the "patron saints" of chemical science, a position which, on the whole, he deserves, but he was an ardent electrical enthusiast as well, and we are indebted to him for a detailed knowledge of a number of interesting electrical generators which were forthcoming after the middle of the 18th century.

Dr. Priestley devised an electrical machine of his own, "the result," he wrote, "of my best attention to this subject." In the Priestley machine a short metal rod was cemented into a glass globe. A disc or other type of rubbing pad was pressed against the sphere, and the electrical charge was collected by means of a bunch of fine wires which lightly contacted the revolving globe.

A Schoolmaster Experimenter

Among the really serious adherents of the electrical science of this period was a schoolmaster, John Canton by name. He was born in 1718, and died in 1772. He was friendly with Benjamin Franklin, and had been the first to repeat and to confirm the electrical experiments of that pioneer in this country. Canton, too, had interested himself in the Leyden jar, the then newly discovered accumulator of static charges, and, besides being elected a Fellow of the Royal Society, he had received a gold medal from that body for a paper dealing with the making of artificial magnets.

Naturally enough, John Canton gave his attention to the frictional electrical machine. His contribution to the improvement of such machines was the coating of the "rubber" or contacting material of the machine with an amalgam of mercury and tin, thus increasing its efficiency.

But, in 1753, Canton made a far more important discovery. He found that electricity could be generated in a material merely by the approach of an electrified body to it and without any actual contact between the two. Stephen Gray, before him, had obtained glimmerings of this phenomenon, but Canton, living in a slightly more advanced age, was enabled to study the effect at greater length. He found that if a cork ball suspended on a thread is brought near

Original electrical machines are rare nowadays. Here is a recent photograph of an early machine constructed on the disc principle originated by Jesse Ramsden. It is still in working order.

to a positively charged metal rod, the ball becomes negatively electrified on the side facing (but not touching) the ball. If the closeness of proximity is sufficient, the cork ball is attracted to the rod, and, on touching the latter, the ball is at once repelled, since positive repels positive. The ball remains in this state of repulsion until its positive charge is dissipated by the ball's being touched. On this principle, Canton constructed a set of light bells which were sounded by "hammers" consisting of cork balls in their attractions and repulsions. "Canton's electric chime" is still an article of lecture and laboratory demonstration in the majority of present-day technical schools and colleges.

Electricity Across the Thames

Another contemporary experimenter in the realm of frictional electricity was William Watson (1715-87), also a Fellow of the Royal Society. Watson made electrical machines, including a multi-sphere machine, but his most important technical achievement comprised his sending an electric charge across the River Thames. This took place in the year 1747. Aided by several other Royal Society members, Watson rigged up an electrical circuit consisting of a large Leydon jar, a length of wire stretching across Westminster Bridge and two collaborators standing on opposite banks of the river and holding long iron rods in contact with the water. The circuit was broken at a suitable point by Watson himself. When he completed the external circuit from the Leydon jar by grasping two ends of the wire with opposite hands, the Leydon jar was instantly discharged and all the individuals included in the circuit received an electric shock, proving that the electric charge had flowed out of the Leyden jar via the wire across Westminster Bridge and through the water of the river, passing, of course, through the bodies of the operators on its way.

William Watson was, in reality, an experimenter who followed closely in the footsteps of Stephen Gray early in the century, for just as Gray had transmitted feeble charges through hempen lines, so also did Watson, some two decades afterwards, transmit more powerful static charges stored up in Leyden jars through external circuits, the largest of which amounted to some two miles in length. Watson also made a serious attempt to discover the actual speed at which the electrical charges were conducted by the wire circuits, but his attempts were inconclusive, and only pointed to the fact that the speed with which the electric charges travelled was very great. It is interesting to note that Benjamin Franklin found Watson's experiments sufficiently important to repeat for himself in America.

The Disc Machine

A decade or so after the middle of the 18th century, an important modification was introduced into frictional machine construction by Jesse Ramsden (1735-1800), who introduced the use of a revolving glass disc instead of the rotating globe or cylinder which had been used previously. This construction not only simplified the electrical machine, but it also made it more efficient and it quickly resulted in the previous types of machines becoming obsolete.

Jesse Ramsden was in many ways a truly remarkable man. The son of a Halifax inn-keeper, he became a clerk in a woollen warehouse. At the age of 23 he threw up this job and apprenticed himself to a mathematical-instrument maker. Afterwards he opened a shop in the Haymarket, London, and quickly acquired lasting fame for himself as a reliable and ingenious instrument-maker, an optician, a telescope constructor and, last of all, an electrical experimenter. It is of interest to note that all the present-day frictional electrical machines, including the well-known "Wimshurst Machine," operate on the glass disc principle originated so long ago by Jesse Ramsden, the London instrument-maker.

Big Ben

A Description of the Movement of the Great Clock at Westminster

THE Westminster clock tower (Big Ben) is 40ft. square. There are four dials, 180ft. above the ground level; each of them is 22½ft. in diameter, or nearly 400 sq. ft. in area. Cast-iron framework forms the divisions and figures, the spaces being filled in with opalescent glass. The hour figures are 2ft. long and the minute spaces 1ft. square. The hour hands are solid, and cast of gun-metal. For lightness the minute hands are tubular; they are of copper, the shells being thin, but strengthened by diaphragms at intervals. The copper tubes are tapered and closed at the tips, their open ends being fitted to gun-metal centres, which also form the outside counterpoises. Each minute hand measures 11ft. from its centre of motion to the point, besides the counterpoise of 3ft., so that the load on the block when the hands are subjected to a high wind or covered with snow can be understood.

Cast-iron Frame

The movement is contained in a frame made up of two cast-iron girders 15½ft. long, placed side by side 4ft. apart and braced together. There are three trains or sets of wheels, each one driven by a separate weight: the "going" or "watch" train that drives the hands, and is controlled by the escapement and pendulum, occupies the centre of the frame; on the left hand in the accompanying illustration is the hour striking train, which only moves once an hour, when it is released by the going train, and locks itself after it has struck the number of blows corresponding to the hour of the day; on the right is the quarter train, which is released by the going train and allows a chime of either one, two, three, or four quarters as required, and again locks itself. The first quarter denotes 15 minutes past the hour, and the interval between the first and second, and between the second and third quarters is 15 minutes, but the fourth quarter is let off 20 seconds before the hour so that it shall be completed before the first blow of the hour.

The Going Train

As it has less to do, the going train is lighter than either of the striking trains, and in all three the strength of the wheels and other parts is greater near the weight barrel and is gradually diminished as the velocity of the parts increases. In the going train the parts near the escapement can hardly be too light, for it is necessary that they should get into action quickly, directly they are unlocked, and give as light a blow or shock as possible when they are locked again. The four pairs of hands are driven by four horizontal minute arbors placed high above the movement, and leading each one to the centre of one of the dials. Each dial has separate motion wheels for reducing the rate of travelling of the hour hand, the motion work being carried on the walls of the clock room. It will be seen from the illustration that connection between the movement and the minute arbors is made by means of the oblique shaft A, and the mitre wheels, B, C, D and E.

The numbers of teeth of the going train are: great wheel 180, driving a pinion of 48 on the right for the hand work, and one of 12 on the left; on the arbor of the latter is the second wheel of 120 driving the pinion of 16, which carries the third wheel of 90, driving the escape pinion of nine. The great wheel is 2ft. 3ins. in diameter and the escape wheel 12ins. The pendulum beats once in two seconds and weighs 685lb.

Striking Mechanism

For striking the quarters the four-armed cam or snail G turns once in an hour. It is gradually pressing down the lever H. The quarter train is held by the locking lever I, which rests on the upper one of two blocks on the lever K. The lever H acts on the lever K, and as the quarter hour approaches, the lever K rises and allows the locking lever I to escape from the first locking block to the second one, which is rather lower on the lever; this allows the train to move a little, and causes the noise generally known as warning. When the quarter is to be sounded the lever K falls free of the locking lever I and the train of wheels begins to run, the lever K being lifted sufficiently high by the cam L to disengage the tongue M from the notch of the locking plate or count wheel N, in which it is resting. If one chime only is to be struck the tongue M descends into the same notch of the locking plate, for that notch is wide enough to receive the tongue again after the small angular movement made by the plate, and the upper block on the lever K catches the locking lever I as it comes round. But at the next quarter, after one chime has been sounded, the tip of the tongue rests on the periphery of the locking plate till another chime is struck, when it falls into the next notch. The locking plate makes one rotation in three hours, and it will be observed that it is spaced out to allow three sets of quarters. The interval between the hammer blows is kept constant by the resistance of the air against the revolving fly O, which is composed of two large blades of sheet iron.

The action for letting off the hour striking is very similar to that for discharging the quarters, except that there is a double warning. The hour striking train is held by a stop on the locking lever, resting against the upper of the two blocks on the lever T. A few minutes before the hour the locking lever falls on the lower block and is released 30 seconds before the hour by the snail R, which revolves once in an hour (the four-armed snail attached to the hour snail is for actuating a lever which stops the winding of the quarter part when the time for striking the quarters approaches). The locking lever is then held by a small independent lever till two seconds before the hour, when a snail on the second wheel arbor, which rotates once every 15 minutes, allows one extremity, then hits up the independent lever and releases the locking lever. By the time the two seconds have elapsed the first stroke is sounded on the bell. While one o'clock is striking the lever T is held clear of the locking lever by the cam W, the tongue on the lever then descends into the wild notch of the locking plate S; at two o'clock it is retained on the edge of the plate till two blows have been struck, and so on; the locking plate, which turns once in 12 hours, being divided so as to allow all the hours to be struck in rotation.

Operating the Bell Hammer

Around the side of the great wheel (X) of the hour part are 10 cams for pressing down the lever, which, through the intervention of the wire rope shown in the drawing, raises the hammer of the great bell in the chamber above. This wheel is 3ft. in diameter, has 140 teeth and gears with a pinion of 21; the second wheel has 90 teeth and gears with a pinion of 15 on the arbor of the locking lever. The great wheel of the quarter past (Y) is 3ft. in diameter, and the side of it is spaced out for 60 cams. This wheel has 150 teeth, gearing with a pinion of 20; the second wheel of 90 teeth gears with a pinion of 15 on the arbor of the locking lever.

Attached to the clock frame over the hour striking lever is a strong curved spring, as shown in the drawing, to check the upward motion of the lever. The length of the wire rope connecting this lever with the bell hammer lever is so adjusted that the hammer is lifted after the last blow is struck; so that when the train is again released the lifted arm is disengaged from the cam at once, and the hammer immediately falls.

Maintaining the Pendulum Movement

To maintain the vibration of the pendulum during the 20 minutes or so that it takes to wind the going part of the clock, Lord Grimthorpe invented a special kind of maintainer. The back bearing of the winding pinion arbor is carried in a loose link slung from the barrel arbor. To obtain a resisting base so that the winding pinion should not run round the wheel with which it gears a click presses against the ratchet teeth on the side of the great wheel, and so drives the clock. But as the great wheel travels on the back end of the winding arbor in following it is taken out of the horizontal line, and soon becomes so oblique that the winder has to stop and let it down to its normal position again. Although this maintaining work is ingenious for clocks of moderate size that take but a few minutes to wind, a spring maintainer is preferred.

To obtain sufficient purchase in winding the hour and quarter parts there is an intermediate wheel and pinion to each, and the bearing of the arbor of the intermediate pinion is formed of an eccentric bush, so that the pinion may be readily disengaged from the wheel when the time for striking approaches, or when the winding is completed. The hour pinion is shown out of gear, the lever attached to the eccentric being pushed away from the spring catch, while the one for the quarter winding is shown in gear ready for winding.

The clock frame is not in the centre of the room, but placed so as to allow a space of about 2ft. clear from one of the walls, to which a very strong cast-iron bracket is fixed, and from this bracket the pendulum is hung.

Hour and Quarter Bells

The bells are arranged in a chamber above the dials, and hung from massive wrought iron framing. The hours bell is 9ft. in diameter, 8¾in. thick at the sound bow, and weighs 13 tons 11 cwt. It is struck by a hammer with a cast-iron head weighing 4 cwt., which is lifted 9in. vertically and 13in. altogether from the bell before it falls. There are four quarter bells, weighing respectively 78 cwt., 33½ cwt., 26 cwt. and 21 cwt.

