THE STORY OF RADAR

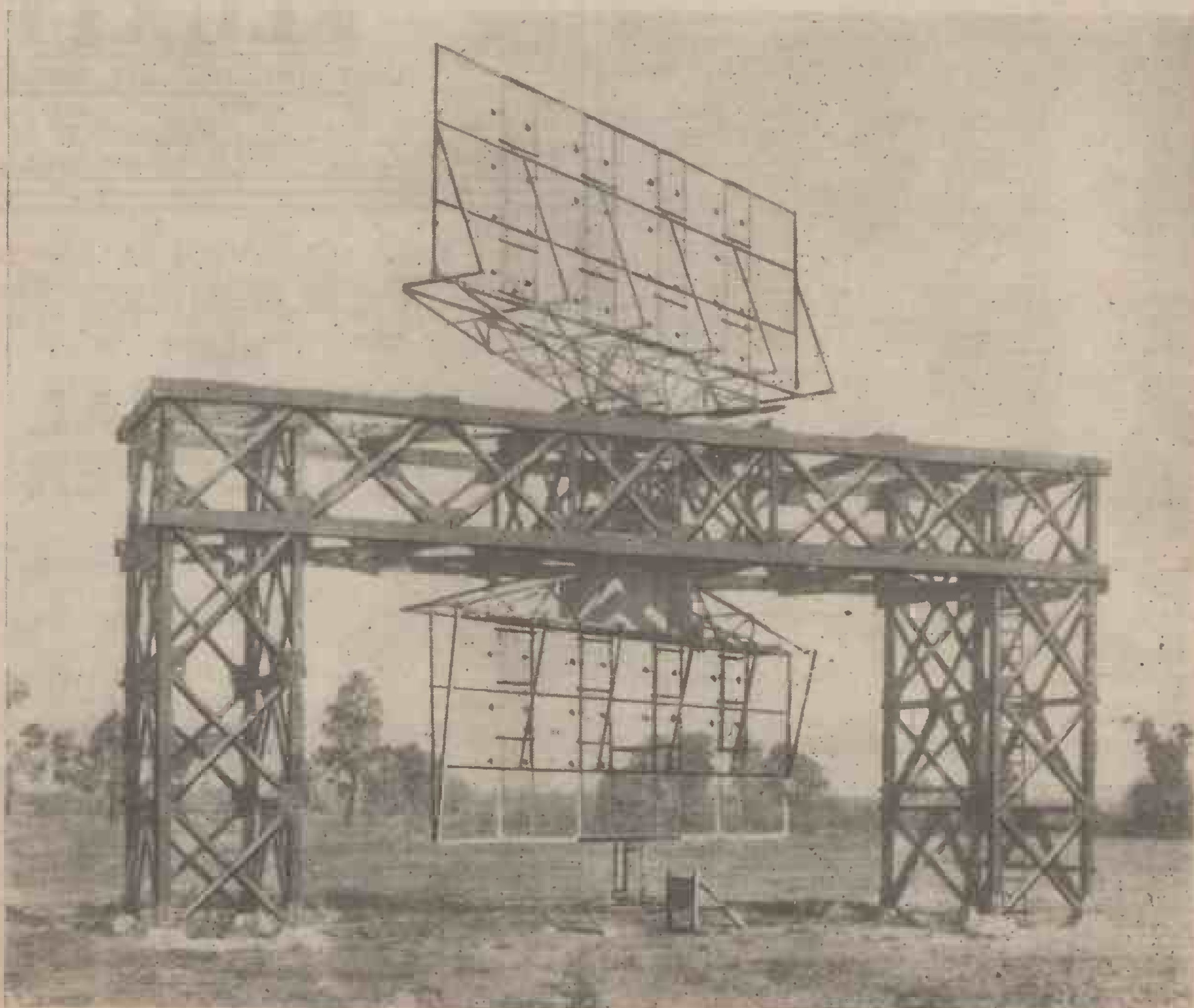
NEWNES

PRACTICAL MECHANICS

9d.

EDITOR: F. J. CAMM

NOVEMBER 1945



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PRACTICAL MECHANICS

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Editor: F. J. CAMM

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FAIR COMMENT——BY THE EDITOR

New Maps of England

A GLANCE at Ogilvie's original road book of England, with its strip maps, beautifully coloured, and a comparison with a modern Ordnance Survey map, indicates the great progress which has been made in cartography during the past century. Although these maps, in conjunction with our road numbering system, have made the lot of the traveller easier, they still leave much to be desired. A simple place-to-place map was satisfactory in the days of the stage coach, when only rich people could afford to travel, whilst the world of the average individual was confined to the parish boundaries. Indeed, the maps of those days were merely lines drawn between the locations of the coaching inns, taverns and hostelries—the places of call, where messages and parcels were delivered and passengers picked up or discharged.

The great time which must necessarily lapse between the preparation of a map and its publication renders it more or less obsolete before it is published—for road developments in peacetime proceed apace, but the process of charting the roads and the changes have not been speeded up to the same extent. Hence it is that a map will often take the traveller by the longer or the most uncomfortable route.

Maps are thus a good guide to the past, only a moderate guide for the present and quite inadequate for the future. There can be little doubt that this country has led the world in the making of maps, and it undoubtedly is the best mapped country in the world. The contour map is not so necessary to-day, except perhaps for cyclists, as it was in the days of horse-drawn vehicles, for modern cars can easily surmount the steepest hills encountered on our roads.

Now that the war is over plans will be made for building new towns, industrial centres, and for making the new roads which must link them with the old. The need, therefore, for a prompter system of charting the changes in our topography is keenly felt. Indeed, it was recognised before the war when a committee appointed by the Council of the Town Planning Institute recommended that a commission should be set up for the purpose of making a factual survey of the national life. The National Atlas Committee of the British Association also made proposals for the compilation of an atlas which should embody information of service to administrators, public men, educationists and students in many fields, since it would present in convenient form the data upon which many conclusions of national importance must be based. In 1941 the Minister of Works set up an Advisory Committee to consider the preparation of a series of maps in readiness for the promised planning of post-war Britain. The chairman was the Director-General of the Ordnance Survey Department, and the members included Professor E. G. R. Taylor, Dr. L. Dudley-Stamp, and Sir Edward Bailey, Director of the Geological Survey.

A Useful Series

THIS committee decided to produce a series of maps to a uniform scale of 1 : 625,000, which is equivalent to about ten miles to an inch. A Maps Office, under the direction of Dr. E. C. Willatts, was established in the Planning Branch of the Ministry of Works to give effect to the decision. A similar office was instituted in the Department of Health for Scotland. As is well known, the Ministry was reconstituted in 1943 as the Ministry of Town and Country Planning, but this did not affect the work of producing the maps, which are now beginning to appear. Forty-seven maps are in preparation and 15 have appeared. Each map consists of two sheets, one covering all Scotland and the part of England north of Kendal and Northallerton, and the other the rest of England and Wales. Each map measures 5ft. 6in. by 3ft. 6in. The first of the series is the base map, which is in lightly printed outline, indicating the main topographical features. It forms the main underprint for the remainder of the maps, with one exception. The maps now published deal with land utilisation, administrative areas, topography, population density in 1931 (date of the last census), types of farming, the population of urban areas in 1938, and land classification.

Three more maps, roads, coal and iron, and iron and steel, are in the press. A further nine are approaching the proof stage, and these include maps of physical features, railways, and the statutory electricity supply areas, a solid geology map, and one dealing with gas supply and the grasslands of the country.

Further maps in preparation depict population distribution and changes, the distribution of various minerals of economic importance, a drift geology map, maps of electricity transmission lines, and maps showing the location of ports, canals and the distribution of water.

Special Value to Industry

THESE maps should be of extreme value to industry, although a great deal of modification will be necessary to take care of the changes brought about by the war. The coal and iron map, and the iron and steel map, together will show the location of the beds of coal and ore, and the number of persons employed, as well as the situation and capacity of all iron and steel works, with indication of blast furnaces and whether the steel works are of the Bessemer, open hearth or electric types. Coke ovens and limestone quarries will be shown, and those owned by the iron and steel industry will be marked distinctively. They will be of great value to those whose work it is to plan large engineering developments; the large scale Ordnance Survey Map, used in combination with Admiralty charts for harbour, seashore, or estuarine work, are valuable, but they do not eliminate the need for improved small-scale maps on which to correlate work in prospect to others in existence or in prospect. An enormous amount of work will be involved in keeping these maps up to date, and it seems to me that purchasers should be kept informed of any important changes from time to time. Certainly it will be necessary for the changes to be recorded promptly if the maps are to fulfil the function for which they have been produced at so high, but unavoidable, a cost.

Regional Boards to Assist Peace-time Reconversion

AS part of their plans for the reconversion of industry to peacetime requirements, the Government have decided to retain the Regional Boards formed in the war to assist the Government to make the best use of all productive resources for munitions production.

Regional offices were established and representatives of the supply departments acted as links between local industry and their headquarters in London. To provide the machinery of co-ordination the first Regional Boards were established under the name of Area Boards in the Regional Areas in 1940.

In their present form the Regional Boards and the National Production Advisory Council were set up in July, 1942, as an outcome of the report of the Citrine Committee. Responsibility for their work was exercised by the Minister of Production, whose regional controllers have been the chairmen of the Boards.

Hitherto the functions of these Boards have been chiefly concerned with the production of munitions, and their interest has been consequently mainly in the engineering and allied industries, while more recently they have been concerned with the transition from munitions production to production for civilian needs.

The Story of Radar

Its Development from its Conception to the End of the War in Europe

An R.A.F. pilot leaves his radar-equipped Beaufighter after a reconnaissance sortie.

THE present and following articles in the series tell the story of the scientific principles, technical devices, and operational triumphs of radiolocation. There is some danger that the inner essence of this British achievement may be obscured by the very wealth of external facts. So we speak first of that inner essence.

These devices which have transformed every major aspect of war were born of a timely combination of scientific imagination, technical resource, technical restraint, operational appreciation, and organisational courage.

The scientific imagination was exercised in taking the step from old knowledge, available to everyone, of many isolated facts and methods in radio research to a coherent new system fitted to military needs and capable of use by military personnel. The old knowledge—much of it not very old—was international in origin, much of it British, some of it American, the crucial part of it a British experimental method.

The technical resource was exercised in producing, under severe difficulties imposed by the need for stringent secrecy, pulse transmitters of unprecedented power, receivers of unequalled sensitivity, aerials of unique design, ancillary equipment of novel character, all doing somewhat better than before something previously done after a fashion, some doing things never done before.

The development of airborne systems for locating ships at sea was deliberately slowed down in favour of night-fighter equipment, the night-fighter equipment in favour of ground early warning and location equipment; the improvement of that ground equipment was deliberately sacrificed to the installation of rudimentary systems to give nothing but early warning. A ruthless objectivity sacrificed refinements, elegancies, and versatilities to the desperate need for "something to be going on with."

Operational appreciation and understanding were achieved in the course of the most intimate and productive co-operation between scientists and officers of the fighting services that has ever been attained. To admit that co-operation of this kind in 1945 is less close than it was in 1937 is not to criticise those concerned today; it is to recognise with gratitude and admiration the heights to which the men of 1935-39 rose in planning how to save their country from a fate that was constantly in their minds.

The organisational courage was exercised by the first half-dozen workers in their firm assurances that they could do things hitherto undone, in their persistent and intolerant badgering of all branches whose ideas on tempo differed from their own, and in their firm refusal to await solutions to the temporarily insoluble problems posed by "what the enemy might do if he knew as much as we do." It was exercised by the Committee for the Scientific Survey of Air Defence in the acceptance, support and reinforcement of the workers' promises, claims and impatiences. It was exercised by the Secretary of State for Air and his Civil and Air Force Advisers, who obtained Cabinet sanction for heavy expenditure on a grandiose and far-flung chain of stations, of which the military value was assured only by the confidence of scientists, and by the not invariably satisfactory performance attained in small air exercises.

The Scientific Background

Radiolocation was a direct but not an inevitable fruit of pure research. Britain had for many years been a prominent leader in pure research on the travel of radio waves, on the things which make long distance radio communication possible and the things which make it difficult or imperfect. The Department of Scientific and Industrial Research had followed the very enlightened policy of accepting the advice of its Radio Research Board, that the best contribution which it could make to better radio communication was the long term and fundamental investigation of the basic processes rather than the short term search for individual cures to individual ills. The Department had supported the pioneer research of Dr. E. V. Appleton on the existence and properties of these electrified regions in the upper atmosphere, now called the ionosphere, which made long distance communication possible. Appleton had trained a number of ionospheric workers who are now continuing and expanding ionospheric work in many parts of the British Commonwealth and Empire. The Department had gathered together and trained a team of young research workers which at Radio Research Station, Slough, and in the National Physical Laboratory, had done work of the highest quality on other aspects of the physics of radio communication. Appleton had been the first to measure distance by means of radio waves, when he devised a way of measuring the height of the Heaviside layer. Briet and Tuve, in America, had very soon afterwards proposed and used an alternative and a somewhat more convenient method which was adopted and improved by Appleton and his co-workers. Throughout the programme of the Radio Research Board, the cathode-ray oscillograph had been increasingly applied as the most versatile and powerful single implement of radio research. Since the time when Heinrich Hertz laid the foundations of radio telegraphy, it had been known that radio waves were reflected from material objects. The British Post Office had in December, 1931, observed such strong reflections from aircraft in flight near a radio receiving station as to produce considerable interference with reception.

The British pioneer work in radio research, the British leadership in ionospheric research, the British pioneer observations of the magnitude of the radio echo from an aircraft, the British leadership in research, development and production in the television field, combined with British vulnerability to

Gunnery radar in a British cruiser. The radar operator turns a handle to align the radar echo with the marker and so transmits range automatically to the guns.

surprise air attack, provided a most favourable background for the synthesis and rapid evolution of radiolocation. When the Air Ministry set up, towards the end of 1934, a Committee to examine the applications of science to air defence, the Superintendent of the Radio Department, National Physical Laboratory, Mr. R. A. Watson-Watt, proposed to it a system for the detection and location of aircraft by radio means, based on techniques, including mainly the earlier work of Appleton and Breit and Tuve, which his Department had used in their experiments at Slough.

On the left is the height finding set. On the right is the plan positioning apparatus. These units work in conjunction and were designed for use in the Pacific war. (Note the small generators in the foreground.)

Pulse Technique

He submitted a memorandum showing in great detail how he would propose, using the pulse technique, to find from a ground station the distance, bearing and flying height of any aircraft, in a wide zone in front of his observing station, how he would affix a radio label to friendly aircraft for their identification by the radiolocation station, and he gave figures which led to a probable location range of 100 miles on a high-flying aircraft. He gave reasons for choosing the pulse method in preference to others which he mentioned as "reserves."

At the request of the Air Ministry he arranged a field demonstration, not a demonstration of the system which he proposed for operational use, but a demonstration that the amount of radio energy reflected from an aircraft many miles away would suffice for accurate measurement by the proposed system when it had been set up. This was the experiment referred to, at the time of the 1941 broadcast which revealed the existence of "radiolocation," as having taken place in a "rather ancient lorry" near Daventry on February 26th, 1935. A junior scientific officer in the Radio Department of the N.P.L. had, with the assistance of one laboratory assistant (who also drove the lorry), set up the equipment in the late hours of the 25th, and was ready to demonstrate near dawn on the 26th.

It was on this demonstration that the Air Ministry based its policy for the immediate development of a radiolocation system. The improvised demonstration showed that an aircraft eight miles away gave very strong signals in an insensitive receiver with a poor aerial when the aircraft was "illuminated" by a radio beam of only moderate intensity; the mention of 300 kilometres in the memorandum proposing radiolication had not been wildly optimistic if 12 kilometres could be surpassed within a few hours of the first arrival of the "rather ancient lorry" near a handy short-wave transmitting station.

But there was still no more than a paper plan, backed by a rough trial of something which did not pretend to be the system proposed, looking at an aircraft known to be there and isolated from other air traffic. The paper plan promised a radio ring-fence through which no aircraft flying at any reasonable height could penetrate unobserved, however many aircraft were approaching the ring-fence, and promised tracking of each separate formation as it advanced, not merely tracking across the map, but measurement also of the height at which it was flying. As a preliminary to keeping this promise, the plan demanded the solution of a mass of technical problems still unsolved—for example, no radio pulse system had ever measured distances as short as 30 miles, because of the crudity of the "sorting-out" by pulses of inconveniently long duration. A system that became confused while the enemy was still 30 or more miles away would be a poor defence system, yet this difficulty had to be overcome, while at the same time the pulses were being made much stronger than any previously sent out—this to ensure detection and location at distances much greater than 30 miles.

All this required courage born of special knowledge and enthusiasm in the proposers; it required the more difficult courage born of wide knowledge and cool judgment in the members of the Committee to put their high scientific reputation and sense of responsibility behind the scheme; it required the courage of statemanship in the Secretary of State for Air to accept and apply their advice and that of the Air Staff on this gamble against formidably long odds.

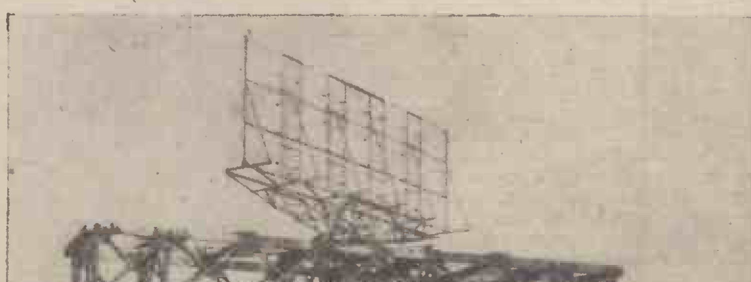
As soon as the Air Ministry had taken the momentous decision to proceed, a very small party of gifted researchers with picked technical assistants began to make the first radiolocation equipment, and on May 13th, 1935, they moved into a laboratory at Orfordness "to extend ionospheric investigations" in the peculiarly favourable conditions of quiet and isolation offered for the academic work of this little team of National Physical Laboratory workers by an enlightened and benevolent Air Ministry! Under the general direction of the Superintendent of the Radio Department N.P.L. the party worked on the design of the novel and powerful transmitter required, on the receiving antennas, amplifiers and cathode-ray display systems, and one engineer supervised both the field engineering and the workshop construction. The earlier Radio Research Board work on the "squegging oscillator" and precision "timebase generators" was extended and used at Orfordness.

Within three days of their arrival the team had their transmitter "on the air," within eight the receiver was installed, and on May 31st echoes from the ionosphere were observed.

Meanwhile, at a meeting of the Scientific Air Defence Committee, held on March 11th, 1935, to discuss possible means of detecting aircraft in naval warfare, the naval representative had referred to the Post Office experience of 1931, and suggested that the interference could be put to good naval use. No immediate action followed, but after the first experimental results of the N.P.L. party had been obtained at Orfordness in July, 1935, D.S.R. Admiralty was invited to participate actively in the experiments at Orfordness. A naval officer was appointed for liaison duties, civilian scientists were attached to Orfordness, and H.M. Signal School undertook to make the silica valves needed to produce more powerful pulses. Their later contributions in this direction were of very great importance to the operational success of radiolocation.

To return to the experimenters at Orfordness, there is no official record of the modest ranges at which, in the next fifteen days, they "saw" aircraft by radiolocation. The ranges were better than their rivals the sound-locators could normally give.

On June 16th, 1935, through what the officer commanding the Air Ministry Wireless Station called the "worst conditions for radio reception in years," because of the atmospherics from widespread thunderstorms, the Air Defence Committee saw an aircraft followed by radiolocation out to 17 miles; a few hours after the members of the committee had left, the experimenters followed an aircraft to 27 miles; a month later ranges of 40 miles were being exceeded; and on July 24th a formation of three Harts



The special intermediate transportable aerial system, as used for offensive as well as defensive purposes.

was picked up at 20 miles, correctly diagnosed as comprising three aircraft. One was seen to break formation at about 15 miles, and this one and the two which remained in formation followed simultaneously for some time. The correctness of the diagnosis was confirmed by the pilot of the "target" aircraft which had been under observation when the Harts unexpectedly appeared.

Measurement of Flying Height

On August 21st work on measurement of flying height began, and in mid-September an aircraft flying at 7,000ft., 15 miles away, was read with an error of 1 deg. in elevation, 1,200ft. in height.

Up to this point distances had been measured accurately, heights were beginning to be measured, but azimuth or compass bearing, promised in the paper plan, was missing. It had been concluded that two years might well elapse before a direction-finding system of sufficient sensitivity and accuracy could be developed. Indeed, so firm was the pessimism on this point, in an otherwise optimistic atmosphere, that the initial letters "R.D.F." were selected as a code name for the new system, with the deliberate intention of misleading the uninvited and undesired inquirer into believing that the new system was a mere improvement in the existing direction-finding network. The initials were chosen to have not true meaning, but to suggest a false one. Most inconveniently, the solution of the direction-finding problem for R.D.F. came almost as soon as the false trail had been laid; the later impression that "R.D.F." meant "Reflection Direction Finding" or "Range and Direction Finding," was thereby given some colour.

An elaborate, ingenious and not wholly dependable system had, in the absence of early hopes for direction-finding, been worked out for locating individual formations by "range-cutting" from adjacent stations; the elaboration and the independability arising from the need for ensuring that when station A observed a range on aircraft X, this was not married to Station B's observation on Aircraft Y to put a ghost formation on the plotting table. It had already been decided to proceed with a coastal chain of stations working on this range-cutting system when the solution of the problem of a direction-finder with sufficient sensitivity, and preserving the essential feature of a "radio-floodlight" system as opposed to a "radio-searchlight" system, presented itself and made a vastly more convenient plan available in time for the first big-scale construction.

The argument about floodlighting as opposed to searching with radio beams was fundamental to the plans for practical air defence by radiolocation, and thus requires fuller mention here. Our natural geography has made us vulnerable to attack on a wide front, with no political or natural barriers to constrain attacking aircraft to follow a limited direction of approach. Radio beams of wavelengths practicable in 1935, and of sufficient power to give observable echoes, could not be "swung" sufficiently fast to ensure that the enemy should not slip in unobserved while the searching beam was investigating another part of the wide area. It was most desirable that the radiolocating device should have "eyes all round the front of its head"—it was desirable that, until the system made great advances, it should not have "eyes in the back of its head" with which to see friend or enemy, easily able to be confused with enemies in front. It was therefore, to repeat the obvious analogy with light already used, desirable that the primary radiolocation chain should "floodlight" the whole zone to seaward of it, should "illuminate" brightly the landward zone behind it, and that its associated receiving equipment should "see" simultaneously, but separately, all the aircraft thus "illuminated" by the radio floodlighting, and should be able to make quick measurements on any one of them without losing sight, even temporarily, of any of the others. It was this insistence on floodlighting that most strongly characterised our fundamental operational thinking about radiolocation in contra-distinction to much planning in Germany and elsewhere of which we learned later, planning which put all emphasis on searching with radio beams. We, too, were clamouring for radio searchlights, but we hardened our hearts against letting them interfere with the satisfaction of our greatest need, an unblinking watch over our unbroken zone of seaward radio-floodlighting.

A magnetron transmitting valve (left) and a Sutton valve.

Experiments began in the last days of November, 1935; in January, 1936, good bearings were being read at 25 miles on an aircraft flying at 7,000ft. On December 5th, 1935, a promise was given that direction finding would be incorporated in the Air Ministry Estuary Chain.

Special Valves

After a period of attachment of a naval liaison officer to the Air Ministry Station at Orfordness, the Admiralty agreed their requirements of "R.D.F. for Naval Uses," and ordered Signal School to explore the wavelength spectrum below 1½ metres and provided a staff of three scientific officers and three assistants to do it. It must be understood how closely the progress in radiolocation has been bound up with progress in design of very novel electronic valves and similar devices. Where special progress has been required, it has been obtained only after the related progress in valve design had been achieved. The silica valves with very large-emission filaments, their "metal-glass" counterparts and successors, the velocity-modulated tube, the multiple-cavity magnetron, the cathode-ray tube with peculiar screen characteristics, the host of ionised gas devices and the many advances in receiving valve design; all have played their part, and without them, and without the enthusiastic workers who have devoted themselves to the design and practical production of them, little progress beyond the "1935" stage would have been possible.

By now the need was pressing for taller masts than the 70ft. ones at Orfordness, which gave 70 km. ranges on aircraft flying at 7,000ft. altitude. (The limiting range to the horizon goes up as the square root of the mast height.) The effective range could also be put up by reducing the wavelength used, but there were serious limitations there, as work on 4-metre wavelengths (which had been carried on in parallel with the main work on 50 and 26 metres) had shown. So self-supporting timber towers of at least 200ft. were demanded, with a second station to try out the first link in the unbroken East Coast Chain which was being planned. On March 7th, 1936, the first 240ft. tower was completed, and on March 13th a new record was achieved in locating a Hart flying at 1,500ft. at 120 km. (75 miles).

By September, 1936, the experimenters were ready to participate in the first air exercise to be devised round radiolocation; they disagreed with some of the aircrews about where they had been over the North Sea, and demonstrated that some aircraft had turned round the wrong lightship. A stage had been reached at which the men at the radiolocation station knew more about the whereabouts of an aircraft than did the men in the cockpit.

Here ends the first chapter of the story of radiolocation; the original experimenters, taking to themselves reinforcements, moved to "larger and more commodious premises" at Bawdsey Manor, near Felixstowe; they knew more about the estimated time of arrival and place of landfall of the K.L.M. liners from Amsterdam and the D.L.H. liners from Hamburg than did the controller at Croydon Airport; they even noted a tendency for D.L.H. to make landfall near Bawdsey, and they wondered. The next part of the story tells of the conversion of an ingenious technical device worked by scientists into an everyday weapon of war worked by Service personnel and fitting into a planned defence system.

A radar "magic eye" photograph of the woods at Nordhausen which, giving an "echo" and showing up their outlines distinctly, are of great help in navigation.

(To be continued)

The Foundations of Thermodynamics—1

The First of a New Series of Informative Articles on this All-important Subject

By R. L. MAUGHAN, M.Sc., F.Inst.P.

THERMODYNAMICS is a branch of physical science which is concerned with the laws of exchange between the different kinds of energy. The subject had its origin, as its name suggests, in the discovery of the laws relating heat to mechanical work, but its principles have since been extended and generalised so as to include energy in all its known forms. It has proved to be an instrument of great usefulness to the scientist and engineer in the work of reasoning about scientific matters and in probing the secrets of the physical universe. Thermodynamics is greatly concerned with one quantity called "energy," and another quantity called "entropy," and some understanding of these quantities is needed to appreciate the meaning and aim of the subject.