The hammers for the quarters are each about one-fortieth of the weight of the bell it strikes. To prevent the hammers jarring on the bells they are kept from contact by india-rubber buffers on which the shanks fall.—" *Watch and Clockmakers' Handbook.*"

AERODROME IMPROVEMENTS

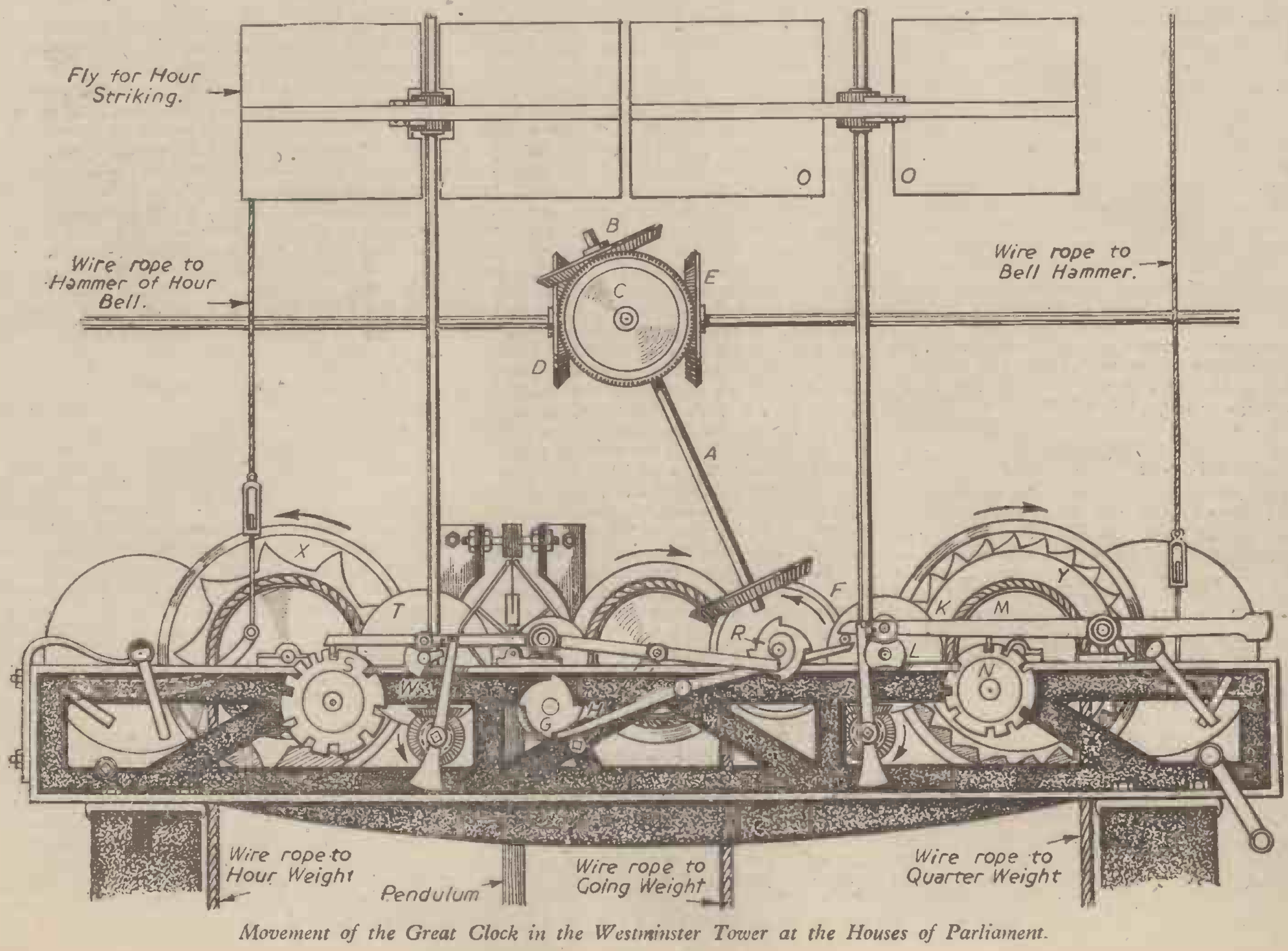
AMONG recently accepted applications for a patent in this country is one relating to an invention which enables the take-off of a 'plane to be easily and quickly effected.

Another object of the invention is an improved method of conveying passengers to and from an aerodrome.

The new device arranges for an aerodrome having a circular track and a platform to run on the track and to carry an aeroplane.

Radiating from the track are a number of runways, each of which is provided with a turntable. The platform moves round the track so as to bring the aeroplane into alignment with any selected runway, the turntable being employed to turn the 'plane.

The invention further comprises the above-mentioned aerodrome in combination with an overhead railway, the inner terminus of which is located at a station within the circular track.



Movement of the Great Clock in the Westminster Tower at the Houses of Parliament.

THE WORLD OF MODELS

By "MOTILUS"

A Miniature Fair Ground, and Some Examples of "Pyruma" Modelling by Schoolgirls

THE fair has been a feature of English life for generations, and, with the advance of steam, and later the Diesel engine and electricity, this feature has become more attractive and more noisy, and it still has the greatest thrill for youngsters. The whirling roundabouts playing their tunes, the coconut shies, the stalls and booths—in fact "all the fun of the fair"—I hope will long remain the peculiar property of the English countryside.

Figs. 1 and 2.—Two views of the model Fair made by Mr. S. G. Cooper, of Norwich. To give a rough idea of the size, the large roundabout is approximately 4ft. in diameter.

I feel, therefore, that it is appropriate to hear from Mr. S. G. Cooper, of Norwich, who has been a reader of PRACTICAL MECHANICS since the paper first appeared, and who now sends me photographs (Figs. 1 and 2) of a most ingenious model of his, which represents ten years' work during his spare time, and has already been the means of raising over £300 for Norwich war charities.

Miniature Fair Ground

It is a fair ground in miniature, constructed to a scale of 1in. to the foot, which has been on view at several exhibitions.

The fair has its own loudspeaker, and current is distributed from a transformer van. There are models of living vans and two or three container vans into which it is possible to pack the whole apparatus. There are a variety of stalls and booths shining with multicoloured lights, fair engines chugging away, and roundabouts whirling round with the familiar music coming from the centre hub. The big roundabout, nearly four feet in diameter, is complete to the last detail, with inviting-looking "gondolas," and a model organ.

It is amazing to realise that Mr. Cooper has worked throughout without the aid of drawings. The three fair engines alone—two driven by electricity and the other by steam—must have kept him busily occupied for hundreds of hours. The whole model—or series of models—contain much finely-constructed engineering work, and even now Mr. Cooper does not consider his fair ground complete, and continues to add new pieces as time permits. More power to his elbow!

A Model Zoo

Last month we were discussing the value of model making in a school—a model boat constructed by a class of boys. This month we also have news of model work at a girls' school, and our old friends "Pyruma" and "Tiluma" come into the picture. Miss Gretchen Studer, A.R.C.A., art mistress at the Northampton School for Girls, Northampton, decided to introduce this modelling cement to her girls. First she made an experiment, giving the cement to an adult, who had previously very little modelling experience. The result was the Zoological Garden which is seen in Figs. 3 and 4. The model depicts a group of students wearing the school blazer, visiting the Zoo with their mistress. Among the animals modelled are gorillas, elephants, a lion, kangaroo, polar bear, horse, zebra, seal, tiger, camel and hippopotamus. The cages are ingeniously made from wire flower baskets, and ordinary wooden boxes have been effectively disguised to make realistic local colour. The garden foliage came from the shrubbery plants, suitably adapted and fixed with Pyruma and Tiluma, which form the bulk of the model.

The dimensions of the Zoological Garden are approximately 4ft. by 3ft., and the figures are for the most part approximately 1/15th actual size. Some of them, particularly the kangaroo and the elephant, are good examples of modelcraft.

Figs. 3 and 4.—Views of the Zoological Garden made in Pyruma and Tiluma.

From this model Miss Studer decided Pyruma was a suitable modelling medium for schoolgirls, and subjects of the three other illustrations, Figs. 5, 6 and 7, are the work of girls from the ages of 11 to 16. Toy Town, an attractive layout, showing a toy soldier with a circle of toy animals around him and a little tree shrub in each corner, is the work of one girl. Four eleven- to twelve-year-olds were responsible for the Recreation Ground, with its swings, sandpit, see-saws, and other items of fun for kiddies. Fig. 7, the modern Nativity, was the work of three fifteen-year-old girls.

All these models were on view last year at the Art and Handicraft Exhibition of the school, held at the local art gallery.

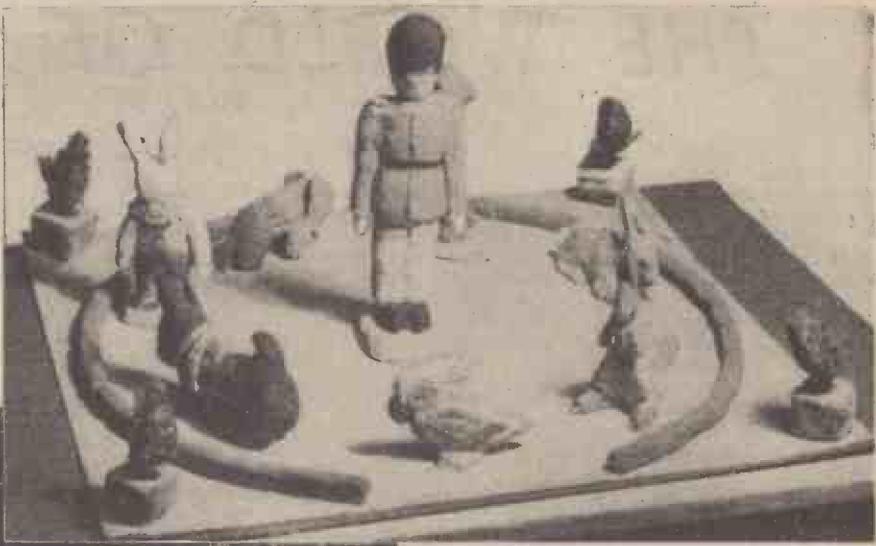


Fig. 5.—" Toy Town "—the work of one girl scholar in Pyruma.

This modelling is done by the girls from their own choice, and this season again a number of pupils are working on another Pyruma model for the next art exhibition.

New Book on Models

Looking in Bassett-Lowke's branch at Holborn the other day I see they have a new book on sale—Marvellous Models, published by the Penguin people. It is the joint work of Mr. W. J. Bassett-Lowke and Mr. Paul B. Mann, and I should say from scrutiny will prove one of the most popular in this well-known series of Puffin books for juveniles.

Among the models featured in the book are Euston Station in the early days, a canal model complete with water, and the process of picking up the mails on the L.M.S. There is the Queen's Dolls' House, H.M.S. *Hood*, some historic models from the Science Museum at South Kensington, including the *Cutty Sark* and an Elizabethan galleon, and finally the famous Robot model which was the feature of a Radiolympia Exhibition some years ago.

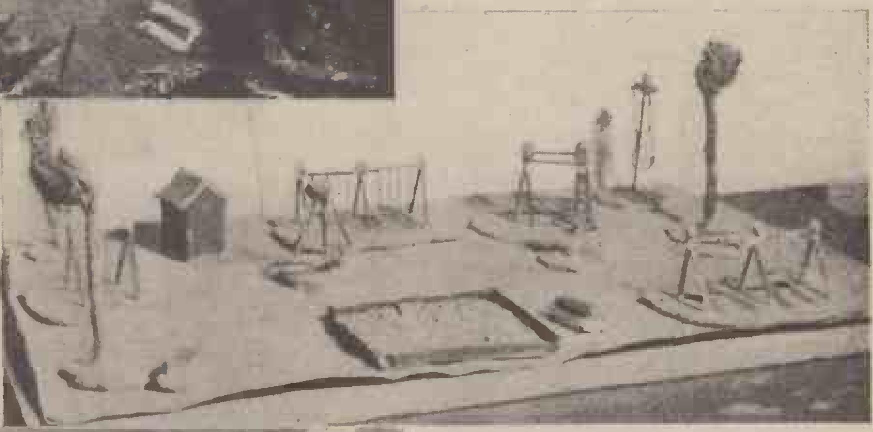


Fig. 6.—Recreation Ground—a model by the younger girls.

Fig. 7.—A modern Nativity—the work of three 15-year-old girls.

The centre spread deals with the building of the largest model of the largest ship —R.M.S. *Queen Elizabeth.* Another point to appeal to the younger generation is the description of how to make their own models, including a windmill, a waterline model of the *Hood*, and a cardboard dolls' house, and a ship propelled by camphor. The well-guarded mystery of the " ship in a bottle " is explained, and another useful set of pages are those which tell you " How models work," covering steam, clockwork and electric, with descriptions of their internal mechanism.

The author is well known in the model world, and Paul Mann is a sapper in the Royal Engineers who went overseas just as the work was completed. This book is obtainable direct from Messrs. Bassett-Lowke, Ltd., Northampton, post free 10½d.

Inventions of Interest

By "Dynamo"

Bandage Remover

AMONG applications for patents accepted by the British Patent Office is one relating to means for cutting and removing plaster and similar bandages from patients. The object of the invention is to furnish a simple power-driven saw worked by pneumatic pressure.

The device consists of a circular saw mounted in a casing. This is driven by pawl and ratchet means actuated by a piston and piston rod operated by compressed air. The casing is provided with a safety guard extending round the teeth leaving only sufficient teeth exposed for the cutting operation.

One such safety member, preferably the lower one, is shaped as a prong or claw. This serves to engage the end of the bandage and guide saw proper during its operation. It also prevents the cutting member from injuring the skin, underlying tissues or a bone.

Rubber Floors

AN inventor has been devoting his attention to rubber flooring. He points out that this kind of flooring is very generally used, and has outstanding wearing and cushioning characteristics. Certain disadvantages, he adds, have been encountered in special applications. For example, in some places the build-up of static electricity during the use of the flooring creates a serious explosion hazard. This danger, he further mentions, exists in plants where explosives are manufactured. And it has also been suggested that serious consequences may occur in hospital operating rooms when doctors or nurses build up static electricity by walking and then touching a patient whose lungs are full of an explosive anæsthetic mixture.

The aim of the inventor in question is to provide rubber flooring which will minimize this danger and the attendant hazards in particular installations.

The improved flooring consists of a vulcanised rubber compound of relatively high electrical conductivity and, embedded in the rubber, spaced readily stretchable and compressible linear metal elements capable of expansion and contraction with the rubber without breaking.

Fire Extinguisher Guard

FIRE extinguishers when fixed in public positions are liable to be tampered with. It is stated by an inventor who is applying for a patent in connection with these extinguishers that such tampering cannot be detected by a mere external inspection. This inventor has conceived an arrangement whereby the fact that the extinguisher has been tampered with, and may have been partly or completely emptied by proper usage or maliciously, can be visually examined.

The author of the device affirms that it simplifies the means whereby extinguishers may be kept in proper working order.

The invention comprises a fire extinguisher of the pump type, and a bracket to hold it. The latter supports the extinguisher in such a manner that the operating handle cannot be actuated without removing the extinguisher from the bracket and breaking sealing means interlinking the extinguisher with the bracket. The removal of the extinguisher from the bracket will break or destroy the sealing means.

Razor Sharpener

ANOTHER safety razor blade sharpener has made its début. In this instance there is a hollow cylinder rotatably mounted in a frame intended to be held by the hand of the person shaving.

The rotation is effected by a crank or a lanyard. And the blade is held with its edges in contact with the interior wall of the cylinder by a finger of the hand holding the frame. The crank or lanyard is held by the other hand of the user.

The information on this page is specially supplied to "Practical Mechanics" by Messrs. Hughes & Young, Patent Agents, of 7, Stone Buildings, Lincoln's Inn, London, W.C.2, who will be pleased to send free to readers mentioning this paper a copy of their handbook, "How to Patent an Invention."

Flypaper Suspender

WHEN the temperature rises flies usually commence their activities. As a rule the only point in a room from which a flypaper can easily be suspended is the gas or electric light fitting. This is not an ideal position, because it is liable to damage the fitting as well as the shade. Moreover, the paper is often too low to permit it to be used at full length.

An inventor has submitted to the British Patent Office a device the principal object of which is to enable a flypaper to be hung without injuring the ceiling or fittings. The device comprises an open and generally V- or U-shaped attachment adapted to be moved laterally against a lighting fitting for engaging without encircling the latter. There is an arm provided with a hook or loop for carrying a flypaper.

Aircraft Wheel Cooler

THERE has already been invented a wheel for the undercarriages of aeroplanes, making provision for a current of air to be drawn through ducts which separate the braking surfaces of the wheel from the rim that carries the tyre. The object of this arrangement is to prevent the heat generated at the braking surface from damaging the tyre.

An improved invention of this type has air ducts within the wheel and also impelling means rotatably mounted within the wheel assembly and driven by the wheel to aid circulation through the above-mentioned ducts of a cooling medium. This is in addition to the normal impelling effect of the ducts.

The impelling means may take the form of vanes rotated at a speed higher than that of the wheel. It may be mounted either within a hollow space inside the wheel itself or within a hollow shaft or axle on which the wheel is mounted.

New Form of Clock

WHAT is termed a Time and Clock Educator has been contrived to teach young persons how to tell the time.

There is a clock face which has apertures through which are displayed the hours and the minutes corresponding to the position of the hands of the clock.

The clock hands are attached to the concentric mounting of a minute-indicating disc and an hour-indicating disc, upon which the minutes and the hours are applied and displayed through the apertures. The hour aperture is elongated to allow each hour reading to be exposed throughout 30 deg. of its travel.

This Time and Clock Educator is economical to make and may be manufactured in metal, wood, cardboard and plastics. It may be produced in a variety of designs.

An important part of our war effort was the making in this country of artificial sapphires for jewelled bearings. Our illustration shows the electric furnaces in operation in the laboratory of Salford Electrical Instruments, Ltd., a branch of the General Electric Company. The operator, his eyes protected against the violent glare of the flame, watches the sapphire being formed through the slit in front of the furnace.

QUERIES and ENQUIRIES

A stamped, addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on back of cover, 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.

Chemicals for "Storm Glass"

COULD you please inform me as to what are the chemical constituents of the liquid which is used in the so-called storm glasses ?—D. Francis (Brecon).

THIS type of storm glass is very unreliable, and seldom gives lasting satisfaction. However, for what it is worth, here is the method of making one :-

Camphor, 2½ drachms.
Rectified spirit, 11 drachms.
Water, 9 drachms.
Saltpetre, 38 grains.
Sal ammoniac, 38 grains.

Dissolve the camphor in the spirit and the saltpetre and sal ammoniac in the water. Then mix the solutions together. Pour the mixed solution into a tube and then provide the latter with a tightly fitting clean cork, which should be waxed over after being placed in position. Using a fine needle, pierce the cork through with a very fine hole. After mounting the tube suitably on a wooden frame or board, it will be ready for use.

Its indications are roughly as follows :

Tube filled with soft and powdery crystals—Rain.
Crystals at bottom of tube and liquid clear—Fine.
Crystals gradually rising in tube—Change.

In winter, the crystals will usually rise higher in the tube, whilst during the summer they will be lower.

The device is, of course, nothing more than a scientific toy, and you must not expect any reliable results from it.

Immersion Water Heaters

WILL you kindly give me the formula for calculating the windings for copper sheathed electric immersion water heaters rated at 250 volts' 1,250 watts ? These heaters, too, have a core of strip mica approximately 1in. by 15in., which will be formed into a loop and will be used in domestic kettles.—P. L. Pervin (Stoneleigh).

THE average temperature of the wire used in immersion heaters for electric kettles may be taken as about 850 deg. C. ; if the wire was not enclosed but was straight and free to radiate heat in air the equivalent temperature would be about 500 deg. C. A 1,250-watt element operating on 230 volts would take 5.41 amps. If you use Brightray (80 per cent. nickel, 20 per cent. chromium) alloy resistance wire as manufactured by Henry Wiggin and Co.; Ltd., Grosvenor House, Park Lane, W.1, 31 32 s.w.g. would reach 500 deg. C. with 5.41 amps. in free air.

The total resistance of the element would need to be 230/5.41 = 42.5 ohms. The resistance of 31/32 s.w.g. Brightray wire at 850 deg. C. is 5.45 ohms per foot, so that you would need 7.78ft. of this wire. In order to find the correct size of tape which would give you the same temperature rise with the same current as the wire, the formula $p \times a = \frac{P \times A}{0.6 + 0.0002t}$ may be used, where p is the true perimeter of cross section of the tape, a is the cross sectional area of the tape, P is the circumference of the round wire, A is the cross sectional area of the round wire, and t the temperature rise above the surrounding air.

$$p \times a = \frac{0.0352 \times 0.0000988}{0.6 + 0.0002 \times 500} = \frac{3.52 \quad 9.88 \times 10^{-7}}{0.6 + 0.1} = \frac{34.7 \times 10^{-7}}{0.7}$$
$$= 4.957 \times 10$$

Tape of 0.025 by 0.003 gives p × a as $0.056 \times 0.000075 = 4.2 \times 10^{-6}$, whilst tape of 0.025 by 0.004 gives p × a of $0.058 \times 0.0001 = 5.8 \times 10^{-6}$. The latter tape has a cold resistance of 5.3 ohms per foot, say 5.5 ohms per foot at 850 deg. C., which gives 7.72ft. required. As the tape is slightly larger than is necessary, you could experiment with a slightly longer length.

Plaster of Paris : Parchment Paper

I SHALL be glad if you will answer me the following questions :

(1) How is plaster of Paris obtained ?

(2) What is the process to make parchment paper ?—A. Schembri (Malta).

(1) PLASTER of Paris is, as you are probably aware, a form of calcium sulphate or gypsum. It consists essentially of calcium sulphate which has been partially deprived of a portion of its water-of-hydration by heat. Chemically, it is represented by the formula $(CaSO_4)_2.H_2O$. It is produced by heating powdered gypsum in an oven or kiln to a temperature of between 115 and 130 deg. C., and in such a manner that the fuel used for heating the kiln does not actually come into contact with the gypsum. Usually, the kiln is of the rotating type, the gypsum thereby being equally heated throughout its mass. Great care is taken not to let the temperature of the kiln exceed 130 deg. C., otherwise the calcium sulphate will lose all its contained water and will become what is termed "dead burnt," in which condition its properties of setting when mixed with water will become almost nil.

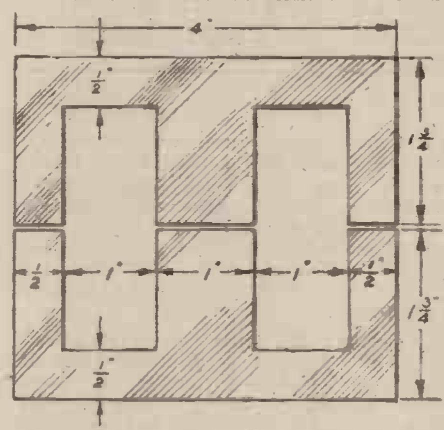
(2) True parchment paper is made by immersing ordinary good-quality paper for a second or two in strong sulphuric acid and immediately afterwards plunging it into a bath of strong ammonia. The paper is finally washed. It will be found to have acquired by means of this treatment, a horny, tough consistency, very similar to parchment or vellum.

Owing to the difficulty of working this process commercially, many of the so-called "parchment" papers comprise merely papers in which have been incorporated different varieties of "filler," such as barytes, during their manufacture. These "filled" papers, however, are anything but enduring, and frequently they become brittle on exposure to air, light and moisture.

Choke for 80-watt Fluorescent Lamp

I WISH to make a choke to use with an 80-watt fluorescent lamp. Can you supply me with core and winding details ?—J. Widdison (Deal).

WE suggest you use a laminated iron core of the dimensions shown in the accompanying sketch, winding a bobbin, into which the two halves of the centre limb will fit, with 1,000 turns of 22 s.w.g. enamelled wire. A certain amount of adjustment will probably be necessary to obtain the best results, and this can be made by varying the air gap between the two halves of the core. You could start with the halves in contact, increasing the air gap very slightly until you obtain the best operating results, or until you obtain 115 volts across the lamp with about 0.8 amp. flowing. Thin strips of mica could then be placed in the air gap to make the core solid. An air gap of approximately 0.015in. will probably give you the required choking effect.



Dimensions for a choke for an 80-watt fluorescent lamp. Iron core built up to 1½in. thick with laminations about 0.014in. thick.

Light-sensitive Emulsion

(1) BEING a keen amateur photographer and unable to procure film or plate, I would be grateful if you could supply me with the following information : What is the formula for the gelatine substance which is found on one side of the film ? Could I buy the amount of cellophane needed ? If not, what is the formula of this ?

(2) Could you also give me a formula for a plastic substance which would pour into a mould and set ? The substance of a hair-comb, for example.—R. Brooke (Mirfield).

(1) PHOTOGRAPHIC films are not made of cellophane, but are composed of celluloid (quite a different material) coated on one side with a thin covering of gelatine, and on the other side with the light-sensitive emulsion. If by the "gelatine substance" you mean the light-sensitive emulsion, then we must inform you that unless you are very highly skilled and experienced you will find it quite impossible to prepare a successful photographic emulsion, since all commercial emulsions used in plate and film manufacture are highly secret in nature.

Essentially, of course, a photographic emulsion consists of grains of silver bromide which are suspended in a "vehicle" or matrix of gelatine, but the actual preparation of such an emulsion is a very difficult proceeding and quite beyond the resources of most amateurs.