Energy

The conception of energy in science grew out of the study of the mechanics of matter in motion. It remained for many years as little more than a vaguely defined idea whose description in words and symbols was debated and argued over by rival schools of scientific thought. It is only in relatively recent times that the familiar definitions and formulæ found in modern textbooks which discuss energy have passed into common usage. In 1695 the mathematician Leibnitz observed from experiments on the impact of solid bodies that the quantity of $m.v^2$ (where m denotes the mass of a body moving with a velocity v), summed up for the bodies before and after the collision, appeared to remain constant. He gave this expression the name "vis viva," or living force, as it seemed to be a suitable measure of the force of a body in motion, just as "vis mortua," or dead force, was subsequently used to describe the pressure which a body at rest exerts on the surface supporting it. In 1807, Dr. Thomas Young, a medical doctor who had formerly been a professor of physics and chemistry at the Royal Institution, introduced the word "energy" into scientific literature in connection with the force of a body in motion, but the term was not universally accepted, and for some time afterwards vis viva continued to be widely used to describe the same thing.

A satisfactory quantitative description of energy was not made until the meaning of mechanical work had been clearly defined. This advance was made in 1826 when J. V. Poncelet, a French mathematician, used the word "work" to mean the act of overcoming a mechanical resistance by moving a force against it, the amount of work expended during the action being measured by the product of the force itself and the distance moved through in line with the force. It was recognised that any object or system capable of performing work in this way was in possession of some peculiarity which for the time being distinguished it from other similar bodies in its neighbourhood; just as a rifle bullet in the process of leaving the muzzle of a fire-arm has for the time being a distinction over all the similar bullets remaining at rest in the magazine. Such objects were said to possess energy, inasmuch as they were able to perform mechanical work by moving a force against a resistance; and their expenditure of energy was defined as being equal to the amount of work performed by them.

Newton's Law of Motion

A simple formula for this particular kind of energy can at once be found from this definition by using the famous law of motion established by Isaac Newton in 1687. When an object is flung upwards in a vertical direction it has to climb against the opposing pull of gravity. It loses velocity at a uniform rate, remains at rest for an instant at the peak of its flight, then returns along its course with gathering speed, and if the small effects of the viscous drag of the air on the body at all stages of its motion are allowed for, it is found that the velocity of the body has the same magnitude at the beginning and end of its journey. The weight of the body is given by Newton's law as $m.g.$ (where m is the body's mass and g is the acceleration it would experience in free fall), and represents the resistive force which must be overcome if the body is to ascend. If h denotes the height climbed, then the work expended during the ascent is $m.g.h.$ according to the Poncelet definition of mechanical work. The well-known law of uniform motion of a point in space gives $h=v^2/2.g$ (where v represents the instantaneous velocity of the body at the beginning of its flight), and therefore $m.g.h.=\frac{1}{2}.m.v^2$.

One interpretation of this equation is made as follows: At the instant the body begins its flight it possesses in virtue of its motion an amount of energy represented by $\frac{1}{2}.m.v^2$. In the process of rising the body gradually loses this energy by performing work against the gravitational pull of the earth. The lost energy of motion reappears as a new and different kind of energy, a latent energy of position, which reaches its greatest value at the instant the body is poised at the peak of its climb. This energy of position is then re-transformed into its equivalent amount of energy in motion when the body falls. By this manner of reasoning the earlier scientists made the discovery of the first two forms of energy, both of which are mechanical, the first associated with matter in motion ($\frac{1}{2}.m.v^2$), was called "kinetic energy" in 1867 by Professors Thomson and Tait, a name which finally displaced the older expression "vis viva," and the second associated with matter at rest at a given level in a gravitational field ($m.g.h.$) was given the title "potential energy" by J. M. Rankine in 1853.

Electrical Energy

As science has advanced, many more forms of energy have been discovered and labelled. Electrical energy is possessed by a circuit in which a current is flowing, or by a condenser in which a charge is at rest. It is generated by moving a wire through a magnetic field, or by placing sheets of copper and zinc in a vessel of dilute sulphuric acid, or by warming one junction of a loop of two different metals while the other junction is kept cold, or by rubbing silk over glass. Luminous energy is generated when the atoms of a substance are suitably agitated, as in combustion by flame, or in an electrically heated filament, or in the discharge of electricity through a rarefied gas, or in the interaction of invisible ultra-violet rays with a fluorescent material, or by the impact of steel on stone. Chemical energy is released or absorbed when the atoms of substances regroup themselves to form molecules of new substances; the chemical energy locked in the molecules of a fuel is released largely as heat energy when the fuel burns. Acoustic energy is propagated through the air surrounding a vibrating bell or stretched wire. Electromagnetic energy is carried through space at great speed in waves whose lengths vary from the relatively long radio waves to the very short waves of X-rays and Gamma-rays. Atomic energy, a British discovery made earlier in the present century, and one which has lately aroused wide interest through its use in bomb warfare, is the most recent addition to the list of energy forms. It is encountered in the bursting of atomic nuclei and in cosmic ray phenomena. Its discoverer, Ernest Rutherford, later Baron

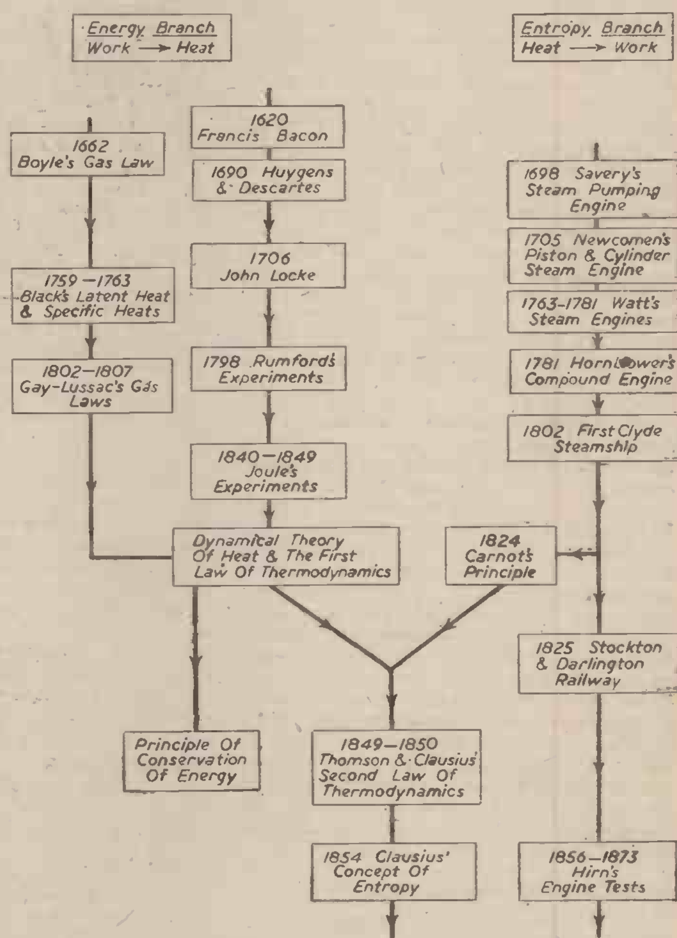


Fig. 1.—Diagram indicating the origins of the subject of thermodynamics.

Rutherford of Nelson, was the first to make atoms explode artificially in the laboratory. He achieved this in 1919 by bombarding atoms which under normal circumstances are quite stable, with small, very fast particles thrown out of the nuclei of the naturally explosive atoms of radio-active substances. The shattering of a nucleus of a normally stable atom in this manner discharges the vast store of energy bound up in a potential form in holding the nuclear particles together. The released atomic energy is a mixture of two sorts, the familiar mechanical kinetic energy of swiftly moving material fragments, and the wave energy of electromagnetic radiations produced by the less familiar phenomenon of the total annihilation of matter, an energy transformation first predicted by the relativity principle in 1905.

It is easier to believe in the existence of energy than it is to define it fundamentally in general terms. Its existence is believed in, though its ultimate nature is not understood, in order to have something to hold responsible for the endless sequence of changes everywhere observable in the physical world. It cannot be directly perceived, but its presence is inferred from its effects. Whenever a change of condition takes place in a material substance —and the word " condition " is used here in its most general sense and is intended to include all the varieties of physical and chemical states, and all the possible locations in space and time which matter and radiation may possess—it is acknowledged that energy has operated on that substance. Two of its particular effects—its capacity to set material bodies into visible motion and its readiness to transform into heat—are themselves such familiar occurrences that they are often offered as definitions of energy, the first one in the well-known sentence that energy is a capacity for doing work, and the second in the statement that energy is something which can always be made to reveal itself as heat.

Energy is present in the universe in great abundance, and though its exact amount has not been assessed with any certainty it is believed that the total amount, whatever it may be, has a fixed and unalterable magnitude. The energy theory, founded upon the results of experience and experiment, consists of a table of the known forms in which energy may exhibit itself, a list of the measured rates of exchange which operate between various pairs of these forms (the mechanical equivalent of heat, sometimes called " Joule's equivalent," is perhaps the best known of these rates of exchange), and a ruling that although transitions from one form to another are taking place everywhere at all times, the sum total of energy is always the same.

Mechanical Theory of Heat

A little less than 100 years ago heat was placed on the list as a distinct form of energy. At the beginning of the nineteenth century the accepted view among scientists and philosophers was that heat was a substance, an igneous fluid called caloric, described in the literature of the time as " a weightless, invisible, indestructible, subtle fluid capable of permeating the pores of material bodies and filling the interstices between the molecules." More than a century of fair agreement between theory and trial by experiment had gone towards grounding the caloric theory upon what seemed to be a reasonably secure basis, but in spite of this the contrary opinion was often voiced that heat was not a fluid or indeed a quantity of anything substantial at all, but was just a condition or state of a substance brought about by the vigorous motions of the small particles out of which the body was composed. In other words, that heat was a sum of kinetic energies of a great number of very small swiftly moving material bodies. This view is described as the dynamical or mechanical theory of heat, and is one of two main sources from which the subject of thermodynamics springs. It is a view which gained a footing only very slowly as items of experimental evidence were gradually pieced together to support it, and it was not until the middle of the last century that it finally succeeded in displacing the caloric theory of heat. From the time it became accepted as a new way of regarding heat, the subject of thermodynamics became established as a new branch of physical science.

The early growth of thermodynamics, sketched in outline in Fig. 1, can be traced from two main sources which can be conveniently described as the energy branch and the entropy branch respectively. The energy branch is mainly concerned with the problems of converting work into heat, and has a somewhat nebulous origin in the speculations of the seventeenth and eighteenth-century philosphers as to the true nature of heat. The entropy branch deals with the converse problem of converting heat into work, and begins more abruptly in 1824, with the work of Nicolas Sadi Carnot on the efficiency of steam engines. The union of the two branches was brought about in the middle of the nineteenth century by the enunciation of the first and second laws of thermodynamics, and from this union springs the main stream of the subject.

Energy Branch

Out of the earlier expressions of the view that heat is a form of energy three may be selected as typical of the trend of thought which, coupled with the necessary backing of practical test and experiment, was to lead to the downfall of the caloric theory approximately two centuries later. In 1620 the English philospher, Francis Bacon, published the opinion that " the heat content of a body is a state of motion of its material particles." About 60 years later Rene Descartes explained the sensation of hotness as " motion conveyed to the nerves," and in 1706 another philosopher, John Locke, stated that " heat is a very brisk agitation of the insensible parts of an object." These are amongst the first recorded statements of the mechanical theory of heat, and in them lie the beginnings of thermodynamics. Some considerable time was to elapse, however, before these and other purely theoretical speculations were to receive any reliable experimental evidence to support them ; the eighteenth century was almost out before the first serious challenge was offered to the caloric theory.

This challenge came from Europe from an English speaking, American born soldier, scientist and statesman, Benjamin Thompson, afterwards known as Count Rumford. In 1798 Rumford was engaged in superintending the work of casting and boring gun barrels in the workshops of the military arsenal at Munich, and while watching the boring of the brass castings was impressed by the immense amount of heat produced by the friction of the drill on the brass. His interest in the purely scientific aspect of the work led him to make a measurement of this heat in an attempt to correlate it to the labour expended in the drilling process. The machinery used by him is illustrated in Fig. 2. The cannon were cast in the vertical position, muzzle-end upwards, with an additional head of metal above the muzzle to allow for shrinkage and piping, so that each brass casting received from the foundry carried a solid cylindrical head projecting from its muzzle-end. Each casting was laid horizontally on bearings and turned about its axis by means of an iron shaft coupled to the breach-end of the cannon, the motive power being provided by a team of two horses harnessed to a wheel which turned the shaft. At the muzzle-end of the casting a non-rotating blunt-bladed steel boring tool about 4in. wide was kept pressed against the brass by means of a screw at a pressure of several thousand pounds. Slow turning of this screw kept the pressure steady and moved the tool forward as the drilling proceeded. The cylindrical head was enclosed in a wooden water trough containing about two gallons of water, and the rate of heat production estimated in terms of the rate of rise of temperature of the water.

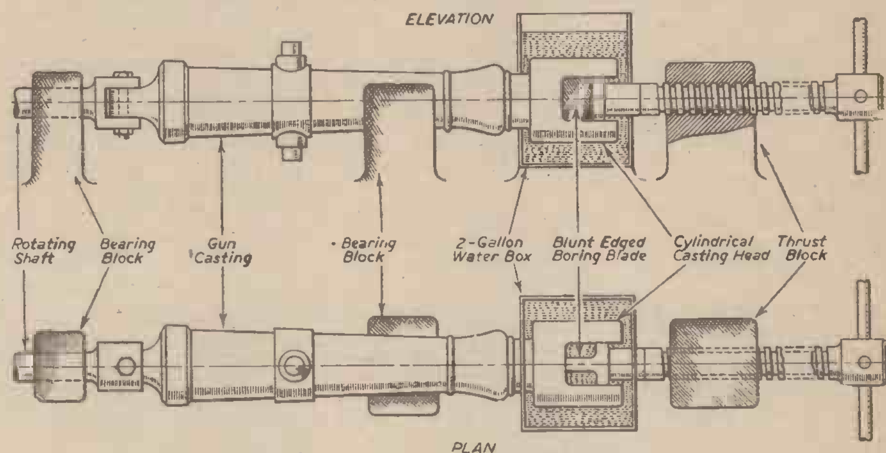


Fig. 2.—Cannon boring apparatus used by Rumford in 1798.

Rumford's experiment was not successful in the quantitative sense. His tabulated observations between work done and heat developed were not sufficiently accurate to enable him to find the true rate of exchange, but the qualitative deductions he made from them attracted the respectful attention of scientific circles throughout Europe. According to the caloric theory the brass casting contained a definite amount of heat fluid dispersed between its particles which would in part be squeezed out of the metal and into the water by the pressure of the drill, but Rumford contended that there could not be room enough inside the brass block to house the quantity of heat fluid needed to produce such a high temperature in the metal and the water. He maintained that some relation must exist between the labour spent in turning the brass against the friction of the drill and the amount of heat generated. He argued that just as a wet sponge when squeezed cannot indefinitely give out water, so a solid when pressed cannot indefinitely give out heat fluid, and that even as a bell will continue to give out sound as often as it is struck, so will a solid continue to develop heat as long as it is rubbed, since the heat has its source in the state of motion of the particles of the solid, just as the sound has its source in the state on vibration of the bell.

(*To be continued.*)

Making Pipe Bowls

How the Engineer Can Make His Own Pipes from Roots and Burrs of Hardwood.

By A. E. BOWLEY

DURING these recent years of war, how difficult it has been for the confirmed pipe smoker to gratify the old habit of casting aside the well-worn briar in favour of a new one.

Indeed, this difficulty is still with us, and the writer was constrained to take steps to remedy this for himself, and for certain of his friends.

It was first of all decided to obtain any available literature on the subject. This, however, proved small indeed, though Dunhill's "The Pipe Book" (published by Black), mentioned that in the Black Forest of Germany the peasants utilised the root of the dwarf oak, and our own country labourers sometimes made a pipe from the root of the gorse bush. Holtzapffels, in his 4th volume of "Turning and Mechanical Manipulation," speaks of the manufacture of smoking pipes, and mentions the use of the roots and burrs of pear, cherry and cocos wood as well as the so-called "bruyère," or Erica Arborea, the tree heath—our well-known briar.

A Walnut Bowl

A first experiment was made with a piece of well-seasoned walnut which had hitherto done good service in a gun-stock.

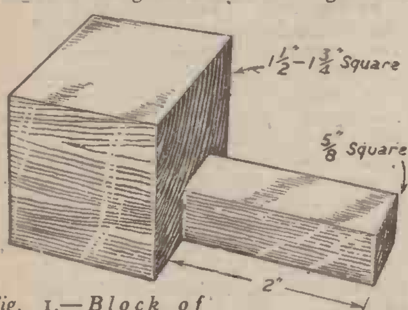


Fig. 1.—Block of walnut roughly shaped.

The wood was first sawn to the shape and size indicated in Fig. 1. It was then held in a four-jaw chuck and the stem turned, bored, and opened for the mouthpiece as in Fig. 2. Before removing from the lathe, files and sandpaper were used to obtain the initial smooth finish. The piece was then re-chucked as in Fig. 3 and the outside of the bowl turned as far as possible. It should here be stated that experience showed the necessity for marking out the job carefully. It proved insufficient to bring the lathe poppet up to the approximate centre and set it by eye. A line should be scribed round the whole piece, otherwise it will be found that the hole in the stem may not centrally meet the base of the bowl.

The bowl was next bored, first using up to ½in. drills, and then a tool as shown in sketch; files and sandpaper then removed all knots and excrescences.

After removal from the lathe, a taper peg, previously turned from hardwood, was held in the vice, and the partially finished pipe held as in Fig. 4 in order that by the aid of a small saw, files, and linen-backed sandpaper, the corners might be removed.

Fig. 4.—The partly finished pipe, showing peg for holding in a vice.

Finishing this pipe proved a failure, though it smoked well, for after staining with spirit stain it was shellac polished, and the writer was reminded of the fact each time it was smoked.

Finishing

Search was then made to discover how the finish of commercial pipes was accomplished, and at the same time some well-seasoned apple root was cut up in readiness, pear not being obtainable just then.

Messrs. Cannings, Ltd., of Birmingham, the well-known plating specialists, publish a very useful work, "Handbook on Electroplating, etc." In the 9th edition the preparation and polishing of pipe bowls is briefly dealt with and is here quoted verbatim.

"Polishing Briar Pipes and Vulcanite Mouthpieces"

"The briar bowls are sandpapered on a disc polishing machine, first with coarse sandpaper and afterwards with finer grades. Subsequently, they are polished with powdered pumice, which is moistened with water and applied to a polishing disc about 9in. diameter, having a felt surface. As an alternative process, a pumice composition can be used on a brown cloth polishing mop.

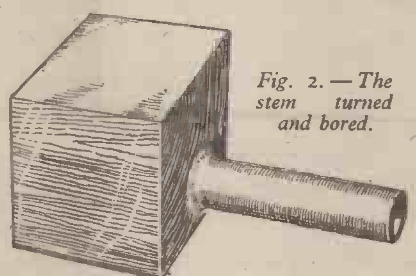


Fig. 2.—The stem turned and bored.

"To get a perfect surface before staining, another disc with felt surface or with a special leather known as 'Buffle' is employed, and a specially prepared polishing earth known as 'Tellurine' moistened with a little oil is applied to the disc while working.

"After staining, use a swansdown mop with a small quantity of 'Vonite' for finishing.

"Vulcanite mouthpieces are either (1) cut from sheet vulcanite, (2) moulded to shape. Both are polished on a felt-covered disc with pumice, as above, after they have been filed or ground to shape. Subsequent polishing is carried out with a brown cloth polishing mop about 9in. or 10in. diameter, and tripoli compo followed by a swansdown mop with 'Vonite' special finishing composition."

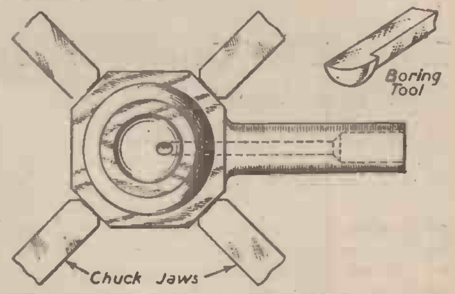


Fig. 3.—The bowl held in the chuck for turning and boring.

An Applewood Bowl

These materials quoted above were quite easily obtained with the exception of the Tellurine, and the next pipe prepared in applewood, as mentioned above. This material did not prove so close grained and therefore pleasant to turn as the walnut. Indeed, there was a strong tendency for the drills to run out when finishing. To minimise this, the small hole to the bowl (approximately ¼in.) was put through last, and the preceding one used for the stem fitting kept short and stiff.

However, this pipe and its fellows proved quite successful, the polish being retained quite well despite the heat, and the reader can be assured that an applewood pipe smokes quite as sweetly as many of the reasonably-priced pre-war briars.

A word as to the interior of the bowl. It is well known that a new pipe requires "breaking in" in order that a thin film of carbon may form on the walls. An experiment was tried which was that of coating the inside of the bowl with graphite. This certainly took away the initial woody taste, and gives quite a professional touch to the work, particularly if the pipe is to be a gift to one of the old-time "critical" pipe smokers.

Pearwood was obtained, and also some more apple root freshly unearthed. Both these samples being green were very kindly kiln dried for the writer by a manufacturing acquaintance. Results were not so good, but in fairness it should be stated that the walls of the bowl were a trifle thin on this effort.

In conclusion, it can be re-stated that of the woods tried out, walnut and apple root are quite good, yew is believed to be suitable, and any interested readers with relations in the B.A.O.R. might get some Black Forest oak. Vulcanite stems are not too difficult now, indeed they are more plentiful than "briars" in the Midlands.

The making of a pipe, or pipes, is quite interesting, and frankly, the results have been worth while, particularly when one occasionally sees or is offered rubbishy pipes at a fantastic price, and made apparently from deal. The desired qualities are a close-grained hardwood which is well seasoned and suitable for turning.

A Model Motor-boat

Constructional Details of a Small Boat Driven by a Simple Automatic Propulsion Unit

By A. J. BUDD

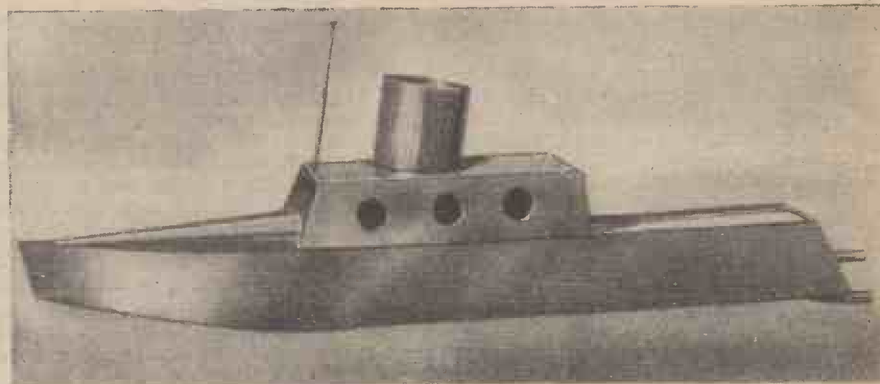


Fig. 1.—General view of the finished motor-boat.

SEVERAL years ago there appeared on the market a toy boat driven by a novel propulsion unit consisting of a coiled piece of copper tubing, the ends of which projected into the water at the stern of the boat. The coiled tubing was heated by a small methylated spirit burner.

In response to inquiries made by several readers of PRACTICAL MECHANICS for particulars of this novel boat, the Editor asked me to prepare a simple design for a model boat incorporating this automatic propulsion unit. The result is shown in Fig. 1, from which it will be seen that the boat is of the cabin cruiser type.

As far as can be remembered, the " boiler " in the original models took a similar form to that used in the boat illustrated (see Fig. 2); anyway, it works satisfactorily.

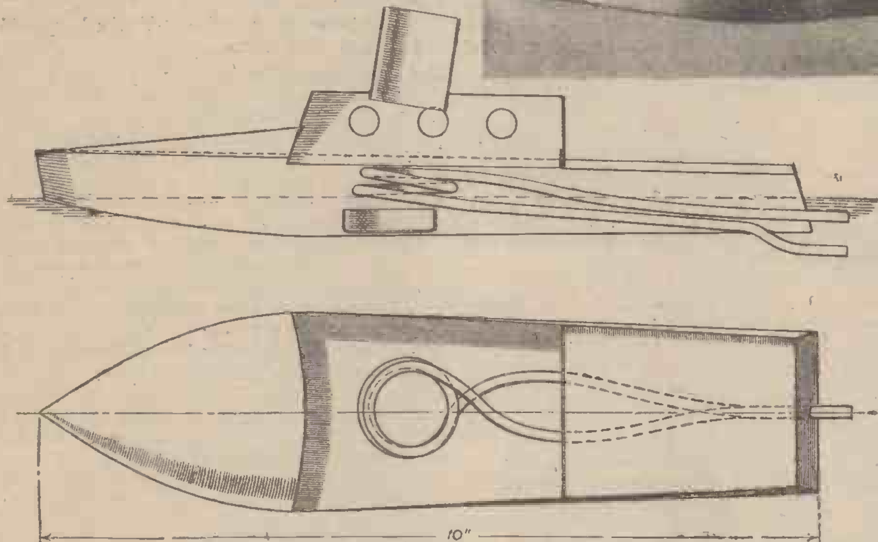


Fig. 2.—Sectional elevation and plan of the motor-boat showing the arrangement of the propulsion unit.

Constructional Details

The hull is made from a single piece of thin tinplate, cut to the shape shown in Fig. 3. The metal is bent along the dotted lines, and the bottom of the hull at the forward end is bent slightly to conform to the curvature of the sides. All the joints are then soft soldered.

By the way, all the tinplate for making the boat described was obtained from two 2lb. jam tins, which were cut up with the aid of a fine hacksaw and small tin-shears.

The next part to prepare is the boiler tube, and for this an 18in. length of 1/8in. outside diameter light gauge copper tubing will be required. The middle part of this tubing is gradually bent round a wooden mandrel, about 1 1/8in. diam.—a tool handle will answer the purpose—to form a double coil, as shown in Figs. 2 and 4. One end of the tubing is passed through a hole made in the stern of the boat, the other end passing through a hole made in the bottom of the hull 3/8in. from the rear end, so that the projecting ends of the tube are one above the other when finally soldered in place. To enable this to be done the lower end of the tube is bent as shown in Fig. 2.

Before soldering the ends of the copper tubing in place put a small block of wood, 3/8in. thick, underneath the coiled part of the tubing in order to provide sufficient space for the burner. The wood block is afterwards removed, leaving the copper tubing in the position indicated in Fig. 2, which also shows the methylated spirit holder in position.