If you desire to read the matter up there is a good book on the subject, the title of which we give below : E. J. Wall : "Photographic Emulsions : Their Preparation and Coating on Glass, Celluloid and Paper" (pre-war price, 12s. net). Even this volume, however, does not purport to reveal any secrets of the trade emulsion makers, but it will certainly give you an insight into the difficulties and intricacies of the subject.

(2) Here, again, there is no actual "formula" for a plastic substance of the nature you require. Bakelite resin powder would suit your purpose, and probably you might be able to obtain some of this from Bakelite, Ltd., London, S.W.1. But bakelite resin, as you probably know, is made by a process of heating together carbolic acid and formalin, together with other materials such as caustic soda. You cannot make such material yourself. If, however, you can obtain some of the thermo-setting bakelite resin, you will have to put it into a mould and subject it to pressure and heat in order to get an accurately moulded article of the type you name. Again, you have a very difficult proposition in front of you.

Plastic materials are not prepared merely by mixing a few substances together and then leaving them to set, as you and many others imagine. They have to be very carefully made by means of delicately controlled chemical processes, and it is just these processes which cannot be imitated by amateurs on the small scale.

Principle of Household Water Softeners

COULD you please explain the principles of an ordinary household water softener ? I am given to understand that when common salt is used to soften the water, the action takes place in conjunction with a special Swedish gravel. Is this correct ? Also, is it to be expected that in the course of time the contents of the softener will deteriorate, needing replenishment ?—F. B. Francis (Gillingham).

THE household water softeners operate on what is termed the "base exchange" principle. You will find the whole matter fully explained in any modern textbook on inorganic chemistry. Briefly, the principle is this : The hard water is trickled through a bed of a natural or artificially-made (generally the latter) mineral material, which material extracts from the water its hardness-giving constituents and securely retains them in chemical combination. After a time, the "active material" becomes unable to carry on with this extraction process. Hence, as you say, the softener deteriorates in its action. When this occurs, the active material may be regenerated merely by pouring a solution of common salt through it, and then by swilling the excess of the salt solution away by means of soft water. The salt solution has the property of removing the combined hardness-forming elements which the active material has removed from the water and of leaving the active material in a fresh and reactivated condition.

Natural zeolite was the first of these active materials to be used in water softeners, and much of this came from Sweden. Hence, your mention of Swedish gravel is quite correct. Nowadays, zeolite material can be made artificially, and even certain types of synthetic resins can be used for the same purpose. Nevertheless, during the war these water-softening materials have been very scarce, but, doubtless, they will soon again be forthcoming.

Painting Asbestos Cement Sheeting

I WISH to apply ordinary household exterior paint to the asbestos cement sheeting used for covering a garage. After this material has been painted some time I have noticed the paint flakes off. Could you please inform me :

(1) Is it necessary to treat the sheeting with anything before applying paint ?

(2) If so, what is the preparation ?—T. B. Smith (Chester-le-Street).

THE compressed asbestos material to which you refer is very difficult to paint satisfactorily, particularly if it is old, because, in time, the material tends to soften and to detach itself in layers. Consequently, old asbestos sheets which are in bad condition are certainly not worth the trouble and expense of painting.

If your asbestos sheets are in reasonable condition, your best plan will be to allow them to dry out thoroughly during a sunny spell of weather. Then give them a thin priming coat of either a red oxide or a "grey primer" paint. Let this harden properly. Then repeat the process. Finally, apply the surface paint which you desire to have on the asbestos sheets.

This is about the only treatment which you can give to the sheets. The function of the priming paint is to "key" the surface paint to the asbestos material. It does this fairly satisfactorily, provided that the underlying asbestos surface is in good condition. Otherwise, the priming paint will have little effect.

Push-button Motor Starter

I HAVE just fitted up a 3in. centre lathe with a ¼ h.p. single phase electric motor, and wish to fit a press-button type of switch. Can you please advise me as to the type to install and where I may obtain same? Also, when I switch on (I am using a tumbler switch temporarily) all the lights in workshop and house go down for a few seconds. Can I overcome this in any way? The electric supply is 230 volts. Further particulars of motor are: S.P.P.H. wound, S.A. type, 2.4 amp., speed 1,425 r.p.m., 50 cycles.—J. F. Holmes (Birmingham).

WE suggest you use a 230 volt 50 cycle 3 amp. Auto-Memota air break push-button direct-on-line starter as manufactured by the Midland Electric Manufacturing Co., Ltd., of Barford Street, Birmingham 5.

Your motor will take a momentary current of a few times the normal full load current when it is started up by switching it direct on to the mains and, evidently the mains to your house and workshop are rather small, so that this current is causing an appreciable volt drop on the cables. This is of little consequence, but if you find the momentary reduction of the lights is a serious inconvenience we suggest you use a graduated resistance starter in series with the motor to reduce the starting current. For this purpose you could use about 60ft. of 26 s.w.g. Ferry resistance wire connected to a tapping switch having about eight contact studs.

Extracting Starch and Oil from Plants

I SHOULD be very grateful indeed if you could answer the following questions:

(1) Is there any economic method of extracting starch from bracken on a fairly large scale?

(2) I should like to carry out some experiments on the extraction of the essential oil from the plant bog myrtle. How should I set about this?

(3) I wish to make a number of aquarium tanks by jointing some sheets of glass together at the edges. Can you give me a recipe for some cement or composition which would both hold the glass and be waterproof at the same time?—H. Jones (Wrexham).

(1) SO far as we have been able to trace, very little, if any, work has been done on the mass production of starch from bracken roots and stems. We would, therefore, advise you to carry out your experiments on a small scale by macerating the washed bracken stems and roots in cold (not hot, or even warm) water, and afterwards by passing the resulting pulp through very fine sieves, whereby the starch grains will pass through the sieves, leaving a mass of gluten, cellulose and other substances behind.

By this means, you should get a milky liquid, and by allowing this to evaporate slowly at ordinary temperature, it will deposit starch as a white powder. In some instances, the starch may be deposited as a paste, but in either case the material should be allowed to dry slowly, after which it can be ground to a fine powder.

If hot or warm water is used for the extraction, the starch grains will burst and will form a gelatinous mass with the water, from which the original starch will not be recoverable.

(2) We do not know whether the essential oil contained in bog myrtle is volatile in steam. If it is, a good plan for its extraction will be to macerate the plant parts with water and then to blow steam into the heated water. This will result in the evolved steam being charged with the vapour of the essential oil, and when the steam is condensed the essential oil will be found floating on the surface of the condensed water. A good still is, of course, needed for this purpose.

Another method used for essential oil extraction is that of "expression." The plant stems or roots are merely put into a press and the oil squeezed out. This process is only useful when there is a relatively large amount of oil present.

A third method is to boil the plant parts with alcohol (rectified spirit) or ether. The solvent is then distilled off, the result being a solution of the extracted oil in ether or alcohol. On distilling off the solvent, the essential oil remains behind.

(3) An aquarium cement should not dry hard and brittle, otherwise it will not be able to take thermal and other strains. Two recommended formulæ for the preparation of an aquarium cement are the following ones:

(a)

Putty	10 parts	(by weight).
Litharge ..	1 part	"
Red lead ..	1 "	"
Soft bitumen ..	¼ "	"

Mix the above to a stiff consistency with just sufficient quantity of boiled linseed oil. If necessary, add sufficient lampblack to impart to the mass a slate colour.

(b)

Plaster of Paris	10 parts	(by volume).
Fine sand ..	10 "	"
Powdered resin (resin) ..	1 part	"

Mix the above with boiled linseed oil to a stiff consistency. In each of the above formulæ the boiled linseed oil is added in small amounts at a time, thoroughly mixing and working the mass before adding more of the oil. The final material should have the workable consistency of putty.

Removing Varnish

I WISH to repolish a cabinet that has been badly varnished. Could you tell me if there is any way to remove the old varnish without scraping or sandpapering it? I understand there is a solution for doing this; if so, could you let me know where this can be obtained?—D. F. Read (Hampstead).

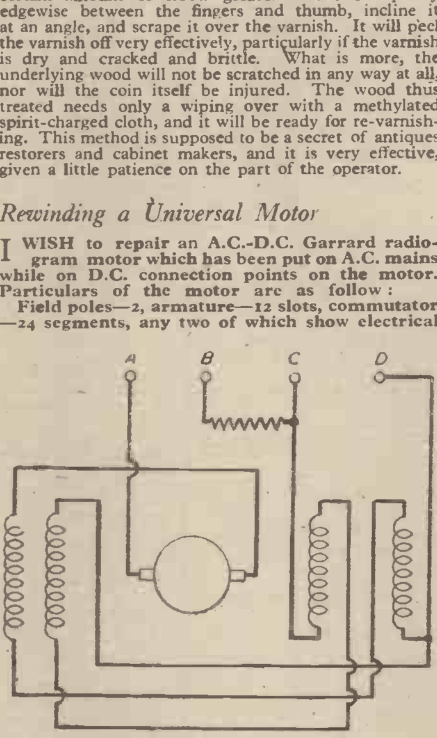
A SUITABLE varnish-stripper may be prepared by mixing together equal volumes of methylated spirit, acetone and carbon tetrachloride, and by dissolving about 1/10 of its weight of paraffin wax in the mixed liquid. This is brushed over the woodwork, allowed to dry, and the resulting wax film scraped away with a blunt edged tool.

If, however, you take our advice you will, for the removal of your cabinet varnish, use a penny plus a certain amount of elbow grease. Take the penny edgewise between the fingers and thumb, incline it at an angle, and scrape it over the varnish. It will peel the varnish off very effectively, particularly if the varnish is dry and cracked and brittle. What is more, the underlying wood will not be scratched in any way at all, nor will the coin itself be injured. The wood thus treated needs only a wiping over with a methylated spirit-charged cloth, and it will be ready for re-varnishing. This method is supposed to be a secret of antiques restorers and cabinet makers, and it is very effective, given a little patience on the part of the operator.

Rewinding a Universal Motor

I WISH to repair an A.C.-D.C. Garrard radio-gram motor which has been put on A.C. mains while on D.C. connection points on the motor. Particulars of the motor are as follow:

Field poles—2, armature—12 slots, commutator —24 segments, any two of which show electrical



Connections for a small universal motor.

connection with each other, whether diametrically opposed or adjacent. Is this correct?

One field coil (former wound) is missing. Can you give me turns and size of wire, also field and brush connections?—A. Almond (Bebington).

IN a sound armature there should be an electrical connection between all the commutator segments. The best plan would be for you to copy the existing field coil as regards weight and gauge of wire, assuming this coil is in order. If this is not practicable we suggest you try winding the pole with a double coil, each coil having 850 turns of 40 s.w.g. enamelled wire. Assuming the motor has 4 terminals you could use the connections indicated in the sketch, the field coils being connected in series with the brushes.

Dyeing Animal Horn: Black Stain for Wood

WILL you please advise me on the following: (1) What chemical can I use to dye animal horns "ebony black"? It must be non-poisonous and durable.

(2) What is the method used to "ebonise" oak?—R. Green (Knaresborough).

(1) ANIMAL horn is a most difficult material to dye, but you may attempt the operation by boiling the horn for two hours in a 5 per cent. solution of an aniline black dye, followed by 24 hours' steeping of the horn in the dyebath in order to enhance the penetration of the dye. To ensure more even dyeing, the dyebath should have about 2½ per cent. of acetic acid added to it. Alternatively, horn articles may be boiled in a 5 per cent. solution of logwood extract for several hours. The articles should then be exposed to the air for two days and then boiled for three hours in a bath containing 5 per cent. of copper sulphate and 5 per cent. of iron sulphate. This process gives a deep unfadable black on horn and bone articles. The necessary materials for carrying out the above processes can be obtained from any firm of laboratory suppliers, as, for example, Messrs. Harrington Bros., Ltd., Oliver's Yard, City Road, London, N.1.

(2) The following method will give a dense black stain on oak: Boil in an iron saucepan 1 pint of strong vinegar, ¼lb. logwood extract, ½lb. green copperas, 1 oz. crushed nut galls, and then add ¼ pint of acetate of iron made by steeping rusty iron in strong vinegar. Liberally brush the above mixture over the wood several times, or, alternatively, steep the wood in the liquid for several days. The wood must be perfectly free from grease, otherwise a patchy effect may be obtained.

Wood may also be stained a very dark colour by brushing over it a mixture of hot creosote oil and lampblack.

Cleaning Liquid for Optical Glasses

CAN you please supply me with a suitable formula for a lotion to clean spectacle lens?—V. R. Williams (Cardiff).