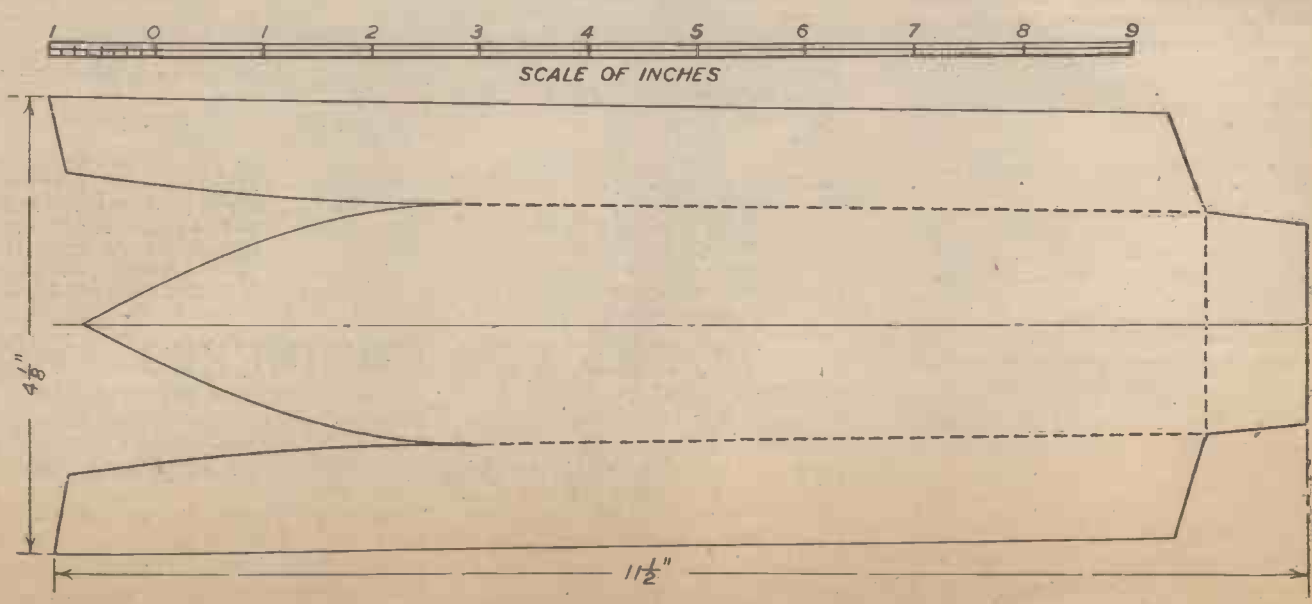


Fig. 3.—Shape of the tinplate blank for forming the hull.

Superstructures

The "turtle" deck is cut out to shape and dimensions given in Fig. 8 and carefully bent till it fits snugly in the bows of the boat. It is then soldered in place.

The cabin is made from a single piece of tinplate cut out, as indicated in Fig. 5, and bent on the dotted lines after drilling the hole for the funnel and the portholes. After soldering the four corner joints, place the cabin in position, and on the front of it mark a line coinciding with the curved back edge of the turtle deck. With the aid of a small metal saw, cut a curved slot, as shown in the illustration, Fig. 4. The edge of the turtle deck, by projecting slightly into this slot, supports the front of the cabin, the rear of which is held in place by the upturned edge of the rear deck part, which is formed by a piece of tinplate soldered in place. This part is cut to the dimensions given in Fig. 6. For the funnel, a strip of tinplate is cut out (see Fig. 7) and bent round a wooden former 1in. diameter. The butt joint is soldered on the inside, after which the funnel is soldered in the hole in the cabin roof, on the inside.

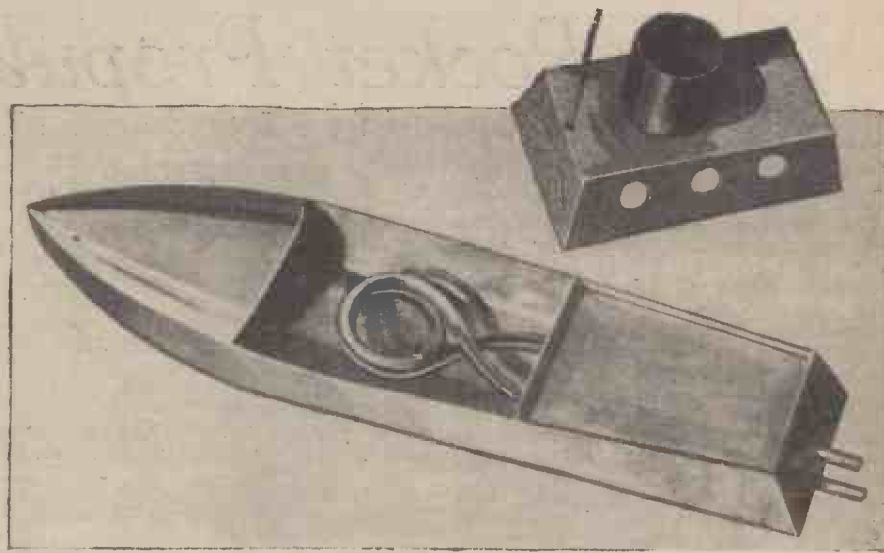


Fig. 4.—View of the boat with superstructure removed. Note the curved slot in the front of the cabin.

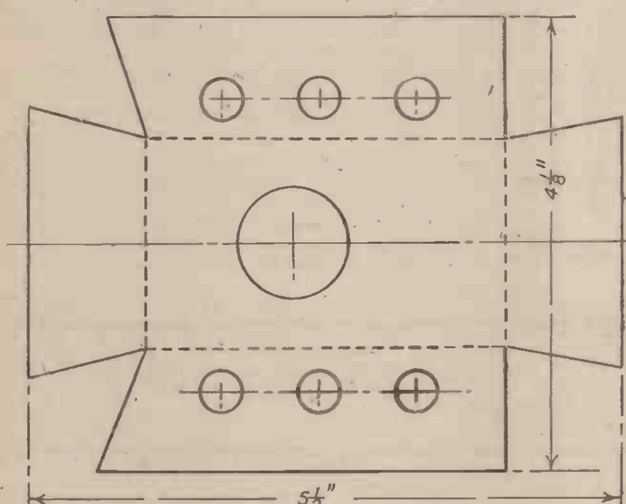


Fig. 5.—The metal blank for forming the cabin.

The Burner

In the boat illustrated the burner consisted of a metal screwed cap about 1in. diameter and 5/16in. deep. This was filled with solidified methylated spirit and placed under the coiled "boiler" tube each time the boat was run. The cabin, complete with funnel, was then placed in position, the boat placed on the water, and the burner lighted with a match inserted through one of the portholes.

As soon as the coils get hot, the boat begins to "chug" away in quite a realistic manner, and travels along fussily till the burner spirit is used up.

An important point concerning the successful running of this kind of boat is that the coiled tubing must be kept as low as possible in relation to the water level when the boat is afloat. It will be noticed, with reference to the sectional view in Fig. 2, that the greater part of the tubing is below water level.

It may be found necessary to adjust the distance between the water level and the top end of the propulsion tube, and this can easily be done by placing a small weight about the middle of the after deck.

Finally, with regard to the burner, if there is any difficulty in obtaining solidified methylated spirit, the small tin holder can be packed with asbestos yarn and a circular cover of fine mesh wire gauze fitted over it to keep it in place. The asbestos yarn can then be saturated with methylated spirit in the ordinary way.

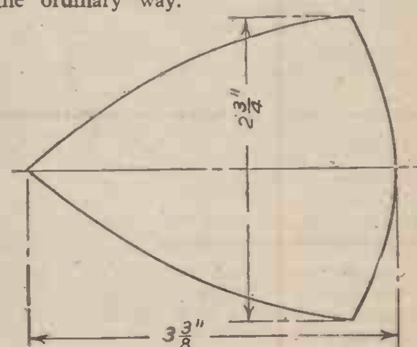


Fig. 8.—A piece of metal cut to the shape shown forms the turtle deck.

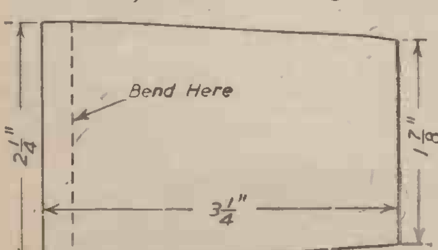


Fig. 6.—Metal blank for forming the after deck.

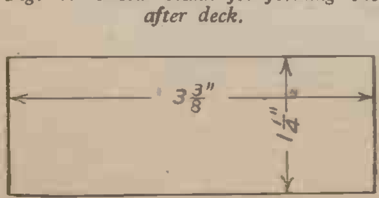


Fig. 7.—The funnel is formed from a strip of tinplate cut as shown.

Attempts are now being made to seal off the breaches in the dykes on Walcheren Island. Parts of Mulberry Harbour used for the invasion of Normandy are being taken to Walcheren, and our illustration shows pontoon units being brought alongside tugs in Southampton Docks.

Rocket Propulsion

Further Details of the B.I.S. Space-vessel : The Lunar Flight

By K. W. GATLAND

(*Continued from page 20, October issue*)

AS has been emphasised earlier, the development and selection of a propellant in the B.I.S. Space-vessel conception cannot be governed by thrust yield alone. The cellular method of construction relies upon a high fuel density to provide its structural stability; and the "otherwise ideal" propellant may also be grossly unstable, liable to detonation. The problem is, obviously, no slight one, and much extensive research will doubtless be necessary before the "Lunar propellant" becomes reality.

A beginning, however, has already been made in the work of a research chemist, Dr. A. M. J. Janser, officer of the pre-war B.I.S. Council and member of the Technical Committee, whose researches have resulted in the development of certain original propellant forms which bear much promise in a cellular arrangement. These can be described as fuels which embody an oxygen-bearing organic substance of viscous consistency with a finely comminuted metal dispersed therein. Many exacting checks remain to be made before anything definite can be expressed of such compounds. What can be said, however, is that the factor of efficiency approaches more closely the theoretical value than any of the more conventional propellants previously tested. There are several metals and metaloids which release very great energies on oxidation, and the comparative values and corresponding exhaust velocities of these, as well as those tested by Dr. Janser, are given in the accompanying table.

The "Life-container"

The crew's compartment presents another factor of design that requires most careful consideration. It must be provided with means for sustaining an artificial atmosphere, sufficient to satisfy the needs of three for three weeks.

The B.I.S. suggest the solution to this problem lies in the use of hydrogen peroxide. This, they assert, would be carried as a syrupy viscous liquid that could be broken up into air and water either by the application of heat or by catalytic action; one molecule of which can be readily split up into one molecule of water and half a molecule of oxygen. Thus, not only is a continuous supply of oxygen issued into the life chamber, but also a supply of water is maintained which alone would satisfy the needs of the crew. It is found that 34lb. of hydrogen peroxide yields 16lb. of oxygen and 18lb. of water, and 1lb. of oxygen occupies 13 cu. ft. at N.T.P., which is sufficient for one man who is normally active for a period of six hours. Working from this basis, approximately 500lb. of hydrogen peroxide will provide sufficient oxygen for three men for 20 days, while allowing also a small surplus for emergency purposes. This same quantity of peroxide will also yield about three pints of water per man each day for 20 days, and allow a little to spare for chemical purposes and other uses.

In this arrangement, weight is saved by the use of one storage tank for two commodities, and also entails a saving in space, since the two substances could never be stored as compactly as when they are in chemical combination. Furthermore, only one set of controls would be necessary to regulate both air and water.

As a precaution against a possible break-down of the peroxide water/oxygen plant, a small amount of liquid oxygen would also be taken. This would also be necessary as an air supply for the "space-suits," which the crew would use outside the Space-vessel while on the Lunar surface.

Navigational Instruments

One problem solved invariably presents another. The "Vessel's" axial rotation

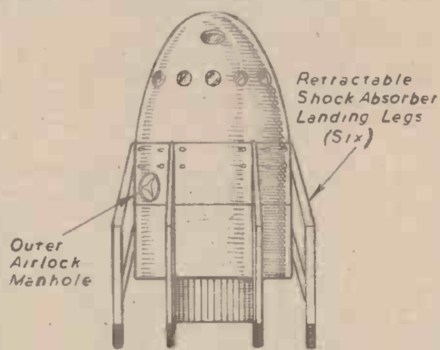


Fig. 39.—Space-vessel, as it would appear after alighting on Lunar surface.

means that the control compartment is also revolving, and although, as already observed, this condition serves to stabilise, and also stimulates an artificial gravitation, it does not facilitate the navigational problem. First, however, the one other principal advantage—*gravitation*. In order to gain this condition, it will obviously be necessary for the crew also to be rotating—the gravitational effect being stimulated by centrifugal force. The crew are, therefore, accommodated on full-length couch type "chairs," radially fitted, which rotate on rails round the life-compartment, and the navigators recline on these with their heads towards the "Vessel's" axis. There is also provided a circular catwalk for them to move round the circumference of the chamber.

The main ignition controls are fitted to the arms of the "chairs," while the navigational instruments, altimeter, speedometer, accelerometer—all functioned by impulse—are mounted on a central pillar in full view of the crew.

The difficulty lies in the fact that, under these conditions, the field of vision will be rotational, and since from time to time the crew will need to make navigational observation, this must be converted to one both stationary and accurate.

A satisfactory solution was found in the development of a system of rotating mirrors—a development of the stroboscope—and the B.I.S. have already constructed a successful test instrument along these lines. The new device has been termed the "coelostat."

The apparatus is fitted on the central control assembly (see Fig. 38) so that direct view in three directions is permitted: (a) axially, away from the firing face (three viewing ports, situated near the apex of the life-container shell); (b) axially, towards the firing face (viewing panels provided in that section of the "Vessel" where the circular life-container floor overhangs the hexagonal main body shell), and (c) radially (12 viewing ports provided in the dome of the life-container, circumferentially spaced equally at 30 degs.). The presence of the ceramic nosing carapace will mean that the ascent through the atmosphere will have to be made without external vision. This is no great problem, however, as the navigational corrections would, in any event, be best left until after the pre-determined thrust phase.

The Lunar Flight

Navigational requirements made it desirable for the launching to take place from near the Equator.

The "Vessel" would ascend from a special launching installation, and be pre-rotated at a designed rate of one revolution every three seconds. This rotation would be maintained throughout the voyage—a duration of almost four days.

Acceleration would be applied to obtain "release velocity" (6.95 miles per second) within $7\frac{1}{2}$ minutes, and the "Vessel" would emerge from the extreme limits of atmosphere after three minutes. At this stage, the ceramic nosing would be jettisoned, and as the propulsion cellules become expended, these, too, would drop away, together with their retaining structure and shell segments.

Having attained "release velocity," power would be cut off; momentum carrying the machine to the Lunar orbit. It is during this period that any navigational corrections would be made.

Still travelling under momentum, the "Vessel" would be steadily slowed by the influence of the Earth's gravity until the transitional point of the opposing gravities—Earth and Moon—is reached. Once beyond this, however, the Lunar influence would come into effect, causing the machine to accelerate toward the Moon's surface. During this period of natural acceleration, the "Vessel" would be turned completely through 180 deg., so that, in preparation for the landing, it approaches the surface stern first. This manœuvre may appear, at first thought, a somewhat delicate operation, but taking into consideration the absence of atmosphere, and remembering that the acceleration at this period would not be very great, the difficulties involved are really slight. It would, of course, be necessary to check the machine's axial rotation before applying lateral forces, employing sensitive steam jets in both instances. This would involve a loss of stimulated gravity, although a limited gravitational "pull" would have effect from the Moon.

Once the turning manœuvre had been fully executed, further banks of cellules would be fired to retard the "Vessel's" speed. These would exert a negative acceleration and serve to further stimulate artificial gravitation within the machine.

The immediate approach to the surface would be made in conjunction with special instruments developed on the basis of time, and rate of negative acceleration. There would also be an instrument to check height, similar in application to the "echo sounding" device used at sea. The individual readings would need to be automatically integrated. In this way direct figures would be shown of the "Vessel's" position, relative to the surface, at every instant of descent, and the thrust modulated accordingly, ultimately, to just balance the Lunar gravitation a few feet above the point of alightment. The force of landing would be taken by six hydraulic shock-absorber "legs," and if correctly done, this should not be excessive, allowing a reasonably level surface. The "Vessel's" mass will have been reduced to less than a third at the time of landing (Fig. 39), and, in consequence, will allow a fine degree of control, with a minimum expenditure of fuel.

The return would be made in much the same manner as the outward journey, although, of course, there would be no launching device or means of pre-rotation. The "Vessel" would simply thrust off on its landing "legs," allowing steam jets to set up the axial stabilising spin as soon as possible. This solution is considered practicable only through the decreased masses involved, and the diminished gravity, which enable the rocket to attain Lunar release velocity with considerably less expended energy than in gaining exit from the Earth. Once this figure is reached the "Vessel" would be allowed to coast under momentum, and having re-passed the area of gravitational equilibrium, would accelerate in free fall towards the Earth. Having attended to any necessary navigational adjustments earlier in the momentum phase, the "Vessel" would be again completely turned about its axis, and further cellules fired to retard it to a safe velocity for re-entering the atmosphere. Having consumed almost completely the propulsive cellules, any reserve that remained would be jettisoned to further lighten the "Vessel."

Once at a specified distance from the surface the supporting parachute would be released, and the life-container, housing crew and records, brought gently to the ground (Fig. 40).

Space-vessel Development Programme

The B.I.S. Space-vessel conception was developed for the express purpose of obtaining a bird's-eye view of the space-flight problem as a whole. Thus, the preliminary design of a space-rocket was commenced; a work started during 1937, and which occupied the B.I.S. technicians for over 18 months.

It was presupposed that certain essential conditions must be met, and the "Vessel" designed to satisfy these conditions. In this way it was readily determined within reasonably close limits where contemporary knowledge would require supplementing by further research. The limitations imposed can be classified as follows: (a) The voyage should serve a definite scientific purpose, and the crew and equipment should be the minimum that could serve that purpose. (b) That provision should be made to allow a reasonable chance of the successful return of the participants. (c) That every danger that could be foreseen should be provided against as far as was practicable; and (d) That no assumption should be made as to the possible development of new fuels or materials of construction that might not reasonably be expected to be developed from those in existence. Having concluded the provisional design of the Cellular-space-vessel, the Technical Committee of the B.I.S. published a report of its findings in the Society "Journal" (January, 1939), and appended a further recommendation to cover an extension of the research programme for the purpose of investigating the following points: (1) The exact experimental verification of the laws of rocket reaction to show how the power developed by a rocket motor was determined and governed by the method of combustion. (2) That a given list of fuel combinations should be tested to discover the maximum energy available, and the best means of preparing and igniting the fuels. Also, that the results of the tests be applied to the production of improvements in the performance of rockets used for life-saving, signalling, etc., etc. (3) That the results of the foregoing experiments should be applied to the design of high-altitude atmosphere sounding rockets bearing recording instruments for the purpose of recording the extent and density of the atmosphere, and the prevalence and density of cosmic radiation. (4) That a mathematical treatment of the dynamics of space-flight should be prepared in such a form as to establish the navigational procedure and power requirements of the Lunar Trajectory. (5) That working models of the instruments, and such original mechanical devices as were embodied in the Report should be made to ascertain their efficiency in so far as circumstances made this possible; and (6) That the physiological aspects of certain conditions the space-navigators might encounter should be investigated as far as possible.

This second part of the programme was curtailed by the outbreak of war, which caused the British Interplanetary Society to abandon its activities in September, 1939. A Nuclear Committee, however, remained in existence, and although little active participation in the science was possible for some little while following the formal disbandment, in more recent years this body has recommenced theoretical work in the form of calculations of the exact masses and cellule powers involved in the Lunar Space-rocket. Other investigations have concerned the calculation of space-rocket trajectories, and similar research connected with spacial navigation.

Propellant	C	V
C to CO_3	2,220	4.3
C to CO	1,050	2.9
$H_2(1/2\ O_2)$	3,240	5.2
$C_2H_2(2\text{-}1/2\ O_2)$	2,880	4.9
$C_2H_4(3\ O_2)$	2,580	4.6
$CH_4(2\ O_2)$	2,400	4.5
$C_6H_6(7\text{-}1/2\ O_2)$	2,430	4.5
$C_2H_5OH\ (3\ O_2)$	1,970	4.0
$H_2S\ (1\text{-}1/2\ O_2)$	1,380	3.4
$C_{14}H_{10}\ (16\text{-}1/2\ O_2)$	2,500	4.6
B (B_2O_3)	3,980	5.8
Al (Al^2O_3)	3,850	5.7
Mg (MgO)	3,590	5.6
Si (SiO^2)	3,000	5.1
Ca (CaO)	2,720	4.7
P (P^2O_5)	2,580	4.6
Metal Sol.	2,300	4.4
Cordite	1,240	3.2

C = Calories per gramme of reaction mixture.
V = Exhaust velocity in km/sec. — 1.

Various propellants tabulated to show comparative efficiencies, including those tested by the B.I.S.

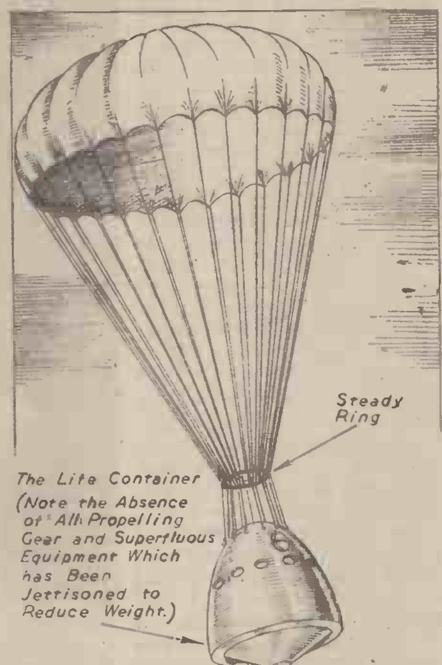


Fig. 40.—The "Vessel," having decelerated against gravity to zero at a safe distance within the earth's atmosphere, descends by parachute.

A National Society?

This same Committee, two years before the conclusion of the war in Europe, was busy formulating plans for the official re-inauguration of the Society, and in league with the remaining British rocket groups the Astronautical Development Society and the Manchester Astronautical Association (now coalesced under the title, Combined British Astronautical Societies), preparations are now in hand for the amalgamation of the three groups under a common heading.

During the war small craft of the Light Coastal Force did invaluable work in sinking, destroying and capturing enemy supply ships, escort vessels and E-boats. Our illustration shows one of these small fighting craft, a British motor-torpedo-boat, at speed in heavy weather.

More About Atomic Energy

Further Noteworthy Features, together with the Problem of Continuous Power Production

THE fact that, locked up in the ceaselessly moving atoms of matter, there resides an almost illimitable store of energy can hardly be dwelt on too often.

Lord Rutherford was one of the first to suspect such a state of affairs, although Albert Einstein, of "Relativity" fame, even as far back as 1905, contended that *Mass* (which is, naturally, a universal attribute of all forms of matter) and *Energy* are equivalents, and that they are pretty much one and the same thing.

If you have anything having the property of Mass (and anything weighable or tangible *must* have Mass), then, reasoned Einstein, you must also have an Energy source. Likewise, Energy (which was usually reckoned to be something utterly intangible) has Mass, and, therefore, it ought, in theory, to be capable of being weighed.

But although Mass and Energy are equivalents, there is an enormously big ratio between them. This means that a very large amount of Energy is equivalent to only an extremely small amount of Mass. Hence, from a practical standpoint, we cannot actually weigh Energy, for the simple reason that it would take an enormous amount of what we may term "Energy substance" to make up the smallest weighable Mass.

Now, since Mass and Energy are equivalent, and since, as we have just seen, it takes a gigantic amount of Energy to give even the most minute amount of Mass, it follows that this very small mass of material must represent or be equivalent to an enormous amount of Energy.

Enormous Energy Production

If, therefore, by some means we could break up and destroy (even partially) that very minute mass of material substance, the latter would be converted into a correspondingly prodigious amount of Energy, for the reason, again, that the ratio between Mass and Energy is so enormously large.

Were it practically possible to convert controllably a mass of material weighing an ounce into, say, pure Heat energy, the heat produced would be sufficient to change about a million tons of water almost instantaneously into steam.

Such is the character of the once supposedly "dead" material substances on and among which we live and have our being, and of which even our very bodies are composed.

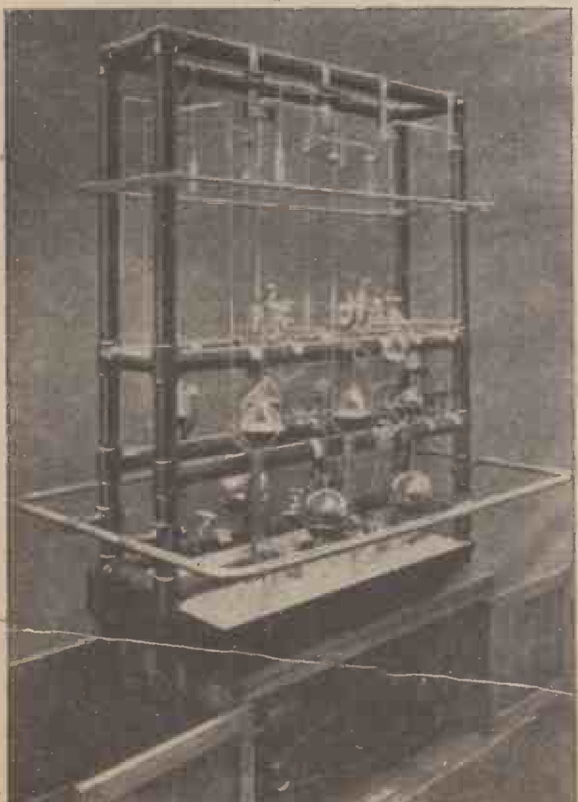
The atomic bomb, as outlined in the October issue of PRACTICAL MECHANICS, has, once and for all, demonstrated in a very practical, notwithstanding a very tragic and spectacular manner, the fact that some types of matter (for the present very limited in nature) are capable of liberating their colossal energies with disastrous results at the behest of human scientific direction.

The activity of uranium atoms is evidenced by the intense fluorescence which uranium compounds give rise to under X-ray and ultra-violet ray excitation. Here are a number of uranium solutions fluorescing brilliantly under a stream of invisible ultra-violet rays.

The atoms of matter, as most of us know, are all ultimately composed of a central positively-charged group or cluster of almost inconceivably minute particles which is called the "nucleus" of the atom, this nucleus being surrounded by a system of revolving electrons, or negatively-charged particles of electricity, which are mostly situated at relatively great distances from the nucleus.

The negative electrons exactly balance in electrical charge the positive particles in the nucleus, so that the atom as a whole is always electrically neutral when it has its full complement of electrons.

When substances react or combine together, it is only the surrounding electrons of the atoms which become linked up or otherwise involved in the reaction. The atomic nuclei remain entirely undisturbed. Ordinary chemistry, therefore, is concerned only with the electrons of the various atoms, for no chemical reaction, not even a most violent one, such as an explosion of T.N.T., can have any effect upon the nucleus of the atom.



Apparatus for the collection of active "emanation" from radium and other radiation materials.

Three Possibilities

If we could devise some sort of reaction which would interfere with the atomic nucleus, which would modify it, split it up or deal with it in some other way, we should at once have it within our power to effect three very wonderful feats.

First, we should be able to convert all or part of the atom's mass (for practically all the atom's mass is in the nucleus) into Energy. Secondly, we should be able to change one type of atom into another type, thus realising the long-cherished dream of "transmutation," and, thirdly, and perhaps more amazing still, we should be able to build up artificially elements which have never been known before, elements, such as metals, which do not occur naturally on earth and, probably, nowhere else in the entire universe. Such "artificial atoms" and "synthetic elements," if they were sufficiently stable, would have a number of uses.

Quietly, and on a small scale, relatively speaking, all the above "possibilities" have, with the coming of the atomic bomb, actually been realised, and such a fact seems to have opened out enormous possibilities for the future.

In the atomic bomb, uranium, the "Last of the Elements" (so called because it is the 92nd and last member of the Chemical Table of Elements) is used for producing the gigantic and devastating explosion. But it is not *ordinary* uranium which is utilised for this purpose.

It will be remembered that most elements are really mixtures of different modifications of such elements, each separate modification being called an "isotope." The isotopes of an element have different masses or weights, but they are chemically so much alike that they can only be separated with extreme difficulty and the highest chemical skill.

The Three Uraniums

The greater part of uranium comprises a stable isotope which has a mass of 238,

A split-second photograph showing the initial phase of an ordinary "chemical" explosion. An atomic explosion releases thousands of times more energy than the greatest chemical explosion.

and which is consequently known as U.238. But there are also uranium isotopes of masses 235 and 234 respectively, these being denoted by the symbols U.235 and U.234.

When it became clear that it was possible to split the uranium atom by means of neutrons shot off from atomic nuclei, it also became a demonstrable fact that the uranium isotope U.235 was much more easily splittable than the common uranium isotope U.238.

To extract the U.235 from ordinary purified uranium metal was a very onerous and difficult task for the Anglo-American scientists. They had to use a "vapour diffusion method," by which ordinary uranium metal, extracted from its ores, was purified and then electrically vapourised through diffusion membranes. The uranium isotopes diffused at varying rates, and thus, in the course of time, an effective concentration and ultimate separation of the varying isotopes was obtained.

U.235 was the isotope which the bomb scientists were after, and in the end they got it in workable amounts.

Now, if a neutron (which is a neutral particle shot out from an atomic nucleus) strikes the nucleus of a uranium atom, it has the effect of splitting that atom up with the liberation of its inherent energy. If the bombarded atom is one of the common isotope of uranium (U.238), the neutron has to have a very high energy content to effect the splitting up or "fission" of the atom. In the case of the rarer uranium isotope (U.235), however, the nucleus of this particular uranium modification is much more readily split up, so that a neutron particle of much lower energy content is able to effect the same result.

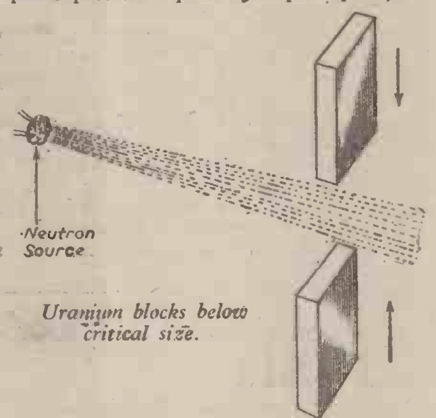
"Critical Size"

When a stream of neutrons impinge upon a block of uranium metal an explosion will not result unless the metal contains a certain minimum amount of atoms, that is to say, unless, in practice, it is of a certain definite size, which latter is known as the "critical size."

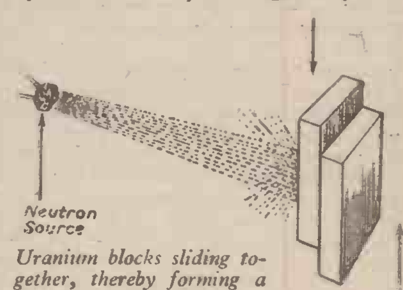
The reason for this is that if the amount of metal is insufficient to attain this "critical size," the neutrons will escape into the surrounding air or surrounding material and will thus be wasted.

But if the uranium metal has a size in excess of its "critical size," then the bombarding neutron particles will split up individual uranium atoms, and each exploded atom will give out, besides its energy, other neutrons which will in their turn explode other atoms, so that a "chain reaction" will be set up in the mass of uranium material, which reaction will, within a split second, develop to such an extent that the whole mass of material will explode and fly apart with stupendous rapidity and violence. For in such an instance the bombarding neutrons will not be able to work their way through the mass of uranium material to the surrounding air without setting countless other uranium atoms into detonation and thus eventually resulting in the disrupting of the entire material.

In an atomic explosion of this nature, not all the uranium atoms are disrupted and so enabled to give out their energies. Only a proportion of the atoms are thus split, the remainder flying apart by the force of the exploding atoms. Nevertheless, even when only a proportion of the atoms in a block of uranium explode (which is always the case), a temperature of several *million* degrees Centigrade is almost instantaneously attained, as well as an expanding pressure of several *million* atmospheres. (One atmosphere pressure equals 15lb. per sq. in.)



Uranium blocks below critical size.



Uranium blocks sliding together, thereby forming a composite block of critical size and rendering explosion imminent.

Illustrating diagrammatically the principle of the "critical size" in a mechanism for exploding a uranium bomb. In the presence of a stream of neutrons, even the most sensitive uranium material will not disrupt unless it is of a certain minimum size. It is, therefore, simple enough to arrange matters so that two blocks of uranium metal, each below critical size, are made to slide into intimate contact, thus building up the combined block of metal to its critical size, the block then being immediately exploded by the neutron stream from a fragment of radioactive material mixed with beryllium metal or compound.

The "critical size" of the uranium isotope U.235 is equivalent to a weight of between 1lb. and 2lb. only. Hence, the "active material" of an atomic bomb need weigh no more than 2lb., and if this explodes it will give an energy-release equivalent to at least the explosion of 16,000 tons of good quality T.N.T.

Source of Neutrons

As a source of bombarding neutrons, a mixture of radium (or polonium) substance and beryllium can be used, for the "alpha" particles shot out by the radium bombard the beryllium, with the result that the beryllium metal emits a stream of neutrons from the nuclei of its atoms. Here, therefore, is a convenient and steady (although expensive) source of neutrons for any atomic bomb-maker.

It will be remembered that the uranium metal must be above a certain "critical size" before an explosion can develop in it under the influence of bombarding neutron particles. So that if we take a block of uranium metal of or above this critical size and cut it in half, the metal will be quite stable and will not detonate, no matter how high the energies of the neutrons may be.

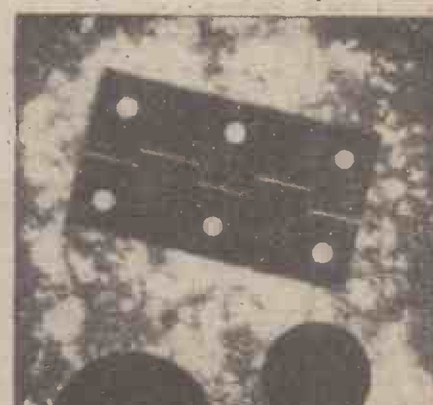
What, therefore, could be simpler in atomic bomb construction than to arrange a fixed source of neutrons from a radium-beryllium mixture and to have two separate blocks of U.235 metal, each of which is below the critical size, these blocks being arranged to slide into intimate contact by means of a clockwork or other motive mechanism? Once the uranium blocks are in contact in the presence of the neutron stream, the chain reaction will be set up in the uranium (for the combined blocks have now reached or exceeded the critical size), and within a fraction of a second the atomic explosion will have resulted.

Death-dealing Dust

It has been stated that anyone inhaling radio-active dust produced by the explosion of an atomic bomb would die, since radium particles, once in the body, can never be expelled, and they would continue to evolve their rays to the speedy destruction of the blood corpuscles. This is quite a truism, yet, at the same time, the amount of active radium material carried by an atomic bomb is, on economic grounds alone, necessarily small, so that the chance of this type of "post-bomb" fatality is not very great.

Can other elements besides the uranium isotopes be exploded? So far as we know yet there are two others which could possibly be detonated, although they would require very fast-moving neutrons to do the trick.

The first of these elements is thorium, a metal whose compounds are present in gas-mantles and which is definitely radioactive,



A brass hinge, a penny and a sixpence photographically silhouetted by means of the penetrating rays evolved from fragments of thorium-containing gas-mantle, thus indicating the intense activity of the thorium atom, itself a candidate for atomic energy release.

as witness the fact that when a fragment of thorium-containing gas-mantle is laid in the dark on an unexposed photographic plate for a few days, the plate, on development, will show a pattern of the mantle, due to the thorium rays affecting the sensitive emulsion.

The other element in question is protoactinium. This is extremely rare, so much so that its use would be an economic impossibility. But if it could be used for atomic energy generation its sensitivity would be about half-way between that of "common" uranium, U.238, and "rare" uranium, U.235. Nevertheless, it would appear that, provided we can obtain neutron sources of still higher energies, other and commoner elements might become capable of being utilised for atomic bomb making.

Continuous Energy

Coming now to a far more agreeable aspect of the case, to wit, that of releasing atomic energy continuously and non-explosively for utilitarian purposes, this scientific dream, as was explained in our previous article, is still unfulfilled.

Yet even at the present time a good start has been made in this direction, because it is known that there exist certain "slowing-down" materials which do actually inhibit the explosive chain reaction which results from the impinging of neutrons on a block of uranium above critical size.

These slowing-down substances are four in number—beryllium, carbon, helium, "heavy" hydrogen (the heavy isotope of common hydrogen gas), or, alternatively, the compound of the latter with oxygen which is known as "heavy water."

If any of these materials are mixed with the "explosive" uranium or uranium compound, the very fast and high-energy neutron particles which are produced by the splitting up of some of the uranium atoms will lose much of their energy contents by numerous collisions with the "slowing down" or "buffer" substance. Hence, after such collisions, they will not have sufficient energy to split any further uranium atoms.

Artificial Elements

Before concluding, it may be interesting to devote a little space to the rather amazing "artificial elements" which have been made, despite their not having any direct connection with the atomic bomb.

When ordinary or common uranium (U.238) is bombarded by neutrons of one particular low energy value, the neutrons, instead of splitting the nuclei of the uranium atoms with explosive results and consequent energy liberation, are actually absorbed by the said uranium nuclei. We now get an entirely new nucleus with a mass of 239, which results in a *new element* being brought into being by this entirely artificial means.

In this way two new elements have been created. The first has been called NEPTUNIUM, the second PLUTONIUM. Both are absolutely man-made elements. They have never had any existence on the earth before their recent laboratory creation, nor have they ever been detected within any of the confines of the universe.

Because they are heavier than uranium (the last and the heaviest of the "natural" elements), they have been styled the "trans-Uranium elements."

Plutonium

Neptunium is unstable, but Plutonium, if it could be made in quantity, would be found useful inasmuch as it seems to correspond in properties to the rare isotope of uranium, the explosive U.235, which recently has been very much in the foreground. It is suggested, indeed, that Plutonium might become the pattern on which other explosive elements could be created.

Such are the scientific tendencies and trails of thought of the present hour. Undoubtedly, therefore, methods for the controlled (non-explosive) liberation of atomic energy will come far sooner than any of us ever thought would be possible, but whether the creation of other types of "artificial atoms" and "synthetic elements" will ever be of much practical benefit is more than even the most sanguine scientist of the present day would care to express any definite and confirmed opinion on.

Human "Fish"

Particulars of Underwater Swimming and Diving Equipment, and the Work of the "Frogmen" on D-Day

A FURTHER Dunlop contribution to the war effort, just released by the Admiralty, was demonstrated in Kingston baths, Surrey, recently, when men from the Landing Craft Obstruction Clearance Units showed how the way was cleared for our landing craft on the invasion beaches. Wearing underwater swim-suits with fins on their feet, and equipped with a new breathing apparatus, they slipped from their dinghy and swam like fish to place charges of explosive on a reproduction of the structures found in rows under the sea on D-Day.

The divers' swimming equipment was first tried out by Royal Marines in an open-air road house swimming pool, at 43 degrees Fahr., near Dunlop's Manchester factory, where it was made.

Underwater Rubber Suits

At the beginning of 1943, the Admiralty called in the Dunlop Rubber Company to assist in developing a fully flexible close-fitting rubber suit which would completely enclose a diver and give protection against the coldest waters and against abrasions. Mr. W. G. Gorham, special development manager, was allocated to the Admiralty for the work.

At this time it was primarily intended for the use of swimming saboteurs, who had to be capable of free swimming under water and simultaneously to be able to paddle canoes and operate ashore without discarding the suit. They had also to be ready at a moment's notice to scramble back into the water. Existing types of shallow water dresses were made of unstretchable fabric, which had to be cut on generous lines to accommodate dressing and give freedom. The resulting folds and bulk (which tend to trap air, thus increasing the amount of weight to be carried by diver) made underwater swimming in such a dress impracticable.

Frogmen go out on patrol in a pneumatic rubber dinghy, all but one using paddles.

The designer of the frogmen's swim-suit, Mr. W. G. Gorham, discusses the equipment with one of the D-Day frogmen, Petty Officer L. A. Maloney, in Trafalgar Square, during London's thanksgiving week.

First Experiments

The new suit had to be developed upon quite different lines. Many trials were carried out, frequently in most unusual places, in order to save undue loss of time—municipal swimming baths, open-air road house swimming pools, in midwinter, a torpedo test range, and a south coast bathing beach. Alterations in dimensions and in manufacturing detail have been necessary, and the design of the outfit is as shown in the accompanying illustrations.

The trials were carried out by divers from the Experimental Diving Unit under Commander Shelford, and from the Royal Marine Boom Patrol Defence, which latter title had no true relation to the organisation's function. It was headed by Colonel Hasler, O.B.E., D.S.O., R.M., Officer Commanding R.M.B.P.D., whose exploits in "cockles" (two-man canoes) had brought forth advanced schemes for underwater sabotage.

An essential feature of the underwater swimming gear is the use of rubber fins on the feet. This device had been used for many years for sporting purposes in warm water, but samples of successful types were not available in this country, and those specially sent over from the U.S.A. were lost by enemy action in the Atlantic. Dunlop therefore had to attempt production for use with the underwater swim-suit from sketchy descriptions and a photograph of a film star wearing them beside a swimming pool.

Now that underwater swimming was proving to be practicable, it was evident that a special breathing apparatus was also required which would give the most comfortable breathing in every position which a swimming diver might assume. Up to this time underwater work could be said to be performed with the feet downwards or, at most, when crawling on all fours. Furthermore, the physical energy expended by a swimming diver was somewhat greater than that for the more normal diving work. Dunlop designed a special apparatus which met these requirements and was specially streamlined in keeping with the rest of the underwater swimming gear.

Human Fish on D-Day

The results of this work were conveyed to an organisation formed towards the end of 1943 for dealing with underwater and beach obstructions. This organisation, now known as the Landing Craft Obstruction Clearance Units (L.C.O.C.U.), and commanded by Lt. Cd. E. C. Davis, R.N.R., cleared the way for our landing craft on the invasion beaches. They were equipped throughout with the new underwater swim-suits.

Shortly after dawn on D-Day, these men slipped unobserved from small rubber dinghies to swim like fish beneath the surface towards the rows and rows of massive underwater structures which the Germans had erected in the shallows at all probable landing beaches. The seaward lines of these defences were steel units 10ft. high and 10ft. wide, weighing 2½ tons each, and loaded with mines and artillery shells. A single heavy charge placed in the centre of this structure would only have resulted in twisting it into an obstruction of another shape, and bombardment was out of the question because of beach craters which would have impeded the landings. It was therefore necessary to place a number of small charges at predetermined points of the structure. Thirty-six charges were necessary to make the mass fall flat so that the resulting debris was no higher than 18in. from the sea bed.

Only mobile swimmers could possibly reach the centre of the structure, place the charges at the vital points and, at the same time, neutralise the explosive booby-traps. In all, 2,400 such obstructions, practically all of them mined, were cleared on the beaches, and were removed from a dozen "Beetle" tanks.

As the work would be carried out under heavy fire, some measure of protection against the effects of underwater explosions, mortar shells and bombs had to be provided. Naval physiologists carried out a hazardous programme of trials, using themselves as "guinea pigs," and finally evolved a kapok jerkin to be worn under the diving suits. Dunlop assisted in producing experimental waterproof models for use during the tests.

Passed on to U.S.A.

Early in 1944 the United States confessed that they had so far failed to produce a suitable underwater swim-suit for use in European waters, and asked the Admiralty to supply some hundreds of underwater swim-suits. As Admiralty demands on existing facilities was heavy, it was suggested that the United States should undertake their own production. Complete information, including moulds, photographs and sample equipment was passed over to them, American personnel being meantime attached for training to units using the equipment in this country. America chose crawl swimming experts of "Tarzan" physique for the work, and the suits had to be specially enlarged for them. Two of their men were sent up to the Manchester factory for measurement, one 6ft. 4in. tall, the other with enormous shoulders, yet in four working days several units of the enlarged suits were on their way to the training base.

Production was never, in fact, started in America, as time did not permit of the development of the special technique on that side of the Atlantic.

(Above) The frogmen's swimming suit is a second skin of supple rubber, dry and shiny like elephant-hide. His breathing apparatus allows him to stay under water for 90 minutes without discomfort, and his "flippers" enable him to swim as fast beneath the surface as a champion racing swimmer can move on top.

Frogmen in Midget Submarines

Underwater swim-suits of a heavy pattern were also used in X-class midget submarines. These craft had to be able to force a passage unobserved through the anti-submarine nets in closely defended harbours. A special air-lock was built into one craft from which highly trained divers emerged on to the upper deck. Armed with net cutters, they severed the heavy wire strands of the nets, allowing the ship to nose her way through the gap they made. In the cramped quarters of the craft, dressing a diver was extremely difficult, and a slight modification of the equipment enabled this to be done with remarkable ease. Furthermore, the streamline of the dress was a great advantage in avoiding fouling the diver in the narrow hatchways.

X-craft divers wore either fins or special streamlined Dunlop rubber boots, according to taste. On one occasion a diver wearing fins was swept from the submarine as it surged ahead through the nets, but, thanks to his underwater swimming gear, he was able to overtake it and regain the hatch.

By intensive training, the time for the whole cutting operation was reduced to a matter of minutes and no disturbance of the surface part of the nets was visible to even the sharpest look-out ashore. The same technique was used for placing delayed action "limpets" on ships' bottoms.

Frogmen preparing to blow up a replica of the two ton 10ft. high German steel obstruction on which they mainly relied to stop Allied landing craft reaching the shores of France. Nearly 3,000 of these obstacles were blown up in less than five hours before the first boats touched Normandy on D-Day at a cost of one casualty.

Against Japan

All midget submarines used against Japan had this equipment. One of their major successes occurred three days before the Japanese surrender when two British midget submarines, after several attempts, penetrated the minefield in the narrow Johore Strait between Singapore island and the mainland. The divers placed their explosives under an enemy cruiser and escaped. Six hours later another submarine saw a great explosion, and air reconnaissance showed that the cruiser had sunk.

High-power Short-circuit Testing–7

Measuring and Computing Records

By S. STATON

(Continued from page 14, October issue.)

IN the last article a list of values was given as obtainable from a short-circuit test record. We concluded by considering the method of measuring and computing the symmetrical and asymmetrical breaking currents. The next item on the list to be considered is the power interrupted.

Power Interrupted

This is expressed as M.V.A. and is evaluated by:

m.v.a. = Recovery Voltage × Breaking Current.

As already explained in Article 2 the term m.v.a. is used in preference to k.v.a.

1 m.v.a. = 1,000 k.v.a. Therefore in the above formula the recovery voltage would be in kilo volts and the breaking current in kilo amps.

Energy in Arc

This is expressed in kilowatt seconds and is evaluated by measuring the area between the phase watts trace and their respective zero or undeflected position.

Arcing Time

The arcing time is the time interval measured between the instant of contact separation and the instant of final arc extinction. Incidentally, the arc length can be measured by means of the contact travel record.

Making Speed

This is obtained by measuring the distance moved through by the contacts in 0.01 second immediately before the instant of contacts make.

Phase	MM.	Peak Amps.
R	15	3,000
Y	12	2,600
B	16.5	3,500

Table No. 2.—Making current values.

Breaking Speed

This is determined at the instant of contact separation. The contact travel is measured during the first 0.01 second after the separation of the contacts. If the average breaking speed is required, this is taken as the average speed of the contacts as they move from the instant of contacts separate to the position at which the oil dashpots commence to function.

Short-circuit Duration

This is the time interval between the instant of contacts make to the instant of final arc extinction.

Opening Time

This is measured from the instant at which the trip coil is energised to the instant at which the arcing contacts separate.

Make-break Time

This is the time interval measured between the instant of contacts make and the instant of final arc extinction.

Total Breaking Time

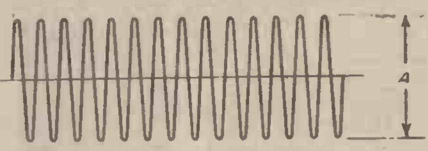
The total breaking time is the time interval measured between the instant of energising the trip coil and the instant of final arc extinction. In other words, it is the sum of the opening time and the arcing time.

Fluid Pressure

The measurement for this is taken across the envelope of the high frequency pressure record at any particular instant of time so required. The maximum point of pressure is usually recorded. Fig. 19 shows an exploded view of a high frequency fluid pressure trace and the method of measuring.

Computing Values from Typical Records

Having now considered oscillograph records in some detail we can go on to compute actual values from a typical record. Fig. 20 shows



High Frequency A.C. Wave

Fluid Pressure = A x Scale in lb/□"/mm.

Fig. 19.—Measurement of fluid pressure.

an oscillograph record of a make-break test in which the D.C. component of the current in any one phase never exceeds 20 per cent. This is, therefore, a record of a symmetrical test.

The open-circuit generator voltage is obtained from trace No. 1. Measuring across the voltage wave envelope with a millimetre scale we find it to be 20 mm. The scale shown in Table 6 is 805 volts per mm.

Phase	MM.	Current in Amperes	
		Peak	R.M.S.
Red	9	1,800	1,272
Yellow	7.5	1,625	1,150
Blue	7	1,484	1,048

Table No. 3.—Breaking currents (A.C. component).

The open-circuit generator voltage is therefore 805 × 20 = 16,100 volts peak value.

The corresponding red phase value is shown on trace No. 3. Measuring in the position indicated, the dimension is found to be 20 millimetres again. This time, however, the scale is different from that of the top trace and is 500 volts per mm.

Then initial red phase volts =
20 × 500 = 10,000 volts peak value.

The yellow phase dimension will be noticed to be slightly smaller than the above, being 19 mm. The scale in this case is 500 volts per mm. thus making the peak value:

19 × 500 = 9,500 volts.

The blue phase value is computed in exactly the same way. It is not proposed to work through every value and figure as the reader may, if he so desires, check through the values tabulated.

Table No. 1 gives values for the initial and recovery voltages as computed from the oscillograph record Fig. 20. The R.M.S. value is obtained by dividing the peak value by $\sqrt{2}$.

Total of initial open-circuit phase values = 7,070 + 6,716 + 6,575 = 20,361 volts (R.M.S.).

Then equivalent line to line open-circuit value $= \frac{20,361}{\sqrt{3}} = 11,750$ volts.

Total of recovery phase R.M.S. values = 6,716 + 6,000 + 6,743 = 19,459 volts.

Therefore, equivalent line to line recovery value $= \frac{19,459}{\sqrt{3}} = 11,240$ volts.

Making Current

The next items to measure are the values of the making currents in the red, yellow and blue phases. As stated before, the measurement is taken on the first major loop after the instant of short-circuit. On measuring, the dimensions will be found to be 15, —12. and 16.5 mm. in the red, yellow and blue phases respectively. The scales for the current traces are shown in Table 6.

The red phase scale is 200 amps./mm. and therefore the making current = 15 × 200 = 3,000 amps. (peak value).

Yellow phase scale = 217 amps. per mm., giving a making current value of

12 × 217 = 2,600 amps (peak value).

Blue phase scale = 212 amps. per mm. This gives a making current of

16.5 × 212 = 3,500 amps. (peak value).

The above making current values are shown tabulated in Table 2.

The highest value (i.e., 3,500 amps. in blue phase) is the most important figure in the record.

Breaking Currents

It will be recalled that the breaking current is measured at the instant of contact separation. The instant is indicated in Fig. 20 by the vertical line X—X. The dimension to be taken for computing the symmetrical or A.C. component is shown as "K" on the red phase current trace (Number 2). On measuring this it will be found to be 9 millimetres. Reference to Table 6 will show that the scale for trace 2 is 200 amps. per millimetre. This gives a current in the red phase of 200 × 9 = 1,800 amps. peak value. The dimensions for the red, yellow and blue phases together with their respective current values are shown in Table 3. Here again, the R.M.S. figure is obtained by dividing the peak value by $\sqrt{2}$. Thus in the red phase the R.M.S. value $= \frac{1,800}{\sqrt{2}} = 1,272$ amps.

The asymmetrical or D.C. component of the breaking current is measured at the same instant as the symmetrical value. The dimension is indicated in the red phase current trace as "J." This dimension is multiplied by the corresponding phase scale in exactly the same way as for previous values. The D.C. component values of the breaking currents obtained from Fig. 20 are shown tabulated in Table 4. The values shown in column 4 are those of column 3 expressed as a percentage

Phase	MM.	Initial or Open Circuit		MM.	Recovery Values	
		Peak	R.M.S.		Peak	R.M.S.
R.B.	20	16,000	11,300	18	14,490	10,244
R	20	10,000	7,070	19	9,500	6,716
Y	19	9,500	6,716	17	8,500	6,009
B	18.5	9,300	6,575	19	9,538	6,743

Table No. 1.—Voltages.

of column 3 in Table 3. Thus in the case of the red phase:

Percentage of A.C. peak =

$\frac{200}{1{,}800} \times 100 = 11.1$ per cent.

It will be seen from this column that the D.C. component of the current never exceeds 20 per cent. of the A.C. component peak value as mentioned earlier.

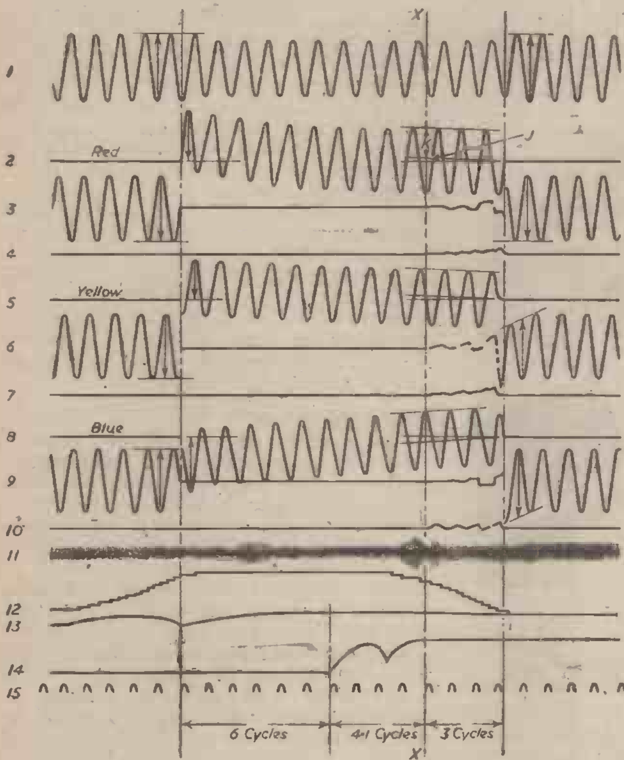


Fig. 20.—Oscillograph record of make-break test. Breaking current symmetrical.