A GOOD cleaning liquid for lenses and optical glasses of all kinds is ordinary rectified spirit diluted with about ¼ of its volume of water. This, unfortunately, is rather expensive, because rectified spirit (being 90 per cent. alcohol) is dutiable under the Excise laws in this country. For this reason, iso-propyl alcohol can be used instead of rectified spirit. This iso-propyl alcohol costs about 2s. 6d. per lb. from Messrs. A. Boake, Roberts & Co., Ltd., (emergency address) "Ellerslie," Buckhurst Hill, Essex.

Some formulas for lens-cleaning fluids include a little dilute nitric acid in their composition. All such formulas, however, are bad, since the nitric acid is liable to accumulate in traces on the lens frames and to corrode them.

Only the slightest trace of the cleaning fluid is required to polish up a lens surface. Merely moisten a clean cloth with the fluid, and then wipe it over the lens surface, finally giving a polish with a clean, soft cloth.

Neon-tube Lighting

CAN you give me any information concerning high voltage electrical discharge tube lighting of the type used for shop signs? I understand that the type of transformer used to step-up the mains is rated about 7,000 volts 25 ma.; is this correct? What length of discharge tube should this transformer light, and does the length depend on the width of the tube; if so, what length of ⅜in. tube? Could you let me know where I could purchase discharge tube?—D. Morton (Wigan).

THE transformer details you mention are correct for the usual type of neon-tube installation. For ordinary sign work a 15mm. tube will take about 25 ma. with 60 to 100 ma. for larger tubes. In a 15mm. tube the volt drop is about 120 per foot of tube, plus about 240 volts drop at the electrodes. About double this voltage is required for starting, however. A transformer giving a no load voltage of 7,000 volts could be used to feed two 10ft. lengths of 15mm. tube.

There are strict regulations governing the installation of high voltage luminous tube signs (see the Electricity Supply Regulations, 1937, No. 31 and Section 8. Regs. 801 to 814 of the Institution of Electrical Engineers' Regulations for the Electrical Equipment of Buildings).

The transformer must be specially designed to give the required voltage drop under running conditions, or must be used with an external choke coil. You might try the General Electric Co., Ltd., of Magnet House, Kingsway, London, W.C.2, for discharge lamp tubing.

Boiling Point of Ether: Thermos Flask Efficiency

I SHALL be grateful if you will supply me with the following information:

(1) (a) Boiling-point of ether;

(b) Boiling-point of ethyl alcohol;

(c) Boiling-point of benzine, at pressures in each case of 200, 300 and 400lb. per sq. in. respectively.

(2) What is the approximate efficiency of a household Thermos flask, and what state of evacuation are these flasks constructed to stand?—W. V. Pattison (Harrogate).

(1) WE have looked up records for the last 60 years in an endeavour to ascertain the boiling-point of ether, alcohol and benzine at the high pressures which you mention, but, apparently, such experiments have not been made, or, at least, published, and hence we are not able to give you the required information.

Ether boils normally at 34.9 deg. C., and at 120 deg. C. its vapour exerts a pressure of no less than 10 atmospheres. It would seem, therefore, that this substance in particular would have a boiling-point greater than 200 deg. C. at the very high pressures you name.

(2) The degree of vacuum in an ordinary Thermos flask lining is equal to a pressure of about 1/50th of a millimetre of mercury. This is amply effective for heat-retaining purposes and, combined with the inner silvering of the glass, gives the vacuum walls nearly 100 per cent. efficiency. The weak area is, of course, at the cork or filling orifice. Here the heat passes outwards relatively freely, despite the close-fitting nature of the cap. For this reason the actual efficiency of a vacuum flask (taken as a whole) is but a mere fraction of that of a hermetically-sealed all-vacuum-walled container.

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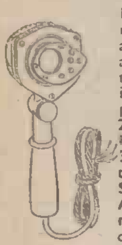

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THE Cyclist

Editor: F. J. CAMM

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Phone: Temple Bar 4363

Telegrams: Newnes, Rand, London

Comments of the Month

By F. J. C.

The "Massed" Attack Opens

IN view of the opposition to any development in cycle sport by the protagonists of the past, and their stupid adherence to the principles of the last century, it is not surprising to find that a cyclist was recently prosecuted for "furiously" riding a bicycle in a recent race. The cyclist in question was a member of the Wrekin R.C.C., a club affiliated to the British League of Racing Cyclists, and he faced a charge that "*he did ride a pedal cycle furiously on a certain highway so as to then endanger the lives and limbs of passengers on the highway,*" a charge made under section 78 of the *Highways Act of* 1835.

The archaic language in which the charge is framed will, of course, be in keeping with the mentality of those whose mind is still back in the last century, and who, having settled the hole-and-corner principles on which cycle sport was to be run, have decided that it must be so run in perpetuity. It would be an anachronism to use modern language in addressing those whose minds have remained static from 1890 onwards. It may strike modern cyclists as odd that a Highways Act of 1835 had to be invoked by the antagonists of massed start racing in order to frame up a flimsy charge against one who was not breaking the law.

However, this particular cyclist was not taking matters lying down. Knowing what had been going on in the cycling world and of the efforts of two rival bodies to get massed start racing suppressed, he reached the conclusion that he was being made a catspaw. Obviously it would be of the greatest possible interest and value to the opponents for a conviction to be secured in this first case since the revival of massed start racing on the roads. So he took the advice of the B.L.R.C., and in their wisdom they went to Messrs. William Charles Crocker, the famous solicitors, who are authorities on cycle litigation, and through them counsel was briefed to defend him. Mr. J. R. Ogilvie Jones, therefore, appeared on his behalf. The prosecuting solicitor, Mr. Davis, opened the case, and stated that on May 13th last a cycle road race under the "imposing" title of the Junior Grand Prix was organised by the Wolverhampton Racing C.C. over two laps of a course starting at Dawley, a total distance of 49 miles. Objection was at once raised to the sneering manner in which the word "imposing" was used. At Madeley, after the competitors had ridden 47 miles, the defendant ran into a small child, causing slight injuries. Evidence was called to show that when coming through High Street, Madeley, the cyclist was travelling "very fast," leading a group of four riders. The prosecuting solicitor submitted that the defendant, being the leader of the group, was obviously "fastest," and that he was "pursued" by three other riders. He also submitted that the cyclist's brakes were not "effective," owing to the small section of the racing rims, *and the small tyre surface contacting the road not providing sufficient grip!* We do not know who instructed this solicitor, but we think that even anti-massed starters will smile at the flimsiness of the charge, especially when the prosecuting solicitor had to admit that *the small child who was mildly injured did not act too wisely.*

One of the witnesses for the police said that whilst awaiting a bus she saw a motor-car pass four racing cyclists who were free-wheeling down the hill. She saw a child suddenly decide to cross the road, *the cyclist swerved to avoid a collision*, and she agreed that *the car was travelling faster than the cyclists.* Another witness said he saw the car pass, followed by four cyclists, who were travelling at about 18-20 miles an hour, free-wheeling. The girl stepped off the path from behind a post, *and the cyclists swerved, but had no chance of avoiding an accident.* Another witness said that the child stepped "right under the cyclist's wheel," and *the cyclist pulled up in about six to eight yards,* doing everything possible, but had *no chance of avoiding the accident.* The police submitted similar statements given by the cyclist after the accident, and stated that *the rider's two brakes were in perfect order,* thus refuting the evidence of their own solicitor!

In evidence, the defendant stated that he had been cycling for nine years and had never been involved in a cycling accident of any kind. He agreed that at the time of the accident he was travelling at 20-25 miles an hour, but that he was free-wheeling and therefore travelling as any ordinary cyclist should. He claimed that his skilful handling of the cycle prevented the possibility of a more serious injury to the child. Counsel for the cyclist emphasised the fact that the B.L.R.C. was a responsible national organisation, with constitutionally-framed rules that were rigidly enforced, that the sport was a desirable one and offered clean, healthy recreation to its followers, and should, therefore, be encouraged.

The fact that the prosecution had been compelled to resort to a century-old highway Act in order to bring the present charge suggested that their case was not only weak but savoured of prejudice, a prejudice most clearly demonstrated by the evidence that had been submitted, in which it was proved that a motor-car had passed the riders at the spot concerned and was, in fact, travelling considerably faster than the cyclist; but no one would dream of charging the driver of the motor-car with driving furiously. *It was not unreasonable, therefore, to suggest that the charge against the cyclist was prejudiced, and therefore indefensible.*

AFTER A VERY SHORT RETIREMENT THE CHIEF MAGISTRATE ANNOUNCED THE DECISION OF THE BENCH TO DISMISS THE CASE.

The result, of course, will be a great disappointment to the N.C.U. and the R.T.T.C., who would have made great capital out of a conviction. They would probably have trotted along to the Home Office, as they have done on other occasions, and urged a further Home Office announcement.

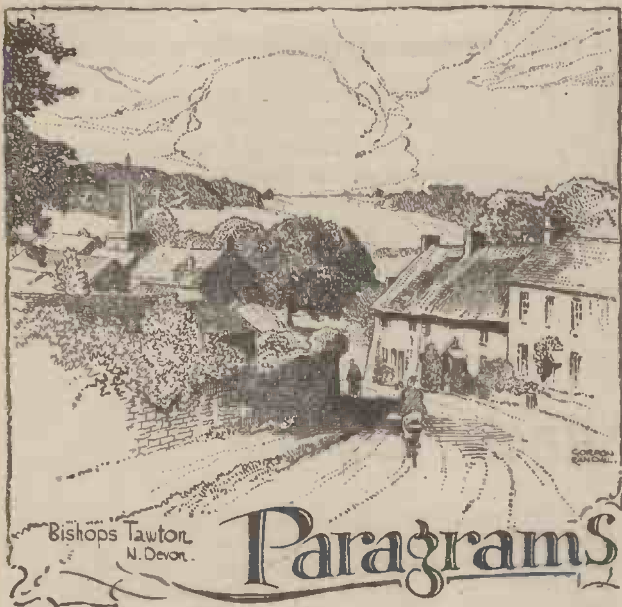
The case reeks of prejudice, and our surprise is that the police were so misguided as to have brought it at all.

We do not suppose that either of these two bodies will give publicity to the result of this case, as they are only interested in anything which can be used against the new sport.

Because, in the early days of the motor-car, our ignorant legislators of the day opposed the development of mechanical road vehicles by passing the Red Flag Act, they will argue that all motor-cars should still be preceded by a man carrying a red flag. It would be natural for them so to argue, since the main platform in their argument against massed start is that it was tried in the 90's and opposed by the police! Therefore, it must always be opposed! The police must always be right. The police opposed time trials, and it was the late F. T. Bidlake who introduced the modern form of time trial in which the riders are started at intervals and race against the watch. It became the custom to refer to such races as "trials" in an effort to hoodwink authority.

They are races whether the riders are started at intervals or in mass, and as we have said before, there is no more danger in the slow start of a massed start race than there is in the massed finish of a time trial. Both are races in which the race is to the swift and the riders are no more coagulated in one than in the other during the course of the race. The police are usually informed to-day by the promoting club when an "open" is to be held.

The secretary of the National Cyclists Union, at the dinner given to the champions at the beginning of this present year, tried to gloss over the attitude of the N.C.U. towards the end of the last century, when it banned time trials and road records. We can well understand why now it seeks to lean upon the R.T.T.C. The arrangement between the two bodies is merely a marriage for the convenience and face saving of the N.C.U.



Poole Wheelers

AN attempt is being made to revive the Poole Wheelers and to place the club back on something approaching its pre-war strength.

Jack Muspratt Passes

JACK MUSPRATT, well-known North London veteran, has died. He was 82 and well known on Northern roads.

Distinction for Ilford Rider

L/CPL. W. COWELL, Ilford Road Club, serving with the Royal Army Service Corps, was mentioned in dispatches for outstanding achievements during the final advance into Germany.

Beds. Road Man Decorated

SERGEANT NAVIGATOR HARRY BOX, Beds. Road Club, was awarded the Distinguished Flying Medal for outstanding bravery.

Going Ahead

THRICE club champion of the Luton Arrow C.C., Squadron Leader B. A. T. Rooke, who was also the club's former hon. secretary, has been promoted to Wing Commander, and awarded the D.S.O. He was previously decorated with the D.F.C. and bar.

Pontypridd's Loss

HARRY NEALE, National Clarion C.C., South Wales Union, Pontypridd Section, died of wounds sustained in the final stages of the war against Germany.

Southgate Celebrates

THREE members of the Southgate C.C., who had been prisoners of war in Germany—Messrs. R. Acutt, M. Matthams and P. Oram—were liberally entertained by club members on their return home.

Bristol Combination

RIDERS and representatives of the Trade have combined in Bristol to form a Defence Committee for cyclists.

Purves Home

WELL-KNOWN Vegetarian and Ealing rider, James Purves, who was twice made a prisoner of war, reached this country after working in Silesian salt mines. He was first captured in Africa and after escaping had the misfortune to be captured again in Italy.

Marguerite Wilson Awheel Again

MARGUERITE WILSON, famed pre-war record breaker, is riding regularly again.

Northern Ireland Traders

A NORTHERN Ireland Branch of the National Association of Traders has been formed following a visit to Belfast of officials of the Association.

Manchester Seaman Decorated

A/B. CLIFFORD SCOTT, well-known Manchester clubman, has been awarded the Distinguished Service Medal for bravery in an operation against enemy submarines.

For the Nation

LATEST gifts to the National Trust include Oldbury Hill, near Ightham, Kent, which has been given by H. A. Hooker. The new acquisition covers 155 acres.

Progress of Phœnix Pedallers

THE Calcutta Forces' own club, the Phœnix Pedallers, continues to progress, and now issues a monthly bulletin.

Midlander Dies

HARRY EDWARDS, prominent Midland track rider of a few years ago, has died. He was a member of the Rover Racing Club. His other interests included cross-country running.

Home Again

AFTER being reported "missing" and then "killed" after the airborne attack on Arnhem, Harry Gallacher, well-known Scottish polo player, is now safe among his 'ain folk.

Towards the End

ONLY a few hours before the capitulation of Germany, Sergeant J. Monahan, Gilberfield Wheelers, was killed in action.

Bromley Road Club

THE Bromley Road Club is again fully active. It has had five very quiet, but useful, years.

Clague Back

AMONG the returned prisoners of war is Sergeant James C. Clague, Manx Viking C.C., who played a prominent part in the initial massed start races on the Isle of Man. He was taken prisoner at Crete.

Finsbury Park Loss

SERGEANT AIR GUNNER ERNIE STAPLEY, for 17 years a member of the Finsbury Park C.C., who was reported missing following a raid over Paris some months ago, has now been posted as killed in action. He was Time Trials Secretary of the North Middx. and Herts. Cycling Association and first National Secretary of the R.I.I.C.

Pioneer Dies

LAST of the original ten members who founded the club in 1876, Harry Bingham, Darlington C.C.—the oldest club on Teesside—has died. He was 82.

Northern Ireland Activities

NORTH BELFAST TEMPERANCE C.C. has been revived after a lapse of some years.

Ilfracombe's Activities

THE Ilfracombe Wheelers C.C. has been resuscitated.

Mr. Fred Keller

MR. FRED KELLER, Advertising Manager of the Raleigh Cycle Group, has been elected chairman of the Incorporated Advertising Managers' Association (London).

Yet Another!

SERVICE cyclists in Aden have formed their own club, and have given it an appropriate title—the Barren Wheelers.

Wedding Bells

ERNIE MILLS, Addiscombe C.C., and prolific pre-war speedster, has married Muriel Powell.

Tyre Export

OVER 80,000 cycle tyres are to be sent to Denmark by the U.S.A. and this country.

Pontin for India

LT. STEVE PONTIN, Finsbury Park C.C., has been posted to the Indian Army.

St. Christopher's Expansion

THE Manchester Section of the St. Christopher's C.C. is being re-formed.

Archer Roads Club

SERGEANT F. NUTLEY, Archer Roads Club, has been mentioned in dispatches for distinguished service in North-West Europe.

Manchester Wheelers' Loss

MANCHESTER WHEELERS regret that their member, Company Sergeant-Major Fred Batley, lost his life in the closing stages of the war against Germany. He died as the result of wounds sustained through an exploding mine.

Junior "10"

IN an effort to encourage their younger riders, East Liverpool Wheelers held a ten-mile event for those under 18 years of age. One of the riders was R. Ross, son of the famous Larry Ross.

Southgate C.C. Loss

L/CPL. JOHN GRAHAM, Southgate C.C., who was serving with the Irish Rifles, lost his life in action during the final stages of the Italian campaign, in which he was awarded the Military Medal for bravery.

"Why I Want a Cycle"

A TWELVE-YEAR-OLD London boy—Bernard J. E. Cooke, of 170, Bury Street, Edmonton, N.9—has won the £10 prize offered by the Hercules Company in a nation-wide contest in certain children's papers on "Why I Want a Cycle." The final judging of the many hundreds of entries was done personally by Sir Edmund Crane.

Twelve monetary prizes in all were awarded, second prize going to Elspeth McMurtrie, Manse of Skene, Aberdeenshire, the third to Pamela D. Barlow, of Moseley, Birmingham, and the fourth to Andrew Fraser, of Russell Hill School, Purley, Surrey, all aged 13.

Children as young as 11 years find themselves amongst the list of prizewinners. Surely here again is proof—if proof were needed—that "every child is born wanting a bicycle," and the future of cycling cannot but be bright whilst this remains a truism.

Although intended for the British Isles, the competition attracted entries from as far afield as the Gold Coast of West Africa and Ontario, Canada.

On the lighter side, the competition has left no doubt in the minds of the judges that the young folk are weary of queueing for communal transport, and that the bicycle appeals to them as the ideal means of escape from this wartime (and post-war?) feature of life.

On the ancient PILGRIMS WAY. The church of St. Martha-on-the Hill, near Chilworth, Surrey.

This interesting church dating from Norman times but largely rebuilt, commands glorious views over the surrounding Surrey countryside—

Around the Wheelworld

By ICARUS

National Committee on Road Safety

THE National Committee on cycling recently considered those paragraphs in the Interim Report on Road Safety which are of especial interest to cyclists. They approved the following clauses in the report:

Training of young cyclists in road safety, and inspection of children's cycles.

Rejection of Alness Committee's recommendation that children under 10 should not be allowed to cycle on public roads.

Those are the only two clauses which are approved *in extenso*. They suggest that the clause referring to cyclists riding more than two abreast should be modified by deleting the recommendation that cyclists should be urged to use cycle tracks. They raise no objection to the proposal that cyclists should be compelled to report accidents in which they are involved—that is to say, whilst they do not approve it, they do not oppose it.

The committee sees no reason to support the recommendation that in certain eventualities consideration should be given to the introduction of stronger measures to control massed start racing. The committee feel that the police already possess the necessary powers. The committee cannot be expected (it says) to agree with the conviction expressed in the report that cycle tracks are necessarily a useful safety measure or that further consideration should be given to the question of making cycle tracks obligatory.

The committee strongly approve of the proposals for the provision of adequate parking grounds for motor-cars and parking places for pedal cycles, equipped with racks and weather protection. They are not opposed to the recommendation that two efficient brakes on every cycle should be made compulsory, nor to the suggestion that an employer should be prosecuted where the employee is found to be using a cycle with inadequate brakes.

The committee object to the recommendation that cyclists should be compelled to carry bells and other devices as no case has been made out for it by law.

On the question of rear lights the committee reserve the right to ask that the situation be reviewed if, unfortunately, as a result of the operation of the Act, accidents to cyclists and other road users at night have not decreased. They approve the recommendation that a bicycle for the carriage of more than one should be adapted by means of a seat, saddle or pad rigidly fixed to the cycle and with support for the passenger's feet. They approve the rejection of the recommendation made by the Alness Committee relating to handlebars and saddle, but they do not regard as practicable the proposed regulation that the Ministry of War Transport's powers be amplified to require that cycle paths shall be in such a condition that no danger is caused.

The President Selects

APPARENTLY the President of the N.C.U. now selects international teams, for the N.C.U. committee "confirmed the action of the President in selecting Messrs. Harris, Pond, Scott and Godwin to compete in Paris on June 17th."

We consider that there were others with stronger claims to inclusion in the team and we therefore do not approve the President's selection, nor approve the approval of the President's selection. No reason has been given as to why the function of the N.C.U. committee was set aside on this occasion.

British All-rounder Competition

AT May 31st the position was as follows:

A. Palmer	Scala Wh.	2. 9. 2 : 23.250	4.31.57 : 22.063	22.651
D. S. Burrows	Calleva R.C.	2. 9.16 : 23.208	4.37.53 : 21.592	22.400
V. Callanan	Norwood Par.	2.13.25 : 22.656	4.33.36 : 21.930	22.293
C. Farebrother	Altrincham R.	2.11.44 : 22.773	4.40.34 : 21.385	22.079
R. J. Brown	Calleva	2.15.15 : 22.181	4.36.28 : 21.702	21.941
A. W. George	Tudor R.C.	2.13.10 : 22.528	4.43.33 : 21.160	21.844
A. D. Slane	Calleva R.C.	2.14.51 : 22.247	4.43.49 : 21.140	21.693

Leading team: Calleva R.C. 22.017.

Single distance leaders.—50 miles: D. K. Hartley, Dukinfield, 2.6.54 : 23.641; A. Bouttell, Barnet C.C., 2.7.59 : 23.441; B. L. Smith, Yorkshire R.C., 2.9.8 : 23.229.

100 miles: A. Overton, Kingston R.C. 4.26.17 : 22.532

N.C.U. Special Meeting

A SPECIAL meeting of the N.C.U. London Centre Council will be held on Wednesday, July 18th, 1945, at the Holborn Hall, Grays Inn Road at 6.30 p.m. No items other than the special purpose, namely alteration to Articles and Rules consequent to the Birmingham General Council can be accepted for the agenda. The alterations involve increase in subscriptions for affiliated members from 2s. to 3s. and associates from 2s. 6d. to 3s., both to take effect from September 1st, 1945.

N.C.U. Decisions

AT a meeting of the Emergency Committee held in London the following decisions were taken: That, in order to implement the resolutions of the General Council on post-war planning, a special general meeting of the General Council will be held in London on Saturday, July 28th, 1945, commencing at 9.30 in the morning. Details of the venue will be announced later. The purpose of the Council will be to ratify the alterations to racing rules, articles of association, and bye-laws of the Union as recommended by the General Council in Birmingham at its meeting held on April 14th–15th, 1945.

This meeting will be followed by an extraordinary general meeting of members at 2.30 p.m. on the same day to deal with the question. Assuming that members implement all the recommendations of the Council the following will occur:

(1) An increase in subscriptions to the Union will become operative at the commencement of the 1946 membership year, September 1st, 1945; i.e., clubs from 2s. to 3s., associates from 2s. 6d. to 3s.

(2) An alteration in the rules of racing permitting the giving of accessories as prizes will become operative.

(3) The General Council will meet three times a year instead of twice. There will be no General Committee; and the Standing Committees, as recommended by the Post-War Planning Committee, will become the system of management.

Herne Hill

THE recent announcements that Herne Hill would come under the management of two distinct committees has now been amended, and the personnel of the Ground Committee, consisting of Messrs. E. J. Southcott, C. Bowtle, S. Scott, J. F. Ditchman, D. Ricketts, D. Brunwin, R. Matthews, E. R. Caspall, J. E. Wyatt and W. F. Devereux; and Messrs. W. B. Bailey, H. Ryan, C. S. I. Scott, J. F. Ditchman and H. M. Ellis of the Organising Committee now become the Management Committee, with Mr. W. J. Bailey as chairman.

Road Accidents During the War in Europe

DURING the war in Europe, there were, on the average, over 20 deaths a day in Great Britain as the result of road accidents. The total number of road deaths during the war period to the end of April of this year (including the first two days of September, 1939) was 42,556.

Of this total, 7,148 were children.