Table 5 sets together the values of the A.C. component peak amps, the D.C. component amps.; this latter value expressed as a percentage of the A.C. peak amps. and the total R.M.S. value or asymmetrical breaking current.

The R.M.S. or asymmetrical breaking current is given by the formula:

$$\text{I asymmetrical} = \sqrt[2]{\left[\frac{K}{\sqrt{2}}\right]^2 + J^2}$$

as stated in article 6.

Taking the red phase as an example for calculating this asymmetrical value we have:—

I asymmetrical (red phase) =

$$= \sqrt[2]{\left[\frac{1{,}800}{\sqrt{2}}\right]^2 + 200^2}$$

$$= \sqrt[2]{1{,}272^2 + 200^2}$$

$$= \sqrt[2]{1{,}618{,}000 + 40{,}000}$$

$$= \sqrt[2]{1{,}658{,}000}$$

$= 1{,}288$ amps. R.M.S.

Power Interrupted

Red phase $= 6.716 \times 1.272 = 8.55$ m.v.a.
Yellow phase $= 6.009 \times 1.15 = 7.00$ m.v.a.
Blue phase $= 6.743 \times 1.048 = 7.05$ m.v.a.
Total power interrupted =
$8.55 + 7.00 + 7.05 = 22.60$ m.v.a.

Arc Energy

It is not proposed to give details of the calculation of the arc energy since it involves the area of an irregular figure, and is purely a mathematical matter. A typical value for the arc energy in this case would be 50-watt seconds. The arc watts at any instant can be obtained by multiplying the deflection by the respective scale. Thus in the red phase the maximum watts $= 2 \times 565 = 1{,}130$ watts.

Arcing Time

This, when measured on the 50 cycle timing wave, will be found to be 3 cycles.

3 cycles = 0.06 seconds for 50 cycles per second.

Making Speed

To evaluate this, it is necessary to know the pitch of the contacts on the travel recorder. In the particular case under consideration, the total travel of the circuit breaker contacts is 4in. and the pitch of the recorder contacts 0.28125in. The making speed is, therefore, 56.25in. per second, since there are two steps on the travel trace during the half cycle immediately before contacts make.

Breaking Speed

On examination of the travel trace in Fig. 20 it will be seen that there are two steps during the first half cycle after the instant of contacts separate. This gives a breaking speed equal to the making speed, since the contacts travel 0.5625in. in 0.01 second.

Short-circuit Duration

The time interval between the instant of contacts make to the instant of final arc extinction is evaluated by counting the number of cycles during the interval on the record and multiplying by 0.02. Then time =

$6.0 + 4.1 + 3.0 = 13.1$ cycles.

$13.1 \times 0.02 = .260$ seconds.

Opening Time

The measured number of cycles on the record is 4.1, therefore

Opening time $= 4.1 \times 0.02 = 0.082$ seconds.

Make-break Time

This is exactly the same as short-circuit duration: .260 seconds.

Total Breaking Time

The easiest way to evaluate this is to add together the opening time and the arcing time. Thus:

Total breaking time $= 0.082 + 0.060 = 0.142$ seconds.

Phase	MM.	Current in Amps.	Percentage of A.C. Peak
Red ..	1.0	200	11.1
Yellow ..	1.0	217	13.35
Blue ..	1.3	275	18.6

Table No. 4.—Breaking currents (D.C. components).

Phase	A.C. Peak	D.C. Component	Percentage of A.C. Peak	Total R.M.S. Value
Red ..	1800	200	11.1	1288
Yellow	1625	217	13.35	1168
Blue ..	1484	275	18.6	1068

Table No. 5.—Breaking currents (summation) current values.

Scale for trace No. 1 = 805 volts/m.metre
" " " 2 = 200 amps./m.metre
" " " 3 = 500 volts/m.metre
" " " 4 = 565 watts/m.metre
" " " 5 = 217 amps./m.metre
" " " 6 = 500 volts/m.metre
" " " 7 = 570 watts/m.metre
" " " 8 = 212 amps./m.metre
" " " 9 = 502 volts/m.metre
" " " 10 = 576 watts/m.metre
" " " 11 = 10lbs. per sq. in. per millimetre
Pitch of steps on trace No. 12 corresponds to 0.28125 inch movement of circuit breaker contacts.
Scale for trace No. 13 = 3 amps. per millimetre
" " " 14 = 0.01 amp. per millimetre
Trace No. 15 = 50 cycle per second timing wave.

Table No. 6.—Scales for use with oscillograph record, Fig. 20.

Fluid Pressure

It was commented earlier that the maximum pressure was usually recorded. This occurs just prior to the instant of contacts separate. Measuring across the envelope at this point, we find the dimension to be 9 millimetres. The scale for trace No. 11, 10lb. per square inch per millimetre. From this the width of the plain light spot portion of the trace has to be subtracted. This will be found to be 3 millimetres. The maximum tank or fluid pressure is, therefore

$10\,(9-3) = 60$lb. per square inch.

Having now considered the methods of interpreting, measuring and evaluating electromagnetic oscillograph records the reader should readily understand the figures recorded in table below. They are taken from a series of tests on a 150 m.v.a. 11,000 volt circuit breaker. Each term recorded has been discussed in some detail and it is therefore not proposed to comment on them.

The value of power factor has been left out since this has not yet been discussed. The method of measuring this latter value will be set out in the next article.

(To be continued.)

Test	Break			Make-break			Make-break		
Phase	Red	Yellow	Blue	Red	Yellow	Blue	Red	Yellow	Blue
Making Current (Peak Value)	19,000	15,100	18,900	20,000	20,850	16,500	17,050	18,000	20,000
Recovery Voltage (R.M.S.)	7,120	7,000	6,900	6,900	6,820	6,870	7,000	6,900	6,960
Initial or Open-circuit Voltage	Nil	Nil	Nil	6,800	6,800	6,790	6,920	6,900	7,000
A.C. Component of Current Ruptured (R.M.S.) ..	9,500	8,950	9,220	9,000	9,100	8,900	8,900	9,020	9,000
M.V.A. Broken	67.64	62.65	64.618	62.1	62.962	60.983	61.588	62.238	62.64
Total m.v.a. Broken	194.908			186.045			186.466		

Table No. 7.—Record of values taken from short-circuit test on 11,000 volt 150 m.v.a. 3-phase oil circuit breaker.

Photo-engraving at Home

The Apparatus Required, and Method of Operation

By E. H. JACKSON

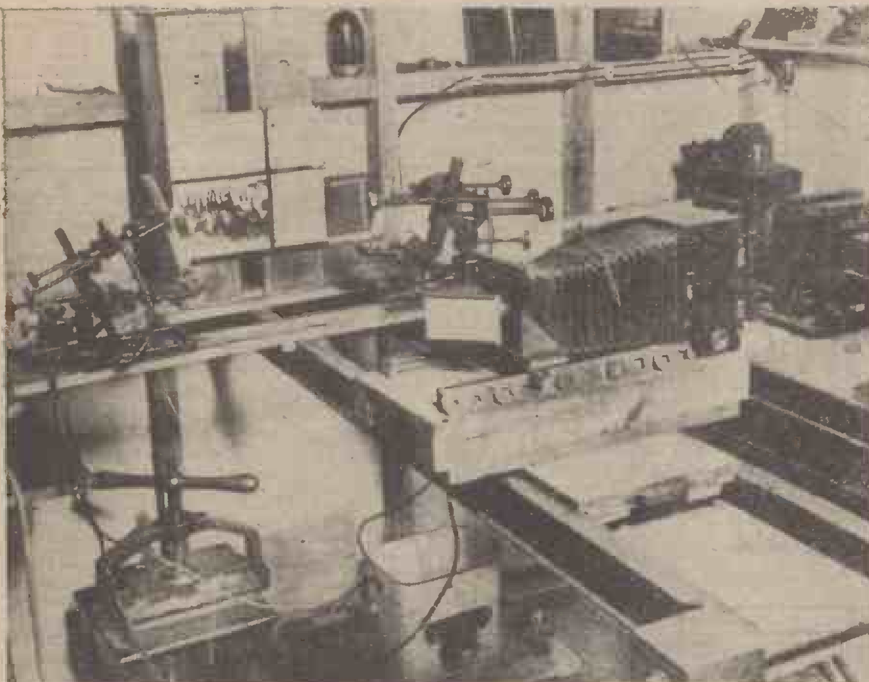


Fig. 1.—General view of the process camera and easel. A short extension has been fitted to the back of the field camera to house the screen mechanism. At the bottom left-hand corner can be seen an old type office press which is used for taking proofs of the finished blocks. Also at the bottom of the picture are the transformer for the arc lamps and the etching machine with motor attached.

THE art of photo-engraving is perhaps one of the least discussed subjects of present-day craftsmanship, and it seems regrettable that more is not written to encourage owners of small home printing presses to acquaint themselves with this fascinating technique.

Modern process-engraving has, of course, become a highly skilled trade, entailing the use of expensive apparatus and special equipment which is quite beyond the scope of the small jobbing printer in its present form. But, like most other crafts, it had small beginnings, which are the foundations of the present process, and examination of the basic principle will show that the process is really very simple, and there is no reason whatever why the enthusiastic amateur printer who has an elementary knowledge of photography, coupled with a flair for improvising and adapting odd pieces of apparatus, should not enhance his letterpress work by the introduction of an occasional half-tone block which he can make himself at home.

Half-tone might seem a strange word to many readers, but we should be quite familiar with it since we see half-tone reproductions in the form of newspaper pictures every day. All it means really is that the lights and shades of a picture are split up into countless small dots of varying size. The skies or whites of a picture are made up of very fine black dots, and the shadows consist of large black dots all joined together. Thus by varying the size of these dots we get light and shade in any required form from black, through half-tone, to white. Actually the whites are not pure whites, but nevertheless white enough for reproduction purposes.

Process Camera and Screen

The method of splitting up a picture into a series of fine dots of varying size is not anything like so complicated as might be imagined. It is done with a process camera. This is just a plain camera, inside which is incorporated an adjustable glass screen. This screen is made up of two pieces of glass cemented together, the inside faces of which are ruled with fine black lines at right angles to each other, giving a fine gauze-like effect. The screen is situated a short distance away from the sensitive plate in the camera, and is usually mounted on some form of rack mechanism so that this distance (which is important) can be varied.

The action of the screen situated in front of the plate is really rather remarkable, since it does not, as would at first be imagined, split up the picture into a series of square dots all of equal size, but for reasons of which there have been many advanced theories, each dot is graded in size in accordance with the amount of light passing through that part of the screen. In other words, the high-lights of a picture being copied through the process camera produce a series of large black dots on the plate when developed, and the size of the dots diminish through the half-tones into the shadows of the picture where they are very small. Thus we have what is termed a half-tone negative. More will be said later about methods of controlling the shape of these dots through the medium of specially shaped stops, screen distance and camera extension.

Preparing the Zinc Plate

Having produced the half-tone negative, a piece of sheet zinc plate is coated with a special glue solution to which has been added bichromate of ammonia to make it sensitive to light. When dry, the prepared zinc plate is put in a printing frame behind the half-tone negative and the picture is printed on to the glue surface in front of a powerful light. The action of the light is to harden the glue at those points wherever it has penetrated through the negative. Thus the simple process of washing the plate in warm water after printing removes the unhardened glue and leaves a series of fine dots forming the half-tone picture on a sheet of zinc.

Subsequent heating over a gas ring "burns in" the glue, turning it a chocolate colour and making it acid resisting; referred to technically as "the resist."

Having formed our "resist" picture on the zinc, it only remains for us to etch it in a bath of dilute nitric acid after painting suitable protecting varnish on the back and sides of the plate. Rotary etching is to be

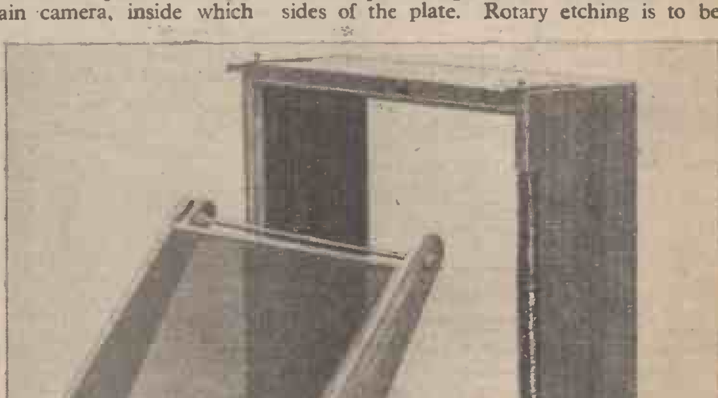


Fig. 2.—Screen carrier with screen fitted. The base of the carrier is made of 16 s.w.g. brass to which are sweated two short racks. The ends of the baseplate slide in two slots cut in the walls of the screen housing extension frame. Screen distance adjustment is made by turning the control knob which is attached to a long pinion shaft engaging the rack teeth. An indicator pointer and numbered dial gives the screen distance from plate in 1/32nds of an inch.

preferred, which means placing the plate in an etching machine incorporating a rotating paddle which splashes the acid against the plate, etching it to the required depth in a very short space of time.

The plate surface after etching will now resemble a series of pimples with flat tops of varying size in accordance with the picture, and in the case of coarse-grained half-tone pictures will feel somewhat like a nutmeg grater when rubbed over the surface with the fingers.

With the exception of trimming and mounting, this is the finished half-tone block which will stand long runs up to several thousand reproductions of the picture.

The Process Camera

Process cameras are, of course, specially made for photo-engraving work. They are usually very large, elaborate and expensive pieces of apparatus for making half-tone negatives 24in. x 20in., or even larger. This, no doubt, is all very well in its way for anyone who proposes to go in for photo-engraving in a big way, but the author improvised and adapted an ordinary second-hand stand camera which was purchased from a furniture dealer for 10s. It is a half-plate camera fitted with a Ross 12in. lens of the fairly common RR "Symmetrical" type. There was no iris diaphragm as is now usually fitted to all lens mounts, but just a narrow slot like a saw-cut midway between the front and back lenses. A set of interchangeable metal stops was provided ranging from f.8 to f.22. The old-fashioned idea of having loose interchangeable stops was a distinct advantage, since it is the usual practice for photo-engravers to use irregular-shaped square stops of different sizes during the exposure of a half-tone negative in order to assist dot formation.

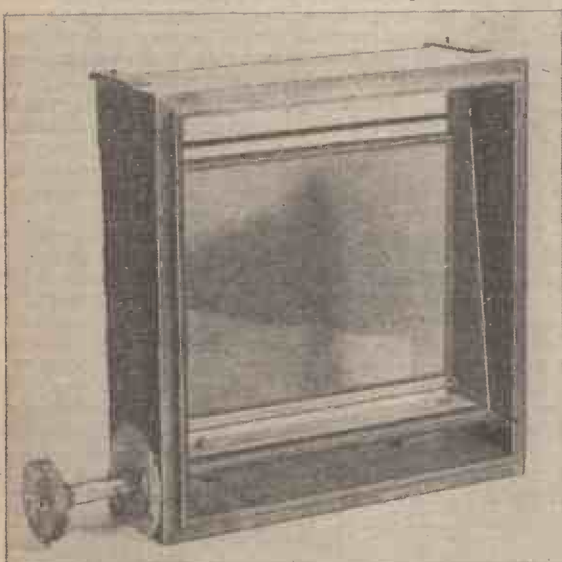


Fig. 3.—Front view of the screen housing extension frame showing screen and carrier in position. This frame is rabbeted as shown to fit snugly on to the camera back. The original plate holder and focusing screen clips are transferred from the camera back and fitted in similar positions on the extension frame. Two of the clips can be seen fixed to the top of the frame in this illustration.

If the reader is unable to obtain a lens without an iris diaphragm, it is quite a simple matter to remove the iris altogether and make a slot for insertion of loose square hole stops, which can be made from thin black fibre or even cardboard blacked over.

In choosing a lens, it is best to go in for one of fairly long focus. Certainly nothing less than 9in. focal length, otherwise we come up against several complications, including oval-shaped dots at the edges of the half-tone negative, and this alone is extremely undesirable. Any good rapid rectilinear lens (usually marked RR) will do, provided it fulfils the condition as to length of focus.

The purchase of a prism costing about £3, or mirror for attachment to the lens mount for reversing the image, is dependent upon whether the reader proposes to make blocks from other people's pictures or just his own. If the latter, he can save the cost of a prism by reversing his pictures in the enlarger, so that when this is copied by the process camera and subsequently made into a half-tone block, it will print the picture right way round. A little bit of thinking on the reader's part will soon reveal why a prism is necessary in the ordinary way for process engraving.

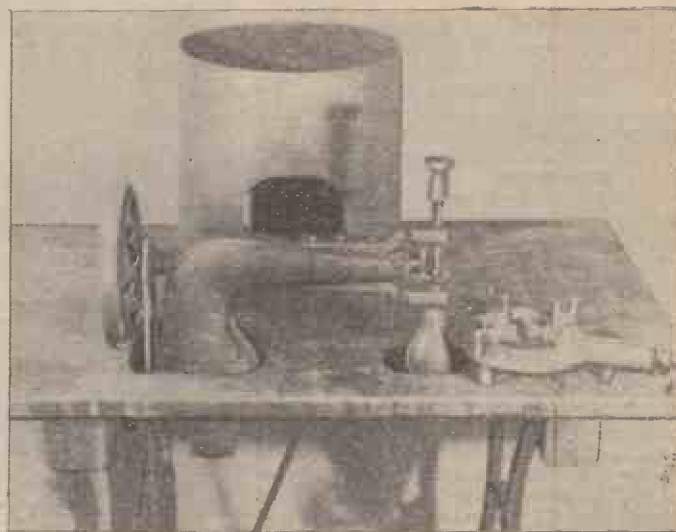


Fig. 5.—The whirling machine. This is a converted treadle sewing machine. The vertical hollow spindle is fitted with a small horn bulb at the bottom and a rubber suction cup at the top to which the plate is attached by suction and rotated while the sensitised glue solution is poured on the surface of the plate. A gas ring provides heat for quick drying of the plate during this operation. A modified 5-gallon oil drum seen detached at the back of the picture is used as a shield during the glue-coating process.

The Screen Mechanism

The choice of screen is dependent upon the size of camera and the class of work the reader proposes to undertake. The author chose a half-plate screen (7in. x 5in.) of 80 lines per inch ruling. This is quite a good average ruling which can be recommended for general work. Such a screen cost £2 8s. before the war, and was obtained from Hunter-Penrose, Ltd., 109, Farringdon Road, London, E.C.1, who are manufacturers of photo-engraving apparatus.

Having obtained the screen, a metal carrier will have to be made for it, and a short extension should be made to fit the end of the camera to house the screen carrier. The general layout of the screen and carrier mechanism is shown in the illustrations Fig. 2 and Fig. 3. No dimensions are given, since these are dependent upon individual requirements, which can vary considerably. The twin racks and pinion mechanism can be obtained from any old stand camera and modified as shown.

Some form of indicator dial and pointer should be fitted to the outside of the screen housing extension so that it will be possible at any time to see how far the screen is from the surface of the half-tone plate or negative. It is usual to reckon screen distance in 1/32nds of an inch, so the dial should be graduated in this manner for ease of operation when adjusting screen distance and camera extension.

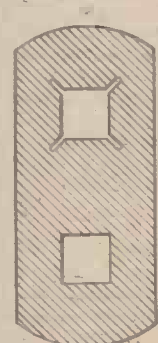


Fig. 4.—Double-ended square stop. With certain pictures it may be difficult to make the high-light dots "join up" on the half-tone negative. If so, part of the exposure is made by using a stop with extended corners, as shown.

It may be as well at this stage to explain that the majority of half-tone negatives are

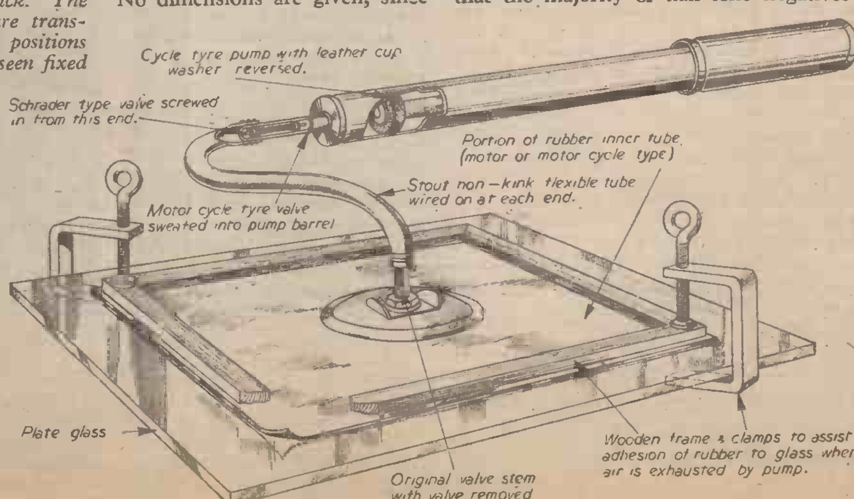


Fig. 6.—Part sectional view of vacuum printing frame.

made with wet plates, known as the "wet collodion process," and there are no doubt distinct advantages to be obtained by this method which need not be entered into here. The beginner, however, will find the dry plate process much less complicated, and manipulations will not require the same care in regard to cleanliness and avoidance of dust which is most important with wet collodion and silver baths. Special "thin film" plates can be obtained from Messrs. Ilford, Ltd., for making half-tone negatives, and the author has found them satisfactory in every way.

Screen Distance

A certain amount of modification may be necessary to the dark slide, or plate holder, and the back of the camera, so that the screen can be racked back to within 1/16in. from the actual plate surface. Actual screen distance, of course, will depend upon the camera extension and the focal length of the lens used. The size of stop and mesh of screen ruling are also deciding factors to be reckoned with. It should be remembered that screen distance increases with camera extension and decreases as it is closed up. The longer the focus of the lens, the greater is the screen distance. A coarse screen will also require a greater screen distance, and vice versa.

Much can be found out by trial and error methods, although there are rules to be followed. Hunter-Penrose provide a very useful little pocket book on this subject entitled "Half-tone Stops and Screen Distances," price 2s.

All this may sound very confusing to the beginner, but it is really very simple once the principle is grasped, and is almost mechanical when the limitations of the camera are found.

The illustration, Fig. 1, shows the copy on an easel illuminated with two arc lamps. Such a strong illuminant is more or less essential for producing half-tone negatives by the wet collodion process, since they are much less sensitive to light, but four photo-flood-lamps 12in. distance were found to be quite sufficient for dry half-tone plates.

Camera Mounting

Mounting the camera on a firm base and adjustable gantry is very necessary in view of the comparatively long exposures that must be given, since any vibration would completely ruin the result with blurred dots. If a prism or mirror is used, the camera will have to be at right-angles to the easel as shown in Fig. 1. Professional process cameras are arranged to extend backwards from the lens, i.e., the lens and prism are fixed, while the rear of the camera is racked back for extension. This enables the operator to keep the lens centred on the copy easel all the time. Otherwise the easel must be moved sideways in relation to the camera extension.

Unlike ordinary photography, the half-tone process requires the use of specially shaped stops, both square, and square with extended corners. Many other shapes have been tried in the past, but square stops are now almost universally adopted. A set of double-ended square stops as shown in Fig. 4 should be made ranging in the following sizes: 3/16in., ¼in., 5/16in., ⅜in., 7/16in. and 9/16in. square. Also one ¼in. round stop.

The baseboard of the camera should be marked in inches to show the amount of camera extension.

Making the Half-tone Negative

Fix the "copy" (as the original picture is always called) on the easel upside down and arrange two photo-flood-lamps in reflectors on each side at about 12in. distance. A certain amount of manipulation may be necessary in order to avoid unpleasant reflections from the surface of the print when viewed from a position near the lens of the camera. Focus the image on the ground-glass screen to the required size with the screen racked back close up to the plate, then with the aid of a powerful watch-maker's eyeglass or pocket microscope examine the dot formation as the screen is slowly racked away from the plate. Using a medium size square stop of, say, ⅜in., the ideal position to set the screen is where the chessboard pattern of white squares as seen through the eyepiece appear to be firmly "joined up" or overlapping at the corners on the high-lights of the picture. If there are no high-lights on the picture being copied, a piece of white and black printed matter may be attached alongside the copy.

Fig. 7.—The etching machine. Made from a small enamelled bread-bin. Photo shows aluminium paddle at bottom of bin for splashing the dilute nitric acid on to the prepared zinc plate attached to the under side of the bread-bin lid.

If the picture being copied is contrasty with very dark shadow detail, a little dodge known as "flashing" is resorted to in order to form a foundation of very small dots all over the negative and thus force the formation of a nucleus of dots in the shadows from which the half-tones are built up.

"Flashing" consists of holding a piece of white paper over the copy and making a short exposure, using a small round stop. With some pictures "flashing" is not necessary, and care should be taken to avoid excessive use of it, since much detail can be lost from a picture if it is over-done.

The author found that very often two or three different stop settings were required for one exposure, and the following is a typical example of exposure given for an average picture:

Camera extension, 17in.
Screen distance
8/32nds (i.e., ¼in.).

Exposure

Large square stop (9/16in. sq.), 18 seconds
Med. square stop (⅜in. sq.), 45 seconds
¼in. round stop (flashing), 60 seconds to white paper covering copy.

Fig. 8.—Front of the process camera showing how prism is mounted inside a sheet metal case attached to front of lens barrel. One of the square stops is shown in position in the slot in the lens mount.

The above figures can only be a very rough guide for beginners, who should really experiment for themselves in conjunction with data given in Penrose's pocket book already referred to.

Develop the plate in a contrasty developer, rinse and fix in hypo as with ordinary plates, but before washing, and while there is still some hypo clinging to the plate, immerse for 30 seconds in weak potassium ferricyanide solution comprising sufficient crystals of pot. ferricyanide dissolved in water to give it a pale straw colour; then wash and dry.

The action of this bath is a form of "cutting" or reducing which removes haze from around the dot formation, thus making them stand out sharp and clear for the following process of printing.

Printing the Half-tone on Zinc

Suitable 16-gauge zinc sheets polished one side can be purchased from Hunter-Penrose, Ltd. (Pre-war price, 10s. per 3ft. x 2ft. sheet.) Cut out a piece of zinc slightly larger than the half-tone negative. It is best to cut this with a fine tooth saw rather than shears, to avoid bending and distorting the plate.

Dress the edges of the zinc, removing all burrs and sharp edges, and polish the surface with pumice powder and water, using a piece of cotton wool. Polish the plate with straight up-and-down movements of the cotton wool until dry and free from dust.

The zinc is now ready for coating with sensitised glue, for which a whirling machine is required.

The object of the whirler is to rotate the plate at about 240 r.p.m. while the glue solution is poured on to the surface. The speed is important, since, if too high, the glue film would be too thin and vice versa.

Hand whirlers can be purchased from Hunter-Penrose, Ltd., but it should be fairly simple to make one.