Ealing C.C. First Road Race Promotion

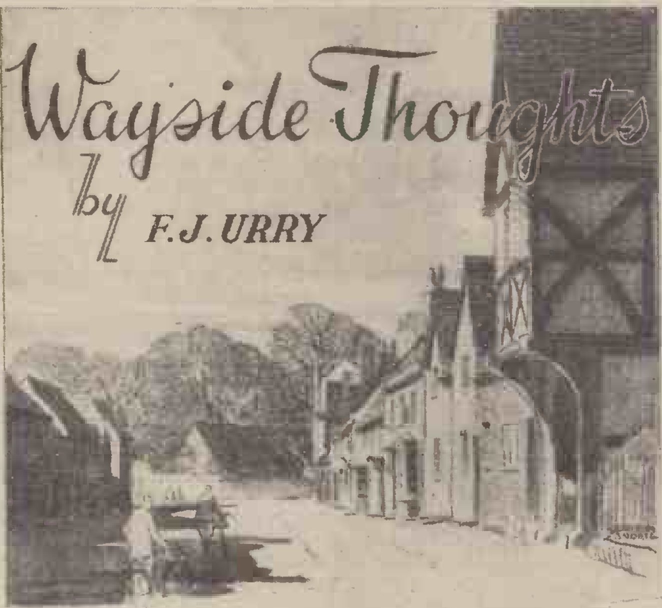
THE Ealing Cycling Club can justly be proud of its first Road Race promotion, which was run over a sticky 87-mile course on Sunday, May 13th. The event, which started at Greenford, went out through Amersham, Princes Risborough, Thame, Stokenchurch, West Wycombe, Gt. Missenden, Amersham, Beaconsfield and back to Greenford. The riders, who included E. Clements, J. Williams (a newcomer to massed start racing), L. Hook, P. Burston, L. Davies and others, got away to a clean start at 1.30 p.m., the start having been delayed because of certain transport difficulties. The field went well along the road to the Amersham turn to Chalfont St. Giles, where Jack Williams, deciding evidently that he had had enough of bunch riding, tried to make a time trial out of the event. Pip Burston, riding his first race for many months, owing to a leg injury, with Dick Boyden of the Southern Couriers, Froude of Manchester, Tilley of the East London R.C. and Ron Filsall of the Achilles Velo took up the chase and soon were 30 secs. up on the main bunch, led by S. Honour, L. G. Davies and E. Clements, who thought that the breakaway was only a flash in the pan. However, the leading riders maintained and increased their lead and at Risborough were 2½ mins. up on the main bunch, which had spread out a bit by this time, with V. Humphreys of the W. London way back, 17 mins. down. The first prime at Stokenchurch was hotly contested by Williams, Burston and Boyden and was only narrowly won by the first named from Burston. At this stage the leading group, although still the same, had also spread out a little and from here to Monks Hill (a vicious climb up a dusty, rough surface nearly a mile long, with two bends near the top and about 1 in 9 on the last bend) the leading three, now Boyden, Burston and Williams, worked as a team.

		h.	m.	s.
1. Pip Burston	Ealing C.C.	4	14	3
2. J. Williams	W. London R.C.	4	14	5
3. R. Boyden	S. Couriers	4	14	6
4. E. Clements	Wrekin R.C.	4	14	31
5. E. Jones	Wrekin R.C.	4	14	32
6. R. Filsall	Achilles Velo	4	14	40

The total amount raised for the Hospital will be about £20.

Wayside Thoughts

by F. J. URRY



The Peace

THE European war is won, and it is difficult to realise that some of our habits of work and play will slowly alter, as nearly six years ago they slowly altered to meet the dread demands of war. How good it will be to see some of the boys and girls come home again, take up the fine habit of cycling with the new values for the lovely land in which we live, and for which so many people have been fighting and working to preserve. and one hopes in the years ahead, to improve. It is easy enough to be patriotic in these days of victory; to feel we are all part and parcel of the new life now glimmering in dawn on the rim of history, and to realise as never before that we are one people, one people who have made many friendships throughout the world and are determined to keep them. It will not be easy to live up to the high standard that now animates our thoughts unless we are agreed that freedom, in its fullest sense, and simplicity in its sheer delight, are the stars to which we must endeavour to hitch our wagon, and to do this thoroughly we must first compose our own quarrels and consider our own particular game of cycling a worthy expression of freedom and simplicity, always expecting some people will not be able to go so far with us along the road of our choosing. Intolerance was the cause of war; it is a terrible sin, and it is very easily caught. Yet the common object that moves all of us is the enjoyment of life, and if we enjoy our way of it, let us say so and give our reasons, but if our friends think otherwise, then do not let us forget that precious gift of freedom of speech and action, part of our own happiness, and no less a part of the other fellow's in a different method of movement. That I shall always be a cyclist does not blind me to the joy of other forms of leisure, but at the end of an argument merely seems to make my way of travel more desirable.

Be Fair

THAT thought of toleration arose when I listened to an argument on road matters by a group of cyclists who were deploring the coming of the basic petrol ration for private cars, and prophesying all sorts of unpleasant things as a result of the release. When I gave my version of the matter under discussion, some of the company seemed to jump to the conclusion that my interests were swiftly swinging over to motoring and I was endeavouring to justify such change of mind. Now such an attitude is intolerant and one that ought not to be in the mind of any lover of the road. I shall never be a motorist by choice; the methods of such travel, with their restrictions of activity and their impatience of speed, do not appeal to me. I like to go my own gait, and sometimes to stand and stare. But there are the other people besides the careless ones my friends seemed to visualise, old people and invalids who have been deprived of their freedom of travel over so long a period, and I shall be glad to see them back on the road, even though they intrude on the peace and loneliness I have known as a cyclist during the last three years. After all, there are plenty of ways still left where I can wander without any sense of overcrowding, and he would be a poor sort of tourist who, desiring loneliness, could not find it among the hills and glens of this delectable land. For the beauty spots, so called, have years ago been ear-marked as such because the way to them was easy to find and travel; but the happy rider with a map and a sense of discovery in him, will find their equal in many a little road devoid of the humming necklace of the telegraph wires. So I say, and I mean it, that the petrol allowance is a fine thing for many thousands of people, and if as cyclists we deplore it, 'twould be an intolerance in thought as selfish as anything I can think of. We want happiness on the road, not selfishness, for that way lies half the troubles that have created the road problems.

Preliminary Test

I KNOW some of my keen cycling friends will feel a little sense of despair that the return of pleasure motoring may mean an increase in accidents, and we must face up to that question. Personally, I look upon the re-introduction of the basic ration in the nature of a try-out, to see how the pre-war cars stand up after so long an idleness, how post-war drivers use their limited freedom, and most important of all, what the certain increase in road traffic will reflect in the way of accidents. The basic ration is a preliminary test, as it were, and on the results may depend what form of legislation the M.O.W.T. will deem essential to achieve that higher degree of road safety which all but the severely prejudiced acknowledge as their aim. Our arguments and objections as cyclists is not and never has been against the betterment of road conduct, but the method adopted to achieve it. I am not going to enter into any form of controversy now; I have my own ideas and my own opinions, but until this preliminary period is a matter of statistical history when they are either confirmed or cancelled, I think it is far better to wait, and as far as in me lies, work for that tolerance and understanding that is the one certain cure for many of our road troubles. Yes, let us watch and wait for a while, strengthen our case in the light of the country's experiences, and when the moment comes be in a position to present our case, if as I suspect cyclists are involved in any kind of repressive legislation. I am much too fond of the road and all it connotes to keep any decent law-abiding traveller from enjoying its freedom, and deep down in them I think most cyclists hold the same opinion. It is the unmannerly fellow we so strongly object to.

A Good Addition

LET us get on to a more congenial topic, the behaviour of a new bicycle. That is to say it was new just prior to Easter, and since then it has travelled over a thousand miles, sufficient distance to prove it a worthy addition to the stable. I am always rather diffident about praising new machines, because the thrill of their possession hangs on quite a period after receipt, and sometimes is inclined to warp judgement; so I lent this bicycle to a sturdy friend of mine for a couple of week-ends, and when he returned it with the expressed hope of buying it off me, I knew my opinion of its soundness and comfort was correct. It is. There is something about a high-class machine that informs you of its quality at the summit of a long rise when pedal pressure may lag a little and speed die down, when you can feel the turn over of your ankle give life to its movement with silky responsiveness. Its silent running, too, without dither or chatter, under free-wheeling speed or when brakes are fiercely impinged; it is just one complete piece of sweetly acting machinery with finger-tip control of steering and the solid comfort of an easy saddle. That, then, is my new machine—obtained as a result of toil and scrounging, and the luck of finding a maker with stainless rims, and a friend with a pair of John Bull open-sided. I had it built 69 deg. old style, hence the easy steering, 21in. frame, 1⅜in. tyres, a B10 leather saddle, cantilever brakes, and a medium ratio 4-speed hub. A lucky fellow to find such equipment to-day, you will say, and I agree; and lucky, too, to find a good friend to put it together and give me a bicycle so close to perfection. It suits me admirably, because it is an exercise in bicycle moderation, with a 60in. normal gear, a dropped bar, but only just, and an all-black finish to stand the weather, and I may add the neglect—except for adjustment—of an all-the-year-round rider with the mud of numerous counties on his mount.

The famous old BRIG O' BALGOWNIE across the River Don at Aberdeen

Confirming Impressions

I WENT a tandem week-end recently, the first one for three years; for in these days my tandem seems to be the perquisite of my younger friends who like to take their still younger friends as crew, and have little use for the "old man." I suppose all that is quite natural, and precisely what I did at their age, so why worry? On this occasion my daughter made the suggestion one evening that we should go to visit some old friends who are comfortably perched on the edge of the Cotswolds overlooking the Dumbleton Hills. The condition was imposed that the weather must be fine for the journey, as if I were the arbiter of the elements; and when I laughed, and said a shower in May is but a refreshment of beauty, I think she thought I really was a trifle mad. But, as it happened the weather was all we could wish, lovely sunny days with a full but not too vigorous south-wester that sent us humming over the road to Evesham amid all the country glory of the month around us. That 30 miles of splendid highway will probably be the last journey I shall make amid such loneliness, for there were miles when no motor vehicle was in sight, and the rich loveliness of Worcestershire was singing under the wind without the whirring undertones of travelling machinery. After Evesham we climbed out of the Avon Valley by way of Winchcombe to Cleeve Hill, a long, hard pull proving that youth and age can still do a traverse in joy, and manufacture an appetite worthy of the occasion. The next day we spent in graceful idling along the ridges of the hills—a day of glorious sunshine and far flung visions made particularly happy with simple hospitality; and on the Monday morning we sailed home with gratifying ease, having collected a nice little century of miles, and confirming for me, at any rate, that tandeming for a fairly active couple is one of the jolliest forms of cycling extant. I wish I could do more of it, but the fact is that the younger folk are too urgent for me—they do not want to sit and smoke, or stand and stare—and the elderly are now thinking of that basic ration, bartering age for ease, and, alas, too often forgetting activity is the sure shield to hold the years at bay.

Busy Times

LIFE is going to be a very urgent business in the cycling world in the immediate future, for the trade, the sport and the pastime. The crescendo of activity will not occur immediately, for neither the labour nor the material will be immediately available, but planning is going ahead, and from all I hear the enthusiasms are on a high level. Firstly, we want better bicycles and far better methods of informing the people that cycling is a great game when it is properly played with the right products. We shall have to await the arrival home of the many thousands of the boys and girls who lost their freedom of the road when they joined the Services—for it will be their personnel, their enthusiasm which will be the main factor in building up club life to something greater than its pre-war level, and inculcating that enthusiasm into the younger—ah! and the older—generation. I see no end to the expansion of cycling, for here is a game within reach of all folk, a game that preserves youth in every one of us, and gives in exchange that sense of achievement so many people envy, but will not bestir themselves to acquire.

CYCLORAMA

By H. W. ELEY

An Instructional Advertisement

SOME advertisements are just blatant "name-blocks"; some are humorous, and depend solely on their humour to catch the eye; others are useful and informative, and in this last class I place a recent advertisement issued by Dawes Cycles Limited . . . "published in the interests of national cycling." It shows, by a series of happy pictures, the right and wrong ways of riding a cycle, and cannot help but assist riders to get more pleasure out of their mounts and their touring. The "squatter" is shown, riding in his grotesque fashion, and so is the "stretcher"—ungainly and awkward; then the "slow roll" is illustrated, and finally, as a centre-piece, we have the "proper way." All credit to Dawes for a good advertisement, and one very much in the best interests of all who ride a cycle.

Bikes and Bunting

ON VE-Day and afterwards I saw plenty of cycles decorated with Union Jacks and other flags, and was glad that the cyclist was not to be outdone by the motorist in a show of patriotic fervour and joy at the end of the war with Germany. One group of riders I saw out on the road to Lichfield might well have been called "The Victory Club"—for every machine sported a fluttering little flag, and most of the riders had rosettes or ribbons. Who says that we are not a demonstrative people?

The King Who Hid in an Oak Tree

IT was, of course, King Charles who hid in the leafy security of a great oak to elude his pursuers, and I was reminded of the legend on May the 29th, "Oak Apple Day," as I rode through some leafy lanes in green Warwickshire. I recalled that when I was a boy it was the custom to wear a sprig of oak (preferably with an apple) in one's coat, to commemorate the episode . . . and woe betide the luckless boy who forgot to "sport" his oak . . . he was severely "nettled" by the others. A strange survival! But somehow these old customs are very alluring, and one regrets their passing.

The Rolling English Road

SOMETIMES a very ancient road, laid down in the days of the Romans, and bearing traces of their genius. Sometimes a road that seems to lead nowhere but to an isolated village "off the map." But to-day, a road that needs much repair . . . and no wonder, when one considers the amount of heavy traffic that has passed over it in these war-years. Those huge American lorries; those amazing tank-transporters and enormous vehicles for carrying parts of 'planes . . . they have all done their bit towards making the road unworthy, though it is fair to say that our roads, in the main, have stood up to the strain exceedingly well. But the time is coming when there will have to be a good deal of repair work put in hand, and it is to be hoped that the Government will adopt a bold and courageous policy, and set going a great programme of road-work. Here is "reconstruction" of a vital kind, and of a character which will repay us a thousand-fold.

"Now It Can Be Told"

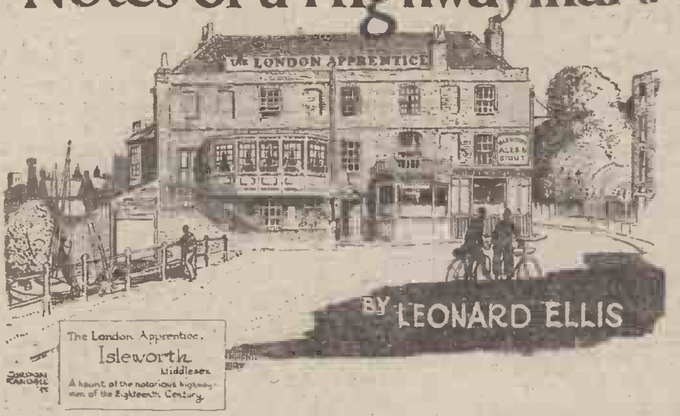
THROUGH all the long war years the curtain was drawn upon the activities of our great industries and their vital contributions to the war effort. Now, with Germany beaten, in many cases the security ban is being lifted, and the nation will be able to learn something of the great and ingenious work of our factories; and let us not forget that the cycle industry has a great story to tell . . . it made a contribution to the common cause which is a source of pride to all who control it, and work in it. Apart from the "special" jobs undertaken, and which did not come within the normal manufacturing programmes of the industry, the making of cycles in itself was a vital contribution. Where would our agricultural workers have been without bikes to get them to and from the farms? How would thousands of munition workers have reached the factories without the help of the cycle? Oh, yes! the cycle plants have done a splendid job, and the industry should not hide its light under a bushel.

Village Worthies

THE twin glories of the English village are—the church and the inn. Both, in many hamlets, are so old as to be venerable indeed. The former, often ivy-covered, and embowered in trees; the latter, often truly picturesque, with its swinging sign, its old worn step, and its little bar-parlour with the sanded floor. But men of the village can be "glories" too . . . and I was reminded of this fact recently when I cycled to a little Staffordshire village, not far from ancient Tamworth, with its castle which dates back to the days of King Offa of Mercia. In this village I met and talked with the sexton, with the landlord of the inn, and with the schoolmaster. Each, in his own way, a village worthy, with a wealth of knowledge of the place and its history; each proud to be a villager; each possessed of a deep love of the land, the fields, the trees, the ways of life in the small community. The sexton knew the history of the church by heart . . . and loved its grey old walls and the call of its bells. The landlord of the inn was just the kind of man a landlord should be—tactful, genial, proud of his calling, and expert in the care and treatment of the good ale he served in those blue and white mugs. The schoolmaster was quite erudite, and obviously loved his calling, looking upon it as much more than a mere way of earning his daily bread; he had a full measure of his responsibilities as a trainer of boys; and as I talked with him I smiled at the thought that many would pity him for being "buried alive" in a country schoolhouse. But he was happy. And I was happy, too, as I rode homewards, with the owls hooting in a coppice, and the road stretching ahead like a silver ribbon in the purpling dusk. . . .

RACING CYCLIST BRIDEGROOM.—The wedding of Mr. Harry Heaton Hill, of 30, Victoria Avenue, Barrow-in-Furness, Lancs, to Miss Daphney Alys Dewsbury, of Formby, near Southport, took place on April 18th, at St. Peter's Church, Freshfield, near Liverpool. The bridegroom, the well-known racing cyclist, represented Great Britain at the Olympic Games, Berlin, in 1936. Milan, World's Amateur Unpaced Hour Record Holder—27 miles 1,132 yards. Represented Great Britain at World's Championships in Milan, 1939. British Professional Hour Record, London, 1939—26 miles 1,006 yards. The bride has been serving in the W.A.A.F. for the past three years.

Notes of a Highwayman.



BY LEONARD ELLIS

The London Apprentice. Isleworth Middlesex. A haunt of the notorious highwaymen of the Eighteenth Century.

Britain's Touring Grounds (8)

I DO not suppose that cyclists come from all over the country just to visit the Chilterns, but there can be no doubt that they form a happy hunting ground for London and Southern England riders. Like other touring areas they have a charm of their own and their own set of characteristics that is not completely duplicated elsewhere. Like the Cotswolds they appear to be in two sections, but whereas the North and South Cotswolds are quite distinct, the north-eastern and south-western areas of the Chilterns are merely one area separated by the valley through which runs the Aylesbury-Watford road. Maybe this is merely an idea of my own. As a whole, this hill country stretches almost south-west north-east, seeming to form a natural breastwork guarding London, 25–30 miles away. The south section begins just north of Reading, and continues in an undulating line of hills to Tring and Berkhamsted, and possibly this is the better known area. The north section continues the line to Luton and Dunstable, with little isolated outposts nearly as far as Hitchin. The chief characteristics of the district are rounded wooded hills and delightful valleys, made beautiful by the prolific growth of beech and wild cherry trees. In some areas in April the woods are covered with a snow-like mantle when the cherry trees are in blossom. The villages are mediocre, although some, like Fingest, Chenies and Latimer have many attractive features, and can be regarded as distinctly pretty.

Interesting Towns

THE towns such as High Wycombe, Wendover and Aylesbury have many attractive features, among which may be mentioned some very fine old inns. On the face of the downs will be found three hillside monuments, all facing north-west. The most famous is Whiteleaf Cross, near Princes Risborough, not such a landmark in wartime, but normally clearly visible for many miles across the Oxford Plain. This is a large cross with a very broad base. As with many of these old relics opinions differ. While some say that the cross was cut to celebrate the victory of Edward the Elder over the Danes in A.D. 910, others point out that the work is not mentioned by any of the old historians, so that it cannot be more than 200–300 years old. The second carving is on Bledlow Ridge, a Greek cross scarcely visible until you are close to it. The reason is that unlike Whiteleaf it has been neglected, and is overgrown. Here again some claim that it commemorates a battle in which the Danes were defeated by the Saxons. They support the theory by suggesting that Bledlow means "Bloody Hill," or battlefield, but there are other derivations equally possible. The third is quite modern, and is a carved lion in the shape familiar during the days of the Wembley Exhibition. This may be seen on the downs near Dunstable.

Pretty Villages and Beechy Lanes

THE hills are not high, and, as a consequence, many good roads cross the range, and the views to be obtained are magnificent. There is some particularly pleasing scenery in a ride from West Wycombe. This village, by the way, has been purchased wholesale by the Royal Society of Arts, with the idea of perpetuating the perfect English village or small town. From here a route may be taken through Lane End to Fingest, a delightful little village with an old Norman church bearing a twin-gabled tower. From the village several roads radiate to Turville, Skirmett, Hambleden, Northend and Christmas Common, through beautiful wooded lanes alive with squirrels and overhung with the beeches typical of the neighbourhood. Another pleasing area is that around Great Missenden, where Chequers, the country home of the Prime Minister, and Hampden House of historical fame, will be found. North-easterward the Chilterns continue to Luton and Dunstable, and at the latter place the beautiful church, figuring in the tragic story of Queen Eleanor, should not be overlooked. There are some delightful villages around Ashridge Park, including Water End and the Gaddesdens, while to the north is the great natural zoo at Whipsnade. Sir Walter Scott is supposed to have taken his title of "Ivanhoe" from Ivinghoe Beacon, from whose eminence there are extensive views for miles. It is said that Rupert Brooke probably wrote "The Chilterns" on the top of this chalk hill.

Water End, in the Chilterns.

My Point of View: By "Wayfarer"

Killing Enthusiasm

RECENTLY, when away from home, I had occasion to move a lady's bicycle, which stood in the way of my own. It was the product of a very well-known firm, and I was astounded—literally astounded—at the weight, which must have exceeded 45lb. What was more astonishing was the bad distribution of weight, the front of the bicycle being much heavier than the back. Without making any comment, I asked another cyclist who was standing near to move the machine farther away. What he said when he lifted it was much more forcible than polite. He, too, noticed the faulty weight distribution. I know nothing about the price of this particular model, but I *do* know that the machine would be well calculated to exterminate any enthusiasm which the owner may have possessed for the pastime of cycling. It must have been an awful handicap to ride such a mount. No wonder the game is "hard work" when such monstrosities are supplied to cyclists, and especially to those of the reputedly weaker sex.

An Obvious Duty

SPEAKING of a heavy rainstorm which had just descended on our long-suffering land, a fellow-cyclist told me that at one point he passed great stones which had been washed down the bank on to the road. He thought that they constituted a considerable danger to cyclists, yet his response to my inquiry as to what he had done about this trap was a rather surprised "Nothing!" Believing that only by the fullest co-operation amongst road-users can our highways be made safe, I retorted that I, personally, would have made a point of removing those obstructions, irrespective of the trouble and delay the process might have caused me. This seems to me to be an obvious—an elementary—duty, which, if carried out by each one of us, as opportunity offered, would prove of great advantage to all.

The Voice of Desperation

SOME of us cyclists are becoming pretty desperate on the subject of cycle capes, the modern version of which is cut skimpily and is anything but waterproof. Moreover—and this is surely a case of adding insult to injury—they are expensive and they call for the surrender of our precious coupons. As for myself, I do not mind paying a good price for a cape provided it is satisfactory. It is a hardship having to surrender coupons seeing that a cape is an additional—and, really, an indispensable—garment, and that the folks who use it are the very ones who are definitely helping the national cause by (a) keeping out of public transport, and (b) looking after their physical and mental health.

When, however, it is difficult, if not impossible, to obtain an efficient cape (and efficiency must be related to size as well as to protective qualities), then one realises the raw deal which cyclists are receiving. I find that my arms are wet after riding two or three miles in rain. Condensation may be urged. But condensation, surely, presupposes perspiration, and *I do not perspire.* Moreover, why condensation in 1944-45 and not in any of my previous 50-odd years of cycling? Can anybody answer that? And would condensation be the cause of the water which I find dripping on my wrists after some 10-15 miles? No! I think that we must look elsewhere for current cape troubles, and this is the voice of desperation seeking wet-weather protection.

War of Words

ONE night recently I found myself at a cocktail party, where I gave a brilliant representation of a fish out of water. Bored stiff, I was on the point of committing *hara-kiri* when two young friends—motorists, and full of mischief—started a discussion on cyclists' rear lights. Relinquishing all thought of making my wife a widow, I at once settled down, gleefully, to wordy warfare, despite the fact that the question of rear lights has passed beyond the discussion stage. Of course, my young friends did not stick slavishly to the point at issue—what motorist ever did?—but darted to and fro, bringing up cycle paths, cyclists riding two abreast, rear lights on motor-cars, front lights on bicycles, reflectors on road signs, taxation, registration, and so on. I did not mind: my policy was to "let 'em all come." The argument cured my boredom, and that was something for which to be thankful.

Good-bye To All That

A FEW years ago, after going through a very disturbed night at a main-road guest-house, I made up my mind that, for the future, such establishments would be avoided, sanctuary being sought in quieter places. When, however, pleasure motoring came to an end, my vow was put into cold storage for the time being. In the spring of last year I spent a week at a house on one of our big main roads, at a point where another main highway came in, and I slept in peace. This spring I put in a week at another main-road house, and again was undisturbed o' nights. I feel, however, that the time is now approaching when my self-denying ordinance must once more come into operation. Certainly, when the full tide of motoring flows along our highways, main-road establishments will be no place for those cyclists who, putting in strenuous rides day after day, like to be sure of resting in peace during what ought to be the silent watches of the night. So, in my case, houses in quiet backwaters, where the traffic "goes dead" early in the evening, will be sought, and, the farther they are from the road, the better I shall be pleased.

Modern Plague

IT is sincerely to be hoped that the plague of pilfering—in other words, thieving—which is sweeping over the land, and disfiguring the national life of this country, will be brought to a full-stop as soon as a return to normality is achieved. The army habit of "acquiring" some article which is missing from one's equipment, at the expense of a comrade's possessions, may be all right—for the army. It is not good enough, however, in the civil sphere, where carelessness or bad luck should be paid for by the person concerned, and not passed on to somebody else. This thieving, of which so many people have reason to complain, is experienced in an acute form by cyclists, who may lose complete bicycles or essential parts thereof. A boy with whom I rode for a mile or two on VE-day plus one complained bitterly that, on the previous evening, at the baths, some unprincipled individual had helped himself to the front fitting and bulb out of his dynamo lamp, failing to annex the latter only because it was secured to the bicycle—and not taking the whole bicycle because it was locked. The poor kid was distressed, owing to the difficulty of obtaining replacements, and, in any case, as he put it, he could not afford to buy them.

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