The author converted an old sewing machine for the purpose. A vertical tubular shaft is fitted in the manner shown in Fig. 5 to the "business end" of the sewing machine. The top of the vertical tube is fitted with a rubber suction cup taken from a Ford valve-grinding tool. To the bottom of the tube is fitted a small horn bulb. The back of the zinc plate centre is lightly pressed on the moistened suction cup while the bulb is depressed, and this is sufficient to hold the plate in position during whirling. A cut-down five-gallon oil drum provides a shield to catch the surplus glue thrown off the edges of the plate. An opening at the bottom of the shield allows a gas ring to be inserted for drying the plate during whirling. The plate is removed when the glue is set dry after about one and a half minutes. The zinc plate is now ready for printing.

Printing Frame

The important thing in printing on zinc is to get the half-tone negative in close contact with the glue surface of the zinc over the complete area. This can be done by using an extra strong printing frame having a front glass about 1in. thick and powerful clamping screws in the back. Such frames can be bought, or even home-made, but at best they are extremely heavy and cumbersome. A better way is to borrow Hunter-Penrose's own idea and make a vacuum frame. This need not be so elaborate as the one they supply for the purpose, and all that will be required is a sheet of thick plate glass and a piece of ⅛in. thick sheet rubber. A piece cut from an old motor-car inner tube to include the valve will serve the purpose. The rubber and glass should be three or four inches larger than the negative. The valve with the inside removed should be arranged in the position shown in Fig. 6. A simple vacuum pump can be made from an old cycle pump with the cup washer reversed and a reversed valve sweated to the end of the pump barrel. Connect up as shown.

Arrange the half-tone negative and zinc plate in the centre of the plate glass, gelatine of negative in contact with glue, and lay the rubber on top. Operation of the pump will exhaust the air from between the rubber and the glass if the edges of the rubber have been previously moistened and are clamped down firmly (see Fig. 6) in contact with the glass while operating the pump. Continue pumping until iridescent circles appear through the plate glass. If the rubber is pliable, the vacuum should hold for a long time.

Printing by Artificial Light

Actual printing can be done in direct sunlight, but since this is so unreliable, four photo-flood-lamps, or an arc lamp, placed 12in. from the frame, will serve the purpose. Exposure times are roughly from two to five minutes, but, as before mentioned, much depends on the type of lamp, thickness of glue film, density of negative, and distance from light source. If the exposure is too short the glue will probably wash off the plate altogether, or if too long it may not be possible to remove it from between the high-light dots, and the shadows will be "filled up."

Before washing the zinc plate in warm water it is a good plan to immerse it first in a dash of water coloured with a few drops of methyl violet dye. The dye stains the glue, so that a careful watch can be made while washing out the unhardened glue from between the dots. It is a tricky stage in the process, since the glue dots are very tender and liable to wash off if carried on too long.

When carried out correctly it is perhaps the most interesting part of the process to see for the first time the half-tone picture in violet on the polished zinc background.

The glue solution should be freshly made up the day before it is required. Special pure photo-engraving glue, costing 10s. 9d. a bottle, can be obtained from the Albumenoid Products Co., Ltd., 164, Market Street, Aberdeen.

Formula for Zinc

Solution 1.	*Solution 2.*
To 3oz. water add 5oz. of glue. Stir up well.	In 4oz. water dissolve ½oz. bichromate of ammonia, and filter.

Mix 1 and 2 together and add water to make 15oz. in all.

This should stand overnight, after which it should be filtered. A suction type of filter

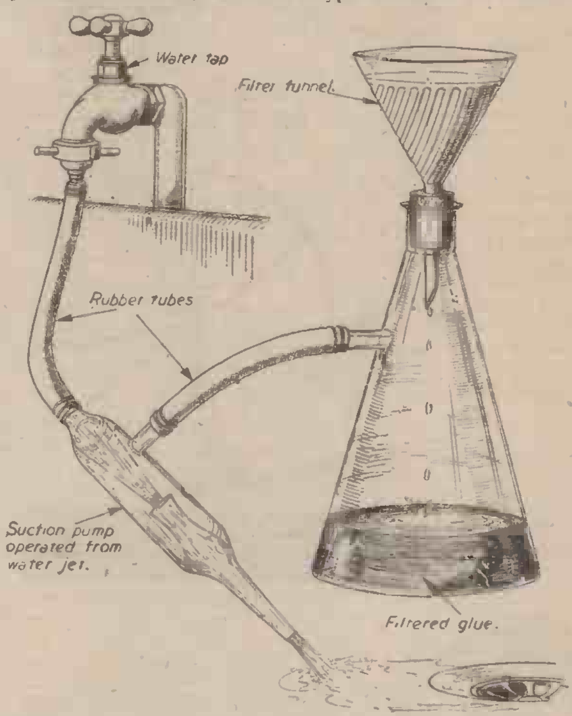


Fig. 9.—Type of suction filter worked from the water tap used for filtering the glue solution.

(as shown in Fig. 9) worked from the water tap is to be preferred, otherwise filtering may take many hours.

Burning-in the glue image is just a simple matter of heating the zinc plate evenly over a gas ring. Care should be taken not to overheat the plate, which will soon melt; at the same time it should be just hot enough to turn the glue a cholocate colour, and as soon as this colour is obtained all over the surface of the picture the plate should be put to one side to cool. Before it is quite cooled down the back and sides can be painted with acid resisting varnish, which will dry immediately if the plate is still warm. It is now ready for etching.

Ordinary etching in a dish of weak nitric acid is seldom satisfactory owing to the accumulation of sludge between the dots, and to try and brush this away during the process usually ends in uneven etching and damage to the "resist." The ideal way is to make an etching machine, Fig. 7. This is made from a small enamelled bread-bin in which has been fitted an aluminium paddle poised between two ball bearings as shown. Since pure aluminium is not readily attacked by weak nitric acid, the two paddles and square axle to which they are riveted with aluminium rivets are made of aluminium as pure as it is possible to obtain.

Two holes are cut through the sides of the enamel bin near the bottom, so that the axle, when fitted, will revolve freely with the tips of the paddles about ½in. clear of the bottom of the bin. Rubber washers, held in position with wood washers, make a rough form of gland around the shaft at each end to prevent excess acid splashing out or creeping along the shaft. The paddles are bent at the tips to form small scoops and are drilled as shown.

Nitric acid, commercial grade, diluted one part to eight parts of water, is poured into the etching machine, sufficient to cover the tips of the lowest paddle. The paddle is rotated at about 500 r.p.m. The author used a small sewing machine motor for this purpose.

The plate to be etched can be attached with drawing pins to a flat board, forming a loose lid completely covering the open top of the enamel bin. When the motor is started, acid is thrown up with considerable force against the zinc plate, and any sludge is quickly washed away from between the dots. Etching usually takes about two and a half to three minutes.

After etching is complete, the plate should be removed, washed in running water and dried by warming. The dot formation should then be subjected to a careful examination under a powerful pocket microscope. The ideal dot in the high-lights should be like a cone with a flat top, very small in diameter. The darkest shadows should have minute, evenly spaced craters, also very small in diameter. It should be remembered that during etching the acid attacks the zinc in all directions once it is below the surface of the "resist," and a certain amount of undercutting of the dots is unavoidable. Actually, immediately after etching, the high-light dots will be like small toadstools.

Over-etching is just as bad as under-etching. The former produces sharp, pointed high-light dots which will not print properly. The latter will not be etched deep enough and will fill up with ink.

All that remains to be done now is to trim the unwanted edges of the zinc down to the required size and mount on a wood block. Special clamped mahogany mounting boards, ready planed to the correct thickness which will bring the zinc to type height when mounted, can be purchased from John Meerloo & Co., Ltd., Cleveland Works, Mile End, London, E.1, but any good quality wood will do if planed to the correct thickness. The professional way of mounting the zinc is to cut a narrow step or bevel along two edges to accommodate small, flat-headed securing sprigs. This can only be done successfully with an iron shootboard and plane, which can often be purchased second-hand from printer's engineers. Failing this, the zinc can be trimmed with a fine saw and stuck to the wood with hot bitumen.

Proofing can be done with an old office screw press, as shown in the bottom left-hand corner of Fig. 1. A spot or two of good quality printer's ink is rolled on to a sheet of glass or metal faceplate with a rubber squeegee, care being taken not to use too much. The ink-charged roller is then lightly applied to the block printing surface. Half-tone blocks always print better on good quality art paper, and blocks of very fine screen mesh are always printed on this paper. Coarse-screen blocks will print on unglazed newspaper, but the screen should not be finer than 80 lines per inch.

Copper is very largely used in place of zinc for half-tone blocks, more particularly on the finer meshes, and it etches very smoothly and rapidly with perchloride of iron in solution. It will also stand higher temperatures without risk of melting during the "burning in" process.

Masters of Mechanics—107

Lewis Paul

The Story of the World's First Spinning Machine

BRITISH prosperity has been to a large extent based upon the textile industry of our country. It was, indeed, largely in connection with that industry that the first mechanical inventions were made some two centuries ago. The expansion of the textile trade consequent upon these inventions brought about a demand for mechanical power. Then came the steam engine and its various applications, together with the necessary improved means of transport.

All this more or less rapid development of commercial and industrial activity occurred in the days of the eighteenth century, and although the "Industrial Revolution," as it is now conveniently styled, took place chaotically, and gave rise to much social suffering, it certainly made Britain enormously rich, to say nothing of putting our nation in a position of world power.

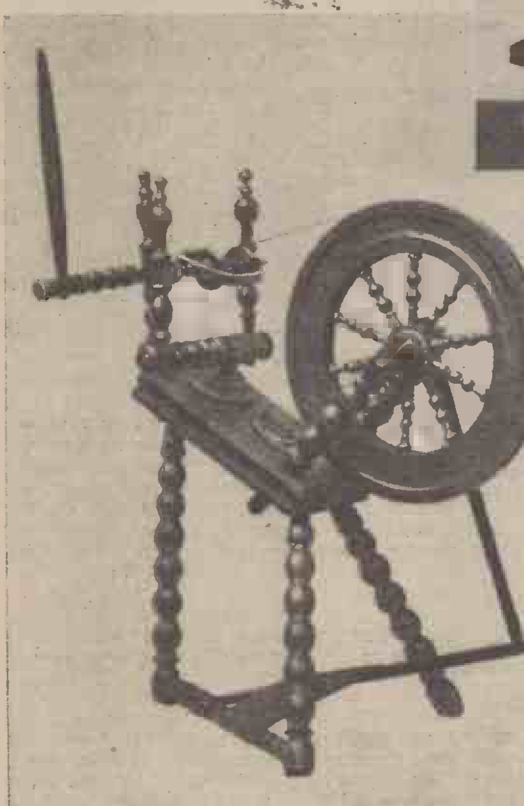
The Industrial Revolution was based on inventions in the cotton industry, the names of Kay, Hargreaves, Arkwright, Crompton and Cartwright being universally famous as the great textile inventors of the period.

There is, however, another name which, for some reason or other, has escaped the historical celebrity which has been accorded to the others. Such a name is that of Lewis Paul, a Londoner who lived through and played a most active part in the rise of mechanised processes during the early part of the Industrial Revolution in England.

It pleases the average history book writer to inform us that Richard Arkwright, who commenced his life as a barber's boy in Preston, was responsible for the introduction of mechanised cotton spinning. To a certain extent this is true, but Arkwright himself was no original genius, nor was he by any means the inventor of cotton spinning machinery. If anything, Arkwright was an immensely successful purloiner of other men's ideas.

Before Arkwright's time, Lewis Paul had devised a machine for the spinning of cotton and wool. The machine was successful, but Paul himself had not the right character to ensure its commercial adoption. Moreover, he dissipated his energies in other inventive directions, for which reason his lack of concentration on his spinning machine probably resulted in its non-acceptance as a means of speeding-up the production of yarn.

A hand wheel for winding spun thread.



A typical 17th-century wheel for the hand-spinning of cotton and woollen yarns.

Pinking Machine

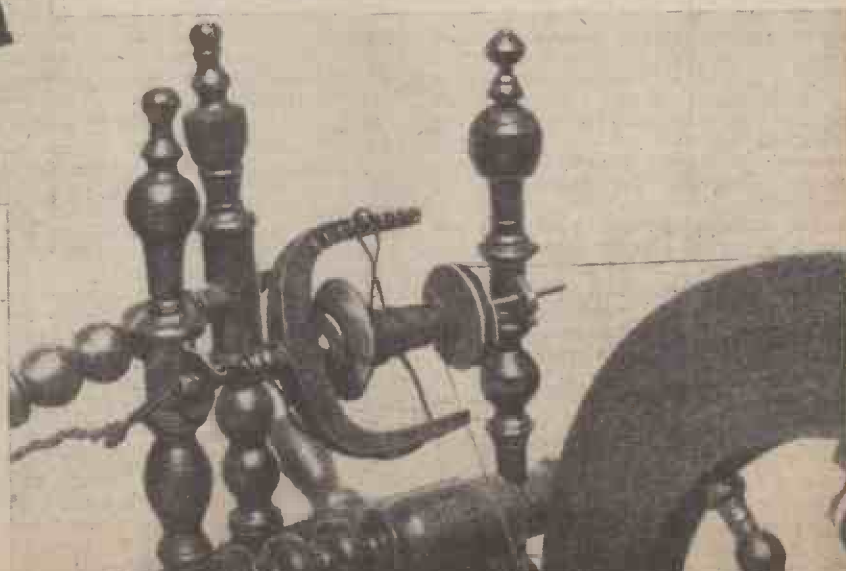
Lewis Paul was of French extraction, and his father was physician to Lord Shaftesbury. To the guardianship of this nobleman young Lewis Paul was entrusted when his father died. The lad must have been born soon after the beginning of the eighteenth century, but of his earliest life we knew nothing. The first definite record which we have of him is that of his runaway marriage to a widow, one Mrs. Sarah Meade, in February, 1728. The adventurous lady died a year later and left her young husband a considerable amount of property. There is reason to believe that Paul married again, but the record of such a subsequent marriage has not been found.

After the death of his first wife, Lewis Paul devised his first invention, which was a rather gruesome one. It comprised a machine for "pinking" shrouds, that is to say, for giving a serrated and decorated edge to those garments. The pinking machine was the most commercially successful of Paul's inventions. It brought a good deal of profit to him and the income which he derived from it stood him in good stead in after years when other inventive activities went awry.

No details of this strange pinking machine have survived and as Paul did not patent it there is apparently no means of our ever being able to ascertain its exact nature.

However, in 1738, Lewis Paul did take out a patent (No. 562) for "a machine or engine for spinning of wool and cotton in a manner entirely new." In this patent, Paul is described as a "gentleman," and "of Birmingham." He met John Wyatt for the first time in Birmingham about 1732, and Wyatt managed to play a very big part in his life, becoming his close associate in his inventions, and even becoming closely coupled with him in historical celebrity in the matter of the spinning machine invention.

In 1732 Lewis Paul was developing some invention of his own connected with gun-barrel manufacture. Probably this was the activity which first took him to Birmingham. The exact nature of this invention is unknown. Nevertheless, whatever it may have been it resulted in Paul's becoming associated



The "business end" of a hand-spinning wheel, showing the wooden bobbin on which the spun thread is slowly wound.

with a Birmingham gun-barrel forger named Heely.

File-making Machine

Now, this Heely was acquainted with John Wyatt, of Birmingham, and Wyatt at this time had invented a file-making machine in which he had sold Heely a share. Lewis Paul, after he went to Birmingham for the first time, bought out Heely's share in Wyatt's invention. It was Paul himself who ultimately perfected this machine, but, so far as we can gather, the machine was never very successful and it probably never returned the money which had been expended on it. Heely went bankrupt in 1734, and that is the last we hear about him.

There is little doubt that Paul's spinning machine patent of 1738 represented the first spinning machine design which had ever been invented. True it is that even as far back as the days of King Charles II (who died in 1685) there had been various sporadic attempts at mechanical spinning, and even a few patents had been taken out for such inventions. Nevertheless, no mechanical spinning machine or device was successful until Lewis Paul had hit upon the brilliant idea of "roller spinning," an idea so fundamentally successful that it still at the present day forms the basis of our modern systems of spinning.

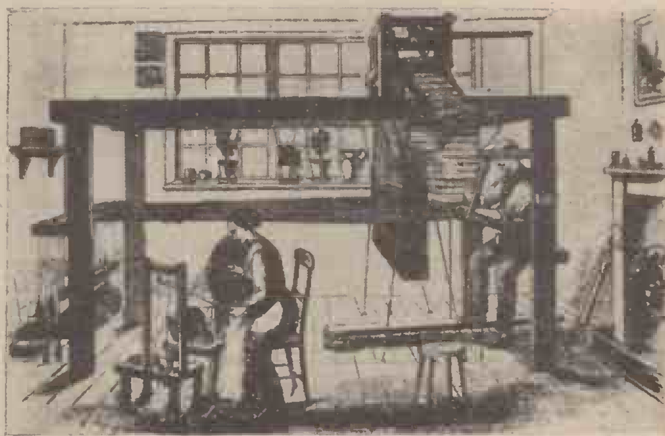
The act of spinning, as the reader will no no doubt be aware, consists in the gradual drawing-out of the mass of "carded" or combed-out wool or cotton-wool into a continuous thread of wool or cotton. This operation, from time immemorial, had been achieved by a laborious and tedious hand method of pulling-out the cotton or wool fibres from the mass of raw material and, at the same time, in giving them a twist in order that they would cling coherently together to form a thread.

Domestic Spinning Wheel

To this end, the various types of domestic "spinning wheels" were used, the treadle-operated wooden wheel serving to rotate a wooden bobbin upon which the spun thread was gradually wound. A so-called "spinning wheel," therefore, was, at the best, little more than a winding-wheel, an appliance for neatly winding the spun thread on a bobbin.

As the eighteenth century wore on, the demand for woven textile goods of every description increased by leaps and bounds. Kay's invention of the "flying shuttle" increased the speed and the facility with which fabrics could be manufactured. Yet there was a bad bottleneck, this comprising the slowness with which the necessary thread could be spun.

Paul's idea was to draw out the cotton material between two pairs of rollers of small diameter, the upper (or lower) roller moving slightly faster than its opposing one. The "slivers," or lengths of cotton wool or raw wool combings, on passing through these rollers were stretched or "drawn" in a regular manner, and, owing to the inequality in the rate of revolution of the rollers, the cotton or wool material was subjected to a continual pull or "drag" which resulted in its being drawn out into a thread.



An 18th-century cottage interior, showing the processes of hand spinning and hand weaving being carried out. (*From an old print.*)

There is no doubt that Lewis Paul had the skilled assistance of John Wyatt in building his first spinning frames. What is more, Wyatt was apparently a man of some means who was able to assist Paul financially. Such facts are indisputable. But some 90 years after the construction of the first spinning machine in Birmingham, and long after Wyatt's death, the latter's son set up a claim to the effect that Wyatt himself, and not Lewis Paul, was the original inventor of the roller spinning machine. Such a claim still remains unsettled, although it is more than doubtful whether Wyatt ever had the inborn originality of mind to hit upon the principle of the unequally moving rollers for mechanical spinning.

Dr. Johnson

A lot of people interested themselves in Paul's spinning project, so much so that Paul, with Wyatt's assistance, was able to set up a spinning mill in Birmingham and to produce the world's first mechanically spun cotton material.

Among the interested parties who patronised the new invention was the famous Dr. Johnson, of London, the great literary man and dictionary-maker. Dr. Johnson was related in some distant way to Wyatt, and Johnson probably had a little financial interest in the invention.

Not only did Paul and Wyatt set up a mill in Birmingham, but they also went farther afield and erected one at Northampton. Still further, they granted licences for other interested parties to set up "spindles" for the mechanical spinning of cotton and wool.

In 1748 Lewis Paul patented a machine for the mechanical "carding" or combing-out of raw cotton and wool. Previously this operation had been more or less effected by hand methods, but Paul's mechanical "card" contained a circular fine-toothed revolving drum operating in conjunction with a mechanical comb which stripped off the "carding" or mass of straightened and aligned fibres from the drum.

Paul's carding machine was not successful. From this time his connection with mechanical spinning became more and more remote. He had already left Birmingham (1745) and was now living, according to a third patent which he took out later, in "Kensington Gravel Pits," London. Possibly only one or two of Paul's carding machines were ever built. One of them, however, was sold to a hat manufacturer, of Leominster, who afterwards (about 1760) introduced it into a Lancashire mill.

Right: An 18th-century hand-weaving loom which operated entirely on hand-spun material. Below: An industrial vista in present-day Lancashire showing the giant cotton-spinning mills alongside a canal waterway.

Paul's Last Patent

The third and last of Paul's patents which is mentioned above was obtained in June, 1758. It was for an improved type of spinning machine. But even this was unsuccessful. Paul, at the instigation of Dr. Johnson, endeavoured to get one of his new machines introduced into the Foundling Hospital, London, to be run by the inmates there, and a letter on this matter addressed to the Duke of Bedford, the then President of that establishment, still exists.

But luck was against Lewis Paul. He had dropped away from his former associate, John Wyatt, although the two still remained quite friendly. There is no doubt that Paul's machine was efficient (relative, of course, to the standards of those days), and that it was capable of doing good work.

The fact is, of course, that spinning machine inventions were not popular in Paul's day. The hand-spinners of the day were intensely antagonistic to their use. They saw in them the taking away of their means of livelihood. Mill owners were suspicious of them, also. To them, they were new-fangled notions, uncertain in operation. Moreover, they had to be operated under licence of the patentee, so that they were somewhat expensive to run.

Lack of Concentration

Still further, Paul himself was not a commercial man. He lacked concentration and, after an encounter with a difficulty, his mind tended to fly off on to some other project. Had Paul been made of sterner stuff, had he engaged more continuously in the textile trade, the spinning machine would undoubtedly have commercialised itself long before it was brought into industrial use at the hands of Richard Arkwright some 20 years later.

Lewis Paul died at Kensington, London, in April, 1759. He was not a poor man when he died, but he certainly did not make any money from his spinning machine inventions.

The Paul-Wyatt Controversy

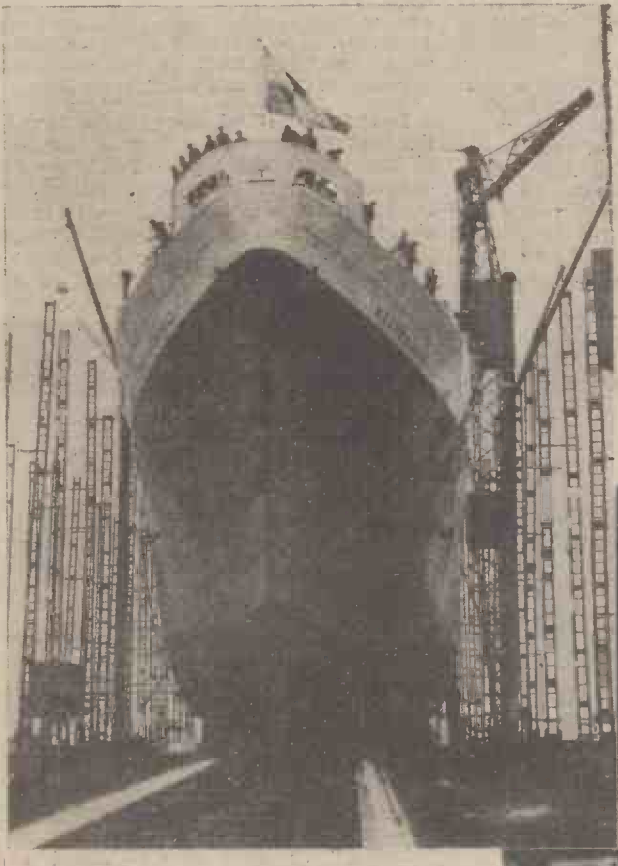
The question of Wyatt's alleged invention of roller spinning forms one of the unsolved problems of engineering history. As we have previously remarked, Paul's claim to the invention of the principle of roller spinning was only first disputed some 90 years after the first appearance of the machine, and, apparently, such a claim was only advanced in consequence of the discovery of a few isolated letters of Wyatt in which he refers to "my" machine.

It is certain that Wyatt during his lifetime never laid claim to the origination of the roller spinning machine. The two roller spinning patents were taken out in Paul's name, and Wyatt himself, judging by the tone of the still available letters written by him, seems always to have been subservient to Paul in the matter of the invention.

Yet the claim, in all fairness, cannot indisputably be decided in Paul's favour, for all the necessary evidence is missing.

To-day, of course, high-speed spinning is one of the most highly mechanised processes of the cotton and wool industries. Yet, without the roller principle of "drawing-out" the raw material, devised by Lewis Paul, these present-day perfections of mechanical ingenuity would be impossible.

Items of Interest



The "Beaverdell" going down the slipway after the launching ceremony

Floating Seaport

FROM the commencement of the war in the Far East, the Navy had to operate between 3,000 and 4,000 miles from its main base in Australia, but the fleet did not return to shore for repairs, re-victualling or to replenish ammunition. The Pacific Fleet train under the command of Rear-Admiral D. B. Fisher, C.B., C.B.E., fed, serviced and maintained the battle fleet, enabling our ships to operate continuously in Far Eastern waters.

There were well over 100 Royal Navy and Merchant Navy vessels of 30 specialised types in the Fleet train . . . a floating seaport with factories, repair shops, floating docks, cranes, stores, barracks, hangars, refrigerators, fuel depots, waterworks, ferries.

Oiling at sea has developed to such a degree that it is now possible for a battleship, a cruiser and a destroyer to refuel at the same time from one tanker.

To work the machines in each heavy repair ship, 700 men are required and the accommodation space holds only 200, so "floating barracks" are supplied by the accommodation ships.

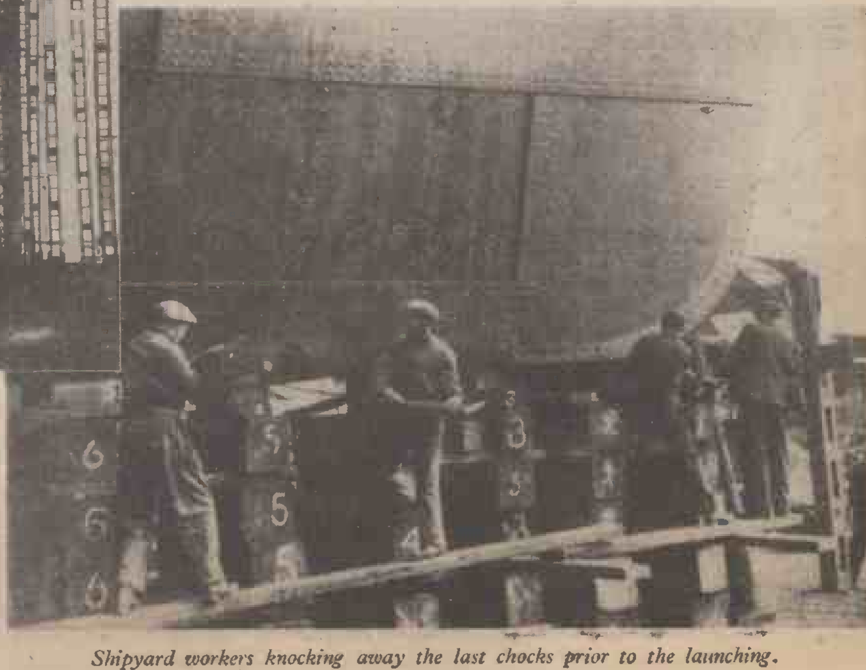
The Pacific Fleet train has done a good job in helping our warships in the Far East. Even now, when the fighting is over, the Fleet train has still got work to do—maintaining the occupational forces in the Pacific.

The Boeing B-29

HALF again as large as the Boeing B-17 Flying Fortress, the B-29 is the first aircraft combining giant size, extreme range, and load-carrying capacity with the speed of a fast pursuit plane. The B-29 has a wing spread of 141ft., a length of 99ft., and the top of its tail stands 28ft. off the ground.

New C.P.R. Cargo Ships

THE first vessel of the Canadian Pacific Railway Company's post-war cargo fleet, the 10,000 ton turbo-electric vessel "Beaverdell," was launched recently from the shipyard of Lithgows, Limited, Port Glasgow. The accompanying illustrations show the vessel just before and during launching.



Shipyard workers knocking away the last chocks prior to the launching.

THE WORLD OF MODELS

The Work of a Newly Formed Model Engineering Society

By "MOTILUS"

Fig. 1.—Commander P. W. Kent (managing director of George Kent, Ltd.) and the members of the Model Engineering Society outside their workshop on the flat roof of the firm's main building.

NOT long ago we introduced Luton to readers as a centre of model engineering—and this month brings news of another group of model makers in this thriving Midland town—the George Kent Model Engineering Society.

Messrs. George Kent, Ltd., are an old established engineering firm, who celebrated their centenary in 1938. They also have the distinction of having been conducted over the whole of their first 100 years period by two successive generations of one family, Sir Walter Kent, C.B.E., and his father, George Kent, the founder of the firm. Managing director to-day is Commander Philip W. Kent, R.N. (retired).

The George Kent Model Engineering Society was formed on January 1st of this year, with a membership of 40 (Fig. 1). The firm is noted for its fine instrument work, which would account for several of its employees being expert model makers. Mr. George Archer, A.M.Inst.B.E., the chairman, has been a model maker from his boyhood days and comes from a family of fine craftsmen, his father being a clever model maker, and his grandfather, the inventor of the Sturmey-Archer three-speed gear. Secretary of the society is Mr. Kenneth S. Terry—also an excellent model maker—while his father, Mr. H. A. Terry, is also a member of the society and an exhibitor in the model display held in connection with the official opening of the society's workshop, which took place on June 1st of this year.

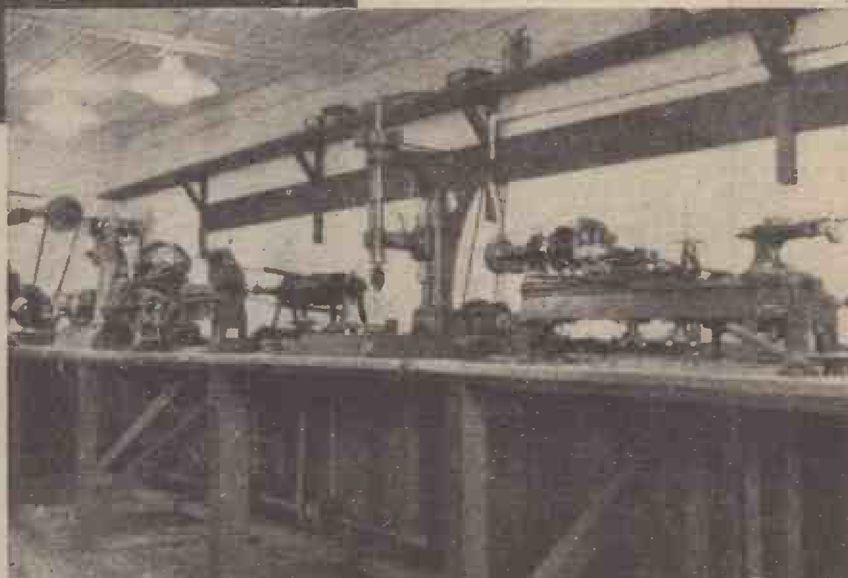


Fig. 3.—The machine tool bench of the workshop.

Fig. 2.—General view of the workshop of the George Kent Model Engineering Society, opened on June 1st, 1945.

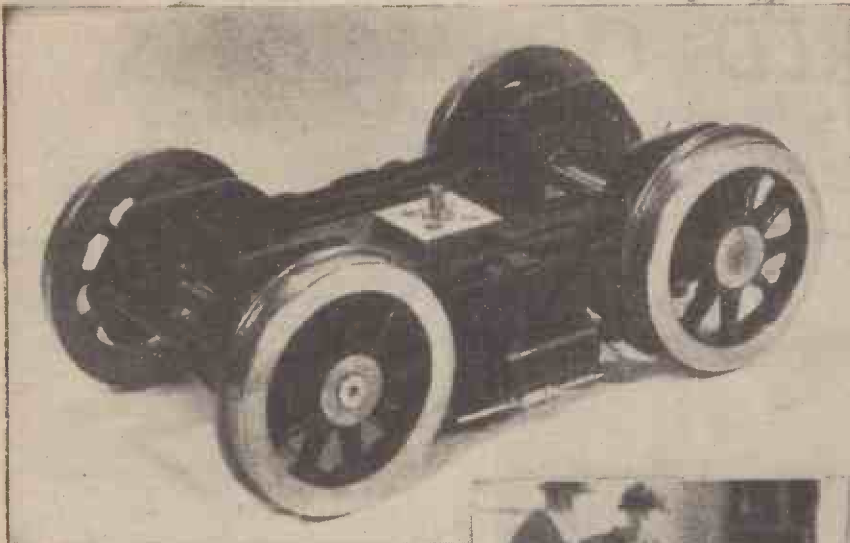


Fig. 5.—The bogie of the model "Royal Scot." This is all built up with complete brake gear, the wheels being cast from Mr. Archer's own patterns.

Commander Kent is the society's president and is also "heart and soul" in the project, and when the society looked around for suitable quarters for its own model workshop, he, with works manager Mr. J. Buckley, the society's hon. press officer, Mr. J. M. White, and a "round table conference" of the members, decided to take over the Home Guard's sleeping quarters for this purpose, now that its usefulness for its primary purpose had lapsed.

Equipment

This little room, perched on the flat roof of George Kent's main building, is well lit by properly disposed windows and is the right size for an ideal workshop (Figs. 2 and 3). It was thoroughly spring-cleaned and painted. The maintenance department and the millwrights put in and reconditioned the machines, and also fixed up suitable power to drive them. The machines are run from a 2 h.p. electric motor and are as follows: large drilling machine, vertical drilling machine, 4in. Spencer lathe, small sensitive drill, Lorsch lathe with 3in. centres, grinder, forge, vice and well equipped tool cabinet.

Among those who showed great enthusiasm in getting the workshop started is Mr. John Gurteen, who has been draughtsman, calibrator and photographer to George Kent, Ltd. His *pièce de résistance* at the "workshop opening" was a scale model of a liner constructed of paper. The materials actually used are post cards, paper and glue, and the model, which is half-finished, is planned to be a special demonstration model, with all sections removable to illustrate the working of the vessel (Fig. 4). As a simple example, five decks take out to discover the auxiliary boiler room, and everything is to be completed to this meticulous style. The model is 52in. long, representing an actual length of 800ft., to a scale of approximately 3/32in. to 1ft. The hull is built up in rib form and plated—just like the real thing.

In addition to modelling, Mr. Gurteen is very keen on music and conducts his own orchestra. We are told that music and models are his main hobbies—a happy choice, because psychologically the one should help the other!

Oldest member is Mr. H. A. Terry, who is 64 and an enthusiastic model loco builder, while the youngest exhibitors—Peter Sharp and Keith Jacobs—are only 16.

Model Sailplane

Peter Sharp's effort was a "King Falcon" 6ft. 4in. span sailplane, which took up most of the space in one corner! It was an excellent piece of woodwork and its constructor, an apprentice in the instrument-making department of the firm, is also a member of the Luton Model Airplane Society.

Fig. 4.—The boat section of the model display, including in the foreground Mr. John Gurteen's scale model liner constructed of paper. In the background are to be seen the model 18-footer yacht of Mr. J. Grout and model motor torpedo boat "Christine" of Mr. A. Readman.

The other 16-year-old is Keith Jacobs, who recently started work in the main toolroom as an apprentice toolmaker. His exhibits were two small aircraft, very nicely finished—an M.E. 163 and a DFS. 230 German jet plane, both to the scale of 1/72in. Keith's next project is a petrol engine.

Mr. H. R. Terry, a brother of the secretary, exhibited his model of a high speed marine engine—1¼in. bore x 1in. stroke—made in 1926.

One of the finest pieces of workmanship in the exhibition is a model of an 18-footer yacht—scale 2in. to the foot—which Mr. J. Grout of the firm's senior technical staff has been building during spare time in the past 12 years. It is an exquisitely finished piece of work, made exactly as the prototype. Mr. Grout is a keen amateur yachtsman and has built in his garden at Luton his own full size dinghy and taken it by trailer to the East Coast. His father, before him, Mr. John Grout, technician and instrument maker, worked for Messrs. George Kent, Ltd.

3½in. Gauge "Royal Scot"

On display from the secretary's work was a bogie for Austerity locomotive—2-8-0 for the War department. A clean simple job—the scale was ¾in. to the foot, and Mr. Terry made his own hexagon screws. That comes of being an instrument maker by trade! The illustration, Fig. 5, shows the bogie of Mr. George Archer's 3½in. gauge "Royal Scot" class locomotive named "Grenadier Guardsman." The model is being built from drawings supplied by the L.M.S. Railway, and he hopes to copy the prototype as nearly as possible. Readers will be interested to know that the bogie is all built up and has complete brake gear, the wheels being cast from Mr. Archer's own patterns. The chassis and boiler are now finished, and the chassis has complete working steam brakes, sand boxes, etc. (Fig. 6).

From a boy Mr. Archer has been brought up in the "engineering" tradition. His first model—a Lancashire weaving loom—worked "reasonably well," and after this he built a model bleaching machine and model spinning mule—also his own 3in. lathe before he was 18 years of age. Later he modelled the Isle of Man steam packet *Viking*, also a tug and model tramp steamer, and then

Fig. 6.—A partly finished model of the "Royal Scot" Grenadier Guardsman, the work of Mr. George Archer.

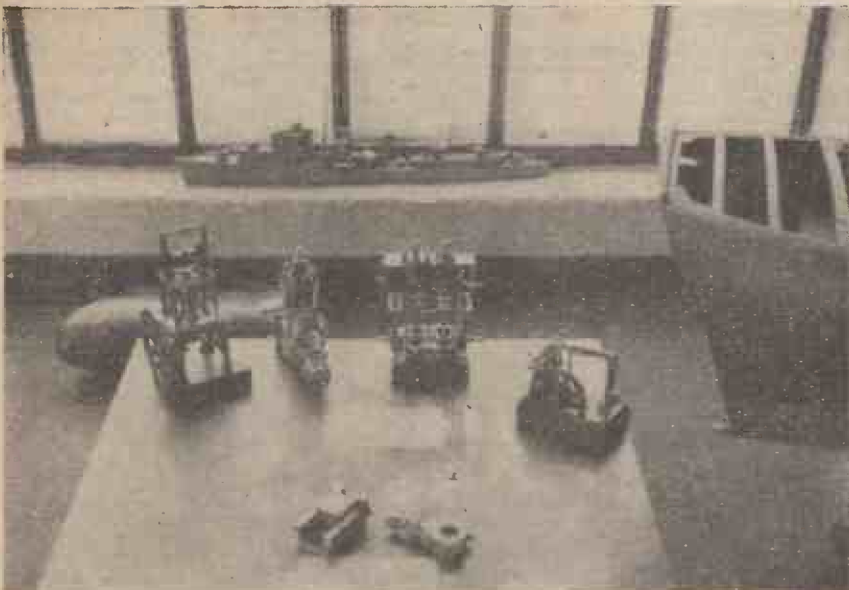


Fig. 7.—A group of models at the exhibition, including the work of a previous "Model Engineer" championship winner—Mr. Wyatt, of Norwich. In the foreground are the ram, coupling and ball screw—parts of the Rhodes 3½in. single-action press which is being made by Mr. Stanley Hills.

turned his interest to locomotives!

Model Torpedo Boat

The model motor torpedo boat *Christine* on display was constructed by Mr. A. Readman, aged 32, who works in the correction bay of the steering gear department. The model is driven by steam at a pressure of 60lb., has 5in. pitch propellers, a compound piston valve engine (⅜in. bore by ⅜in. stroke) a petrol-fired boiler, and a speed of about 10 knots.

The work of a previous winner of the "Model Engineer" championshhip—Mr. Wyatt, of Norwich, was on view. He had made a "Vosper" launch engine (compound), 5 c.c. 2-stroke petrol engine, grasshopper engine, and Maunsell table engine (Fig. 7). His winning "Model Engineer" model was of a coaling crane.

Another "Model Engineer" winner—Mr. J. Hudson, who won the M.E. silver medal with a vertical engine in 1936—had on display a 3½in. gauge 0-6-0 chassis for an L.M.S. tank locomotive.

It was disappointing that so little could be on view of the Rhodes 3½in. single-action press—the work of Mr. Stanley Hills, who is assistant foreman in the main tool room. Every detail of this press is scaled down to .0005in. and when finished it will be complete with forming tools (model Desoutter die sets). When cast the block weighed 47 pounds, and it will weigh 3½ pounds when completed. Mr. Hills is making this magnificent model effort on a little 3in. lathe, and it is all the more creditable that he has not long been a model maker. At the time of the exhibition, Mr. Hills was only able to put on view the ram, coupling and ball screw.

When one learns of the models in the course of production—the 3½in. gauge Austerity locomotive of Mr. Ken Terry (being made from his own drawings), the 3½in. gauge Royal Scot, which his father, Mr. H. Terry, a real old-timer, is attempting, the model Waygood-Otis lift of Mr. J. Burgess, and the traction engines of Mr. Len Christian and Mr. Bran Howard, one realises the tremendous enthusiasm there is in this newly formed society.

Other Activities

At the invitation of Commander Kent, a small party from Bassett-Lowke, Ltd., including their managing director, Mr. W. J. Bassett-Lowke; the works director, Mr. P. F. Claydon; and sales manager, Mr. W. H. Rowe, visited the works on the day the model workshop was opened, and Mr. Lowke spoke to the members and their friends on "The Progress of Transport by Water," illustrated by a series of 100ft. to 1in. waterline models of ships, and an encouraging discussion followed.

Since the opening of the workshop the society has held another exhibition, this time on the occasion of the works annual sports. The attraction of a tent full of exhibits was enhanced by a passenger-hauling locomotive running on a track on the sports field.

Members sent models for exhibition at the show given by the Murphy Radio Model and Experimental Society in September, and a further effort is being made in December when a combined exhibition will be staged in Luton by the societies of the Vauxhall Motors, George Kent, Ltd., and other firms in Luton.

Letters from Readers

Making a Barograph

SIR,—Our attention has been drawn to the article on "Making a Barograph" commencing on page 366 of your August issue, in which is stated: "The pen can be purchased complete with detachable 'V' type nib and tension spring from the Cambridge Instrument Co., Ltd." We have as a result received a number of enquiries for these pens, but regret that owing to the extreme pressure upon our Works for urgent Government orders we are quite unable to supply these small parts.

These pens form part of a complete Cambridge Instrument, and we are not able to supply them separately. We should like to suggest that in order to save your readers disappointment, you may care to publish this note stating that these pens are not now obtainable from us.—CAMBRIDGE INSTRUMENT CO., LTD. (Cambridge).

SIR,—With reference to the letter that you have received from the Cambridge Instrument Co., Ltd., concerning their inability to at present supply recording pens suitable for the barograph described in my article appearing in the August issue of PRACTICAL MECHANICS.

It is perhaps not surprising in view of the labour difficulties prevailing at the present time that they wish to conserve such small stocks of spare pens solely for the maintenance of their own instruments which are in use in many Government factories.

However, in view of the interest that this article has aroused, I have to-day located a suitable alternative supplier of barograph pens and nibs. The name of the firm is: James Lucking & Co., Ltd., 5/7, Corporation Street, Birmingham, 2.

They have shown me their stock of nibs and pens; the latter are in two varieties. One is a plain flat arm which can be screwed or sweated to a brass bush fixed to the pen axle; the other is provided with a short pivot pin for hinging the pen at the axle end. The reader should state which type he prefers when ordering. The price of the pen complete with nib is 6s. 3d. or the nib only is 3s. Messrs. Lucking & Co., Ltd., inform me that they will be happy to supply any readers who apply to them direct.

I should also like to take this opportunity of informing readers that the principal manufacturers of barometer capsules or aneroids are Negretti & Zambra, or Smith's Aircraft Instruments, but there is no guarantee that supplies are available at the present time. Should any difficulty be encountered the author of the article referred to will gladly help in locating alternative suppliers.—E. H. JACKSON (Newcastle-on-Tyne).

Model Racing Cars

SIR,—I have been reading with interest in your June issue Mr. G. H. Dearson's description of a model racing car.

I am pleased to think this form of model is becoming popular in this country. I have two cars, one being American and the other is just about on the last stages of construction. If I was not in the Service it would have been finished long ago. I was in the States in 1941 and 1942 and saw quite a lot of this type of sport. Their tracks are quite good too.

Mr. Dearson spoke of their speeds; well, their record stands at something like 110 m.p.h.

The car which I have is fitted with a 10 c.c. Tornado engine which turns over at 10,000 revs. It has a 2/1 reduction to the road wheels. In other words, it can get a move on! The other car I am building is to try and beat the 110 (I hope!). Anyway, that was my idea of building it. I am afraid it will be some time before I can complete it.

These few points on the type of engines the Americans are using might be of interest. They have in most cases developed engines to suit the requirements of the race track. In other words, they are built more robust than the aero engines. The weight complete with flywheel is about 24 oz., flywheel taking up 12 oz. of this weight. Revolutions are between 10,000 and 15,000. They are fitted with rotorary valves in the crankshaft. All are of the 10 c.c. class. (There may be a few smaller, but not where speed is required.) Price about $24 or £6. I have designed and built a 10 c.c. on similar lines and the results are quite good. My idea is to try and manufacture these engines to sell at a price which meets most pockets.—F. FRANCILLON (Preston).

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.

Pectin Extraction

I UNDERSTAND that pectin may be obtained from fruit and vegetables, and that apples contain quite a lot of it, but I feel that this would be a waste of time as I want to make it into sodium pectate by dissolving in NaOH solution.

Would you therefore please suggest some suitable vegetable, and the method of obtaining the pectin from it ?—J. K. Page (Guildford).

PECTIN is contained in a large number of fruits and vegetables, and also by some roots. It is present in apples, citrus fruits (the two commercial sources of supply), carrots, turnips and beans. It is also present in beet, the dried pulp of the sugar beet containing about 25 per cent. of pectin.

As already indicated, commercial pectin is obtained from the pulp of apples or citrus fruits. It is extracted either by a process of enzymic hydrolysis, or by the carefully controlled acid treatment of the pulp. Apple pectin is obtained as a brown powder; citrus pectin is produced as a white powder which has been precipitated from its solution by the addition of alcohol.

In your case, we do not think you will find the task of pectin production easy. Your best plan is to extract your pectin containing pulp with warm (not hot) water. Add to the extract about 1 per cent. of its volume of pure hydrochloric acid. Leave the mixture to stand for a week or 10 days (with frequent shaking). Then neutralise with sodium hydroxide solution, which will give you a sodium pectate of reasonable purity, and which can be precipitated by alcohol.

Standard chemical literature contains but very sparse references to the production of pectin, but we think the following would be of much interest to you:

M. H. Branfort: "Critical and Historical Study of the Pectic Substances." (Food Investigation Report, No. 33. Department of Scientific and Industrial Research.)

The above is obtainable from H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2, or provincial branches.

Compound Anastigmatic Lenses

IS it possible to obtain a true anastigmatic effect by combining two compound anastigmatic lenses ? My object is to obtain shorter focal length (and presumably improved stop number) for use in my camera.

I realise that the length of the lens system will restrict the angle or field, but a narrow-angle lens is satisfactory for my purpose.

Also, is there an appreciable loss of light intensity in passing through glass, and would the loss in passing through such a long optical system be detrimental to the effective stop number ?—J. K. Page (Guildford).

WE cannot answer your query fully without an examination of the lenses in question. Generally speaking, two separate anastigmat lenses cannot be combined satisfactorily to obtain a combination lens of shorter focal length *unless* each separate lens has been specially made for that purpose. You will appreciate the fact that the two separate lenses may be by different makers and may be constructed to different formulæ. The only way in which this useful lens combination may satisfactorily be effected is by the combination of anastigmat lenses which are specially made for this purpose, as, for example, the very excellent Ross-Zeiss "Single Protar" lenses, which may be used either separately or in combination. These lenses are obtainable secondhand from any good photographic dealers, as, for example, Messrs. Wallace Heaton, Ltd., New Bond Street, London, W.1.

There is no appreciable loss of light caused by passage through optical glass, but there is definitely a light-loss due to partial reflection and scattering at the glass surfaces. It is for this reason that lens makers endeavour to construct their lenses with as few glass-to-air surfaces as possible. Other factors being equal, the lens having the fewer glass-to-air surfaces gives the more brilliant images. It is for this reason that single lenses (despite sometimes their distortion in non-astigmat forms) give their characteristically brilliant images.

Specially made "combinable" lenses, such as the ones above-mentioned, have only two internal glass-to-air surfaces. Hence their light-loss is extremely small and inappreciable. In a complicated optical system, having many glass-to-air surfaces, light-loss might become very appreciable.

Nicotine and Conine

(1) Could you give me any information regarding the preparation of nicotine and conine, also any method for the detection of finger-prints ? I would like to know the silver nitrate method if possible.

(2) Are there any books now obtainable dealing with the preparation, properties and effects of poisons, also is there a book dealing with finger-prints and their detection ?—A. Bosworth (Derby).

(1) Nicotine can be obtained by boiling tobacco or (better still) tobacco leaves with water for an hour. The brown extract is filtered off and concentrated to about a third of its bulk. It is then mixed with milk of lime so as to make a whitish liquid and distilled. The distillate is rendered acid by dissolving oxalic acid in it. It is then evaporated to small bulk and rendered alkaline by adding a strong solution of potassium hydroxide (caustic potash) to it. This liberates the nicotine. The alkaline liquid is then shaken up with ether, which dissolves out the nicotine. The ether can be evaporated off, leaving a brown mass of crude nicotine, or, alternatively, the other extract can be steam-distilled in a stream of hydrogen gas, by which means a fairly pure nicotine is obtained.

This extraction process is difficult to work out unless one has had adequate experience in chemical manipulation. Furthermore, nicotine is extremely poisonous.

(2) Conine can be prepared from the seeds of the Spotted Hemlock (*Conium maculatum*) by simple distillation with caustic soda. Grind up the seeds with double their weight of caustic soda and distil the mass from a hard-glass test tube. A few drops of a colourless oil, rapidly turning brown, will distil over. This is conine. It has a very peculiar and penetrating odour, and it is *very poisonous.*

(3) Books dealing with the subject of poisons and general medicinal chemicals are:

F. G. Hobart and G. Melton: "Concise Pharmocology" (7s. 6d.). A. Lucas: "Forensic Chemistry and Scientific Criminal Investigation" (18s.). P. May: "Chemistry of the Synthetic Drugs" (12s. 6d.). R. A. Witthaus: "Textbook of Chemistry, Inorganic and Organic, with Toxicology" (20s.). W. Autenreith: "Laboratory Manual for the Detection of Poisons and Powerful Drugs" (32s.). Barrowcliff and Carr: "Organic Medicinal Chemicals, Synthetic and Natural" (15s.). Driver and Trease's: "Chemistry of the Crude Drugs" (10s. 6d.). T. A. Henry: "Plant Alkaloids" (28s.). Also, any book on Materia Medica, Pharmacology and Forensic Chemistry.

Figures in brackets indicate the pre-war net prices of the above volumes. Possibly, you might be able to obtain some of them secondhand from Messrs. W. & G. Foyle, Ltd., Charing Cross Road, London, W.C.2.

We are not aware of any available volume dealing specifically with the investigation of finger-prints, but doubtless the above-mentioned booksellers will be able to put you on the track of one if such is at present obtainable.

Preparing Glycerose

WOULD you kindly inform me how to prepare "glycerose" from glycerol and from this mixture, fructose ?—G. J. Brealey (Stoke-on-Trent).

THE material named "glycerose" is, in reality, a mixture of glyceraldehyde and dihydroxyacetone. It is prepared from glycerine by carefully oxidising the latter with bromine water or *dilute* nitric acid, or, alternatively, by the use of hydrogen peroxide in the presence of ferrous sulphate.

For this purpose, diluted glycerine (water and glycerine, equal parts) is mixed with some ferrous sulphate (quantity immaterial) and concentrated hydrogen peroxide is slowly added. The temperature-rise of the mixture is controlled by immersing the vessel in cold water. When the reaction is over, the product is shaken with barium carbonate to remove iron and sulphuric acid, and the clear filtrate is very gently evaporated (preferably under reduced pressure and at the lowest possible temperature). The "glycerose" remains as a syrup.

It is difficult to obtain fructose from the glycerose mixture. The method, however, consists in heating the glycerose solution with 10 per cent. caustic soda solution, when it undergoes condensation, giving a mixture of sugars, including alpha-acrose, which is *inactive fructose*. It has practically the same properties as fructose, but is optically inactive. It may be purified by recrystallisation after decolorisation of the parent solution by animal charcoal. The yield produced by this method of synthesis is but poor.

Plaster of Paris Castings

I AM desirous of casting a few models in plaster of paris, and shall be glad if you will answer the following queries:

(1) What is the best method of imparting a glossy white finish on ordinary commercial plaster of paris ?

(2) What is the nature of filler used prior to painting ?

(3) What are the best paints, dyes and varnishes used for finishing ?—L. Pearson (Walsall).

THE best way to get smooth castings in plaster of paris is to have perfectly smooth moulds, and to use a plaster which has been freed from lumps and reduced to the smoothest possible "cream." Unless the mould sides are highly polished, such a plaster will set to an "eggshell" surface, that is, a non-glossy surface, in which case your best plan is to brush size water over the plaster and then, after it has dried out, to paint or enamel the article. A suitable size water is made by dissolving 3 parts of gelatine in 97 parts of hot water.

Size or gelatine are common fillers in plaster work, since these set to an impervious film and thus clog up the pores of the plaster, thereby preventing the absorption of the paint by the plaster.

Provided that a plaster article has been suitably sized, almost any type of "fine" paint, enamel or varnish will suffice for surface colouring and treatment. Cellulose paints (obtainable in many proprietary varieties) are very popular because they can be obtained normally in very bright shades; they dry rapidly, give a good gloss and are reasonably waterproof and water-repelling.

Sizes containing 5 per cent. of gelatine (5 parts gelatine in 95 parts water) can also be used. They must be used hot.

If a plaster article which has been gelatine sized is brushed over with a solution made by mixing equal volumes of water and commercial formalin solution, the formalin will completely insolubilise the gelatine in the pores of the plaster, making it completely water resistant. This treatment before painting is advised for high-class articles.

Asbestos Tiles : Iron Cement

CAN you please supply the information ?

(1) Composition of asbestos tiles and method of making same.

(2) Composition of "iron cement."

(3) Any substance for mixing with clay to make it set rock hard, without baking or using cement, plaster of paris, or lime.—"Querist" (Delabole).

(1) ASBESTOS tile material is usually compounded from a cement-asbestos mix. Mix one part Portland cement with three parts of asbestos powder (obtainable from Turner Brothers Asbestos Co., Ltd., Rochdale, Lancs), slake the mixture with water in the usual manner and allow it to set in suitable shallow moulds. If required, you can incorporate a proportion of dry earth colour, such as red oxide, in order to colour the tiles.

(2) There are numerous varieties of "iron cement." None of them is very satisfactory. If you want a cement for joining iron to iron the following has been recommended:

Mix together 60 parts (by weight) iron filings, two parts sal ammoniac and one part flowers of sulphur. Make into a stiff paste with water and use at once.

Another similar cement is made by preparing a stiff paste of litharge and glycerine. This must be used at once, as it sets rapidly.

Another cement is said to be made by taking equal parts of sulphur and white lead, and by adding to this mixture about 1/6 of its weight of borax. For use, the mixture is wetted with strong sulphuric acid and applied between the two contacting pieces of iron. It sets in about five or six days.

(3) The only clay-setting material which would possibly suit your needs would be a thermo-setting resin, such as is prepared by Bakelite, Ltd., Grosvenor House, London, S.W.1. This resin powder could be mixed with the clay and then treated with acid in the cold, after which it would set to a hard mass within a few hours. The process is patented, but Bakelite, Ltd. would supply you with the necessary materials.

You could, of course, impregnate the clay with a solution of hard pitch in benzene, and, after the benzene had evaporated at normal temperature, the hard pitch would bind the clay together, but this process would blacken the clay, and would, therefore, presumably not suit your requirements.

Polish for Concrete Floor

I SHALL be obliged if you could give me the following information:

I desire to make a paste for polishing concrete floors, similar to some commercial polishes (which are in short supply), and should be glad if you would give me a formula for both red and green. If the materials are in short supply, can you suggest where they may be obtained?—W. Houghton (Bolton).

FLOOR polishes of the type you refer to are essentially mixtures of waxes dissolved in suitable solvents and dyed by the addition of a little wax-soluble dye.

The best solvent to use is an approximately 50 : 50 mixture of turpentine and white spirit, but since genuine turpentine is nearly unobtainable you will have to rely on white spirit plus a little linseed oil (raw) if you can procure any of it. If these solvent liquids are not obtainable you will have to make use of ordinary paraffin.

As regards the wax component of the polish. The most suitable waxes are beeswax and carnauba wax. Beeswax is soft, but it spreads easily. Carnauba is the hardest of the waxes, but it does not spread easily. It gives a brilliant polish when mixed with approximately equal quantities of beeswax.

To make a wax polish, therefore, melt down in an iron pan an approximately 50 : 50 mixture of beeswax and carnauba wax (the mixture can be cheapened somewhat by including a proportion of ordinary candle or paraffin wax, if desired). Then slowly add to the melted mixture about 6 or 7 times its weight of solvent. Stir well, and allow to cool. If the product is to be coloured, add to the molten waxes about 0.5 per cent. of their weight of a wax-soluble dye, which latter may be obtained in small quantities from Messrs. A. Boake, Roberts & Co., Ltd., "Ellerslie," Buckhurst Hill, Essex, or from Messrs. Harrington Brothers, Ltd., 4, Oliver's Yard, 53a, City Road, London, E.C.1. It is possible, also, that you might get some wax-soluble dyes from Messrs. Towers, Laboratory Furnishers, Chapel Street, Salford.

The waxes may be obtained from Messrs. Harrington Brothers & Co., Ltd., above-mentioned.

All the ingredients above-mentioned are in short supply, but waxes have recently been partially de-restricted.

If you find that your finished polish "fingermarks" too much, remelt it, and add more of the carnauba wax. If it is too slippery, when polished, add more beeswax or paraffin wax to soften it down.

Modelling Clay

COULD you give me a formula for the manufacture of modelling clay that will not harden by air-drying? What actually interests me is a suitable substance to be used for children's modelling sets, that will keep malleable quasi permanently.

I tried kneading dry clay with glycerine, but it was not a success. I presume that colouring the clay with aniline dyes will not be harmful to such users as careless children?—C. G. Anastasiadi (Alexandria).

QUITE a good plastic composition can be made by kneading dried clay (mixed with a suitable pigment) into glycerine. A large amount of clay must be worked into the glycerine. The process is a tedious one, but it can be made perfectly successful.

A better formula, however, is the following:

Clay, 6 parts (by weight).
Grease (such as Vaseline), 24 parts.
Paraffin wax, 11 parts.
Rosin oil (or similar), 1 oz.

Melt the grease, wax and oil together. Keep the liquid just molten and work the clay into it. Mix a suitable pigment colour with the clay, if desired.

Another formula which is said to be effective is:
Kaolin or Clay, 6 parts (by weight).
Flour, 1 part (by weight).

Mix the above with suitable pigment colour. Then gradually stir it into:
Melted paraffin wax, 2 parts.
Medicinal liquid paraffin, 1 part.

Colouring clays with aniline dyes is not to be recommended. Whilst some of the dyes are harmless, the majority of them are more or less poisonous, so that products containing them should not be handled by young children. All these plastic clays are best coloured by the addition of mineral pigments, such as ultramarine, ochres, red oxides, and the like.

"Golden" Lacquer

I SHOULD be glad to have your advice regarding the composition of a cellulose yellow lacquer. I wish to make up a small quantity for my own use.—A. A. Tyler (Colchester).

YOU can make a yellow or golden lacquer of the type you require by obtaining from your local paint shop a small quantity of a clear cellulose varnish and by incorporating into this a quantity of a yellow bronze powder ("Pale Gold") such as is obtainable from Messrs. Johnson & Bloy, Ltd., Metana House, Hind Court, Fleet Street, London, E.C. The bronze powder is rather expensive, costing about 30s. per lb., but, no doubt, you only require a small amount of it.

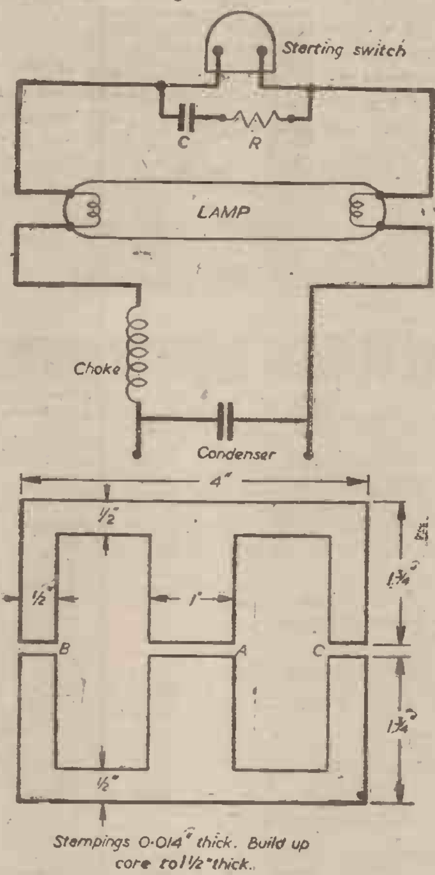
If you are unable to obtain cellulose varnish you can make it for yourself by dissolving scrap celluloid in a mixture of approximately equal volumes of acetone and amyl acetate. Alternatively, you can dissolve scrap celluloid in "Cellusolve," a clear liquid, obtainable (as are also the previously-mentioned solvents) from Messrs. A. Boake, Roberts & Co., Ltd., "Ellerslie," Buckhurst Hill, Essex.

Fluorescent Lamp Circuit: Choke Stampings

COULD you please give me the circuit diagram for an Osram 80-watt fluorescent lamp, and answer the following questions?

(1) Why is a choke necessary for these lamps?
(2) Will a resistance, such as a filament lamp, serve the same purpose?
(3) Do you think one of these lamps would be suitable for domestic use, say, in a large room where normally a 100-watt lamp would be used?
(4) I have a large number of stampings (as shown in sketch, not reproduced), which I think would be suitable for building a choke. Could you please tell me the thickness of core required, number of turns of wire, and gauge and type of wire?—D. A. Pope (Birmingham).

(1) A choke coil is necessary to reduce the lamp voltage when this has started up, as such lamps require a higher voltage for starting the discharge than under normal running conditions.



Circuit diagram for a fluorescent lamp, and details of choke stampings.

(2) Starting operations would not be as good with a resistance instead of a choke and there would be a considerable waste of power in the resistance. If a resistance is used this should have a value of about 140 ohms for a 230-volt supply and should be capable of carrying 0.8 amps.

(3) The lamps are suitable for domestic lighting.

(4) We are afraid the core which you have would be too small for a choke for the 80-watt lamp and suggest you use instead a core having a cross sectional area of about 1.5 square inches, as shown in sketch. Allowing for the fact that the volt drop across the choke will not be in phase with that across the lamp, and since the lamp requires approximately 115 volts with 0.8 amp. under working conditions, we suggest the choke be designed to have approximately 190 volts drop with 0.8 amp.

Allowing 10 per cent. for insulation between stampings gives a net cross sectional core area of 1.35 square inches. The core could be worked with a maximum magnetic flux density of 65,000 lines per square inch so the total flux through the core will be 88,000 lines. The volt drop across the choke (V) is $4.44 \times s \times f \times \Phi_M \times 10^{-8}$, where Φ_M is the maximum flux, s the number of turns, and f the supply frequency.

Then $s = \frac{190 \times 100{,}000{,}000}{4.44 \times 50 \times 88{,}000} = 980$ turns. With a current density of 1,500 amps. per square inch 22 s.w.g. will carry 0.92 amp., so the coil could be wound with 980 turns of 22 s.w.g. enamelled wire, winding on two layers of paper after each two layers of wire. The number of amp. turns needed to create a flux density of 65,000 in transformer steel is less than 10 per inch length of magnetic circuit, quite a negligible value compared with the 785 amp. turns in the coil. It is, therefore, necessary to introduce air gaps in the core between the two sections. The R.M.S. amp. turns required to create maximum density 65,000 in air is $0.32 \times 0.7 \times 65{,}000$ per inch $= 14{,}600$ per inch. The total air gap needed to limit the flux density to the required value will then be slightly less than 0.055 inch. This could be obtained by separating the core halves by strips of mica or hardwood at the points B and C. A certain amount of adjustment is available. We suggest you start with a smaller gap and increase this slightly until you obtain 0.8 amps. with 115 volts at the lamp.

Tinning Brass Articles

RECENTLY I discovered, in my workshop, a stick of pure tin which I had mistaken for solder.

This discovery recalled to my mind a method which I used to employ for tinning brass articles. The granulated tin and the work were immersed in a copper bath containing water and a solution of chemicals, and the water gently boiled for an hour or so.

Unfortunately, I have forgotten the other chemicals, and noticed that the solutions given in a recent issue of "Practical Mechanics" both specified tin chloride. Could you suggest an alternative when pure tin is available?—J. O. N. Burrows (Weymouth).

THE method of tinning which you described is not very reliable, neither does it give a thick coating of the metal. However, here is the method which you require, but we give it without guarantee:

Caustic soda	12 ozs.
Stannous chloride ..	4 ozs.
Common salt	1 oz.
Water	1 gallon.

Place a few tin or zinc strips on the bottom of an iron or copper pan and over this place an iron wire mesh a little raised above the aforesaid strips. The work to be tinned is well cleaned. Then it is placed on the iron mesh and the above solution is poured in, sufficiently to amply cover the work. The liquid is gently simmered for a quarter of an hour or so or until the work has become tin coated. The work is then removed from the solution, rinsed thoroughly in hot water and dried in hot sawdust.

A formula which gives better results than the above is:

Tin chloride	½ oz.
Aluminium sulphate ..	2 ozs.
Cream of tartar	2 ozs.
Water	1 gallon.

This is applied exactly in the above manner. The addition of 1 drop of strong sulphuric acid per gallon of the above solution is said to improve the tin deposit.

Damp Walls: Condensation

IN my home at certain times of the year I experience considerable trouble with damp walls, "bubbled" wallpaper and streaming windows as the result of condensation.

I shall be very grateful to you for any information that will enable me to overcome this nuisance. Would a layer of absorbent pulp cardboard under the wallpaper help matters? Could any advantage be gained by using a sealing solution on the exterior brickwork? Are there any good rules to follow with regard to ventilation?—J. D. Hughes (Harrow).

IT is quite impossible for us to help you in any definite way without having made an examination of the room and its surroundings in question. Indeed, you give us very little information. You do not tell us the dimensions of the room, the nature of its foundations, its walls or its average internal temperature. Neither do you tell us the general type and age of the house.

You see, all these details are essential ones in enabling us to visualise the exact type of trouble which you are having. You talk of "condensation," which implies that the room itself is at a higher temperature than usual. The remedy for this is fairly simple—lower the average temperature of the room. However, it is probable that the trouble lies deeper than this. If the house was built earlier than 1892 the whole trouble is due, most probably, to lack of dampcoursings. If you have these put in you may clear the trouble at once. Again, the outside wall may be cracked and otherwise faulty. It may lie up against specially damp surroundings. It may be subject to water leakages from gutters, etc.

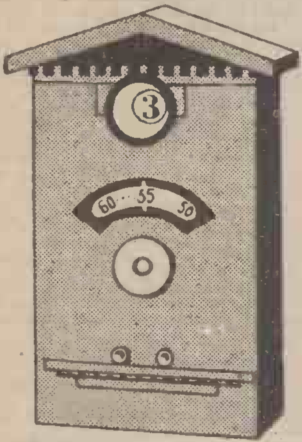
For the above and for other reasons it is really impossible for anyone to give you good and effective advice without having actually examined the room and its surroundings, and we do not propose to advise you to take any steps which would cause you expense and would probably give rise to disappointment.

One thing is certain: a layer of absorbent pulp cardboard under the wallpaper would probably make matters *much worse* instead of better, for there is nothing like this type of material for absorbing and holding damp and setting up mouldy growths. Do not have anything to do with this stuff.

Sealing solutions on exterior brickwork are expensive and useless. If the dampness is arising from the ground no amount of sealing solution will remedy matters.

The room should, of course, be properly ventilated, but assuming that it contains an ordinary fireplace and a window which can be opened at times, these factors will give good ventilation.

The only way in which you can get a permanent cure of the trouble is to have the room and its surroundings thoroughly examined by a *competent* property repairer or builder with the object of determining the root cause of the dampness. Once found, the remedy is relatively simple. We ourselves do not think that the dampness which you complain of is due to simple condensation of moisture on the inner walls of the room.



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Editor : F. J. CAMM
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Comments of the Month By F. J. C.

How Many Cyclists?

IT has always been considered that there are, in this country, over ten million cyclists and this figure received substantial confirmation by the War-time Social Survey, conducted last year for the purpose of supplying certain Government Departments with statistical details. The survey covered all parts of England and Wales and it also comprised all sections of the community, covering factory workers, agriculture, distributive trades, building and transport, mining, clerical, managerial, professional, housewives and retired.

A cross-section of the community embracing these sections and numbering 2,862 persons were interviewed. They were all above school leaving age and it was found that 26 per cent. of them owned bicycles and a further 3 per cent. rode bicycles owned by others. At the time of the last census the number of people living in this country who were over school leaving age was 37½ millions and there were approximately 10 millions of 14 years of age and under.

The survey states that the highest proportion of cyclists is found in East Anglia, the South and the Midlands, whilst Wales and Scotland figure at the bottom of the list. More people ride bicycles in the South of England than in the North. About 57 per cent. of all cyclists reside in the area covered by the Midlands, North Midlands, East Anglia and the South, but excepting London. Only a small part of the population resides in that area. The report states that 27 per cent. of the workers interviewed cycled to work regularly, and 69 per cent. of them used bicycles for this purpose, but not regularly. From this it is assumed that five million workers in this country are regularly using bicycles as a means of transport between their home and their place of business. Workers in rural areas who use bicycles exceed those in urban districts. The proportions given are 47 per cent. and 23 per cent., while agricultural workers total 51 per cent. as against 29 per cent. of manual workers and 22 per cent. of non-manual workers.

Pleasure cycling is undertaken by more non-manual workers than manual workers. Of those in the non-manual class 58 per cent. cycle to work and 74 per cent. use bicycles for pleasure. Among manual workers the proportions were 75 per cent. and 55 per cent. respectively. Only 18 per cent. of those interviewed stated that they used bicycles for leisure purposes.

There are many more men cyclists than women. Of those interviewed 42 per cent. were men and 58 per cent. women, although of the numbers who owned bicycles, 62 per cent. were men and 38 per cent. women.

These statistics should be of enormous value to the cycle trade, for it indicates areas which at present are flat-spots and need developing, as well as the busier areas where there is room for more cycle agents, more cycle repairers and better distribution.

The report does not state how many cyclists are club cyclists, but it is assumed that only about 50,000 of them.

Road Accidents

WE think the statistics issued by the Ministry of Transport relating to road accidents are well presented, in that they give the types of vehicle involved in the accidents. For example, road casualties in August totalled 14,758, including nearly 4,000 killed or seriously injured. The figures were: deaths, 488; seriously injured, 3,452; slightly injured, 10,818.

Compared with August of last year, there were 13 fewer deaths, but 626 more cases of serious injury. Accidents during hours of darkness were considerably higher than in the blackout at this time last year and more than double the number in July of the present year.

Fatalities among child pedestrians and child cyclists numbered 95. Though less than the number in recent months, this is still above the pre-war average.

The following table is an analysis of the number of deaths according to the type of vehicles primarily involved :—

Type of Vehicle	Number of Deaths.
Service (British, Dominion, and Allied of the three Services)	87
N.F.S.	2
Public Service and Hackney ..	76
Goods	84
Private Cars	93
Motor Cycles	55
Pedal Cycles	77
Others	14
	488

The term "vehicle primarily involved" means where more than one vehicle was concerned, the vehicle to which the accident appeared to be primarily attributable. In no case does it imply that the driver of the vehicle was culpable.

It will be noted that Service vehicles head the list. These are grim statistics, and now that all of the bodies interested have had their say and made their recommendations, we hope that the Ministry of Transport will be able to evolve some plan to reduce the risks of the road. There will always be careless people, and so road casualties cannot be entirely effaced. It is obvious, however, that all sections of road user will have to make concessions for the general good. In this connection the remarks of Mr. G. N. Wilson, chairman of the British Road Federation, are of interest. We give them below:

"Better and Safer Roads" Exhibition

Luncheon—October 3rd, 1945

"THE problem of rebuilding is the same in all parts of the country, though it is brought out with particular vividness in areas which have suffered from bombing. The people need homes and with their homes they need all the ancillaries that go to make up a pleasurable and worth-while mode of living. Amongst these, roads are a prime essential. If I may be allowed to adapt an old proverb, we don't want to put the car before the house, but at the same time we must see that the house has an adequate road system to allow the car to approach it.

"Of major importance amongst the British Road Federation's proposals you will note the emphasis placed on the need to avoid congestion in the cities. There is clearly no one way to achieve this object. It is a matter of painstaking approach from many angles. Roads must be provided to cope with fast through traffic; parking places must be provided to ease the strain on the streets; pedestrians must be aided to move in comfort and safety from one side of the street to the other. Above all, measures of safety must be applied to reduce the accident rate.

"When we come to roads beyond the city confines, the British Road Federation has, for a long time, been fighting the battle for motorways, a battle, as you know, that has met with some measure of consideration in Government circles. We want those motorways constructed and we want them quickly. But the motorway system must be countrywide. As you will have seen, it must link Bristol with Birmingham and the Midlands, and with Manchester and the industrial North. To take simple examples, what helps you will help Manchester's cotton and Coventry's vehicles.

"Especially, however, do we want to see London and Bristol linked by a motorway with an extension to South Wales. No one has been more pleased than myself to see that the building of the Severn Bridge remains in a high priority category. I have heard that the site suggested by the Gloucestershire Highway Committee, between Aust and the Beachley Peninsula, has been approved. If this proposal ultimately receives parliamentary sanction, the saving between Southampton, Bristol and Cardiff by such a bridge would be no less than 54 miles, whilst that between London, Bristol and Cardiff would be 9 miles.

"But let me emphasise that in building motorways we need not and we must not spoil the countryside. With the modern landscaping approach there is no reason whatever why we should. Moreover, by attracting fast traffic to motorways, we shall allow our existing road system to perform the function for which it was originally constructed.

"The farmer's needs must be remembered, and the minor roads should be adequately cared for. But let us leave it at that; they are part of our land and must be preserved in their beauty.

"There is little time to lose in all these plans. Although the output of all types of cars is restricted to-day, I don't think it will be long before the flood commences at full spate. To take a local example, we must ensure that when the bore comes on us, the river bed is wide enough to absorb the maximum pressure."

Barnard Meet President Dies

PRESIDENT of the noted Barnard Castle Meet in 1937, Captain C. D. Pickersgill, is reported to have died of malaria in a Japanese prison camp two years ago.

Competition from Moscow!

REPORTS from Moscow indicate that one of the largest fighter-plane factories in the U.S.S.R. is to be turned over to bicycle production.

Dukinfield Diamond Dinner

ONE of Cheshire's oldest clubs, the Dukinfield C.C., appropriately celebrated its Diamond Jubilee with a dinner dance which attracted many members and friends.

In Burma Now!

WITH the formation of the South Burma Road Club—the latest Forces club—the world-wide network of cycling enthusiastic exiles has reached another point.

Lion Forces News

AT the close of the war it was known that 51 members of the Lion Road Club were serving with the Forces: two had made the supreme sacrifice. The clubs annual dinner fixed for January has been postponed but the fresh date will be known later.

Freed from Japs

TWO prominent South Yorkshire cyclists are reported safe and well after being in Japanese prison camps. They are Harold Dawson, one-time member of South Elmshall Road Club, and Henry Ekins, successful Brodsworth track rider.

L. Puckering Safe

GEORGE FLEMING'S brother-in-law, Leslie Puckering, Belle Vue C.C., who was captured while serving with the Crown Forces at Singapore, is now in Australia.

Scottish Loss

J. CLIMIE, Douglas C.C., chairman of the West of Scotland Time Trials Association, has died.

Mine Host

TED AVERY, former hon. secretary of Bath C.C., has become Mine Host of an establishment in Bridgwater.

Eddie Roberts Safe

EDDIE ROBERTS, popular Fountain C.C. rider in pre-war days, who has been in Japanese hands in Siam for some years, hopes to be home by Christmas.

New London Club

LONDINIUM C.C. is the name given a new cycling club in North London which will cater purely for the tourist and hosteller, and will not affiliate to any controlling racing bodies.

Britain Making 1,500,000 Bicycles

MORE than 20,000 men are needed before the British bicycle industry can begin to cope with the present demand, states Mr. George Wilson, O.B.E., president of the manufacturers' Union.

"Europe alone wants millions of bicycles and bicycle parts," he says, "and the British industry is doing what it can with one-third of its pre-war personnel.

"Our present programme is 1,500,000 machines and two out of three of them are for export. The same quantity in parts is also proposed, and we hope to feed overseas bicycle assemblers with parts they previously obtained from Germany and Japan.

"We hope shortly to provide 100,000 for the Dutch Government and Dutch police. A further 100,000 will be earmarked for Denmark and Norway, and we are also ready to supply France's needs.

"These are up-to-date bicycles, with chromium plating and three-speed gears; handle bars, mudguards, and the size of wheels and tyres vary slightly from country to country. Apart from these, utility machines are going out to Europe through U.N.R.R.A. We hope that in due course all Europe will be riding on British wheels."

Irish Activity

THE North Belfast Temperance C.C. is again operative. Its activities were suspended during the war. The Ulster Ladies Road Club, the only one catering for an all-girl membership, is gradually returning to pre-war activity.

Some "12"!

ISOBEL ADAMS, Glasgow Nightingale C.C., has ridden 216 miles in an out-and-home "12." This is the greatest distance ever yet covered by a girl in an event of this kind.

Activity in Rutland

RUTLAND is the smallest county in this country but is an ideal cycling area. Yet it had no club until the R.A.F. Luffenham Road Club came into being. Many noted racing clubs are now represented in membership.

N.A.C.T. Back in London

THE offices of The National Association of Cycle Traders have been moved from Watford to 24, Newman Street, London, W.1.

From Halifax Planes to Tubes

AT Roote's No. 1 bomber factory near Speke, Liverpool, cycle tyres and tubes are being produced. Dunlops have taken over the extensive works which formerly turned out Halifax bombers.

Road Safety Chairman

G. R. STRAUSS, M.P., Parliamentary Secretary to the Minister of War Transport, has been appointed chairman of the Committee on Road Safety in succession to Philip Noel-Baker, M.P.

Southgate's War Record

SOUTHGATE Cycling Club are to prepare a book containing a review of the club's war contribution: over half the active members served with the Armed Forces. Three made the supreme sacrifice and two were prisoners of war.

Back Home

R. K. BRADDICK, who in 1938 represented Wales in the Empire Games and who left Wales for Nottingham just before the war, is leaving the Midlands for home. While at Nottingham he was a member of the Broad Oak Road Club.

Another Club

THE Essex County Bicycle Club is the latest club to be formed in Essex.

Scottish Assistance

FOLLOWING an appeal from Norway for hostel equipment to re-start the movement in that country, Scottish Y.H.A. have sent 250 beds and hope to send additional gifts in due course.

News of Cluff

FORMER Hon. Secretary of the Hitchin Nomads C.C. and well-known Hertfordshire official and speedsman, Quartermaster Sergeant Major Kenneth Cluff, who was taken prisoner at Singapore, is now in Australia.

Club for Bevin Boys

TOM COOPER, Highgate C.C., himself working in a Notts coalfield as a Bevin Boy, is attempting to form a club for those who have been directed to work underground.

Manchester Veterans

THE Manchester Branch of the Veterans Time Trial Association now numbers over 30 enthusiasts.

Scottish 12-hour Record

J. ALLISON, Musselburgh Road Club, broke the Scottish 12-hour record, previously held by Jack Taylor, West of Scotland Clarion, with a ride of 250½ miles.

Croydon Cycling Association

AN association of cycling clubs in the Croydon area—the Croydon and District Cycling Association—has been formed and is being well supported.

Death Confirmed

PREVIOUSLY reported missing following an operational flight over Germany, Flight Sergeant G. Phippen, Royal Air Force, of the Plymouth Corinthians C.C., has now been officially posted as killed in action.

Sussex Police Drive

A PUBLICITY campaign in Sussex designed to encourage the public to take greater care of their machines, has been launched by the Chief Constable. A plea is put forward for the padlocking of all cycles that are left unattended.

The Puncture Fiend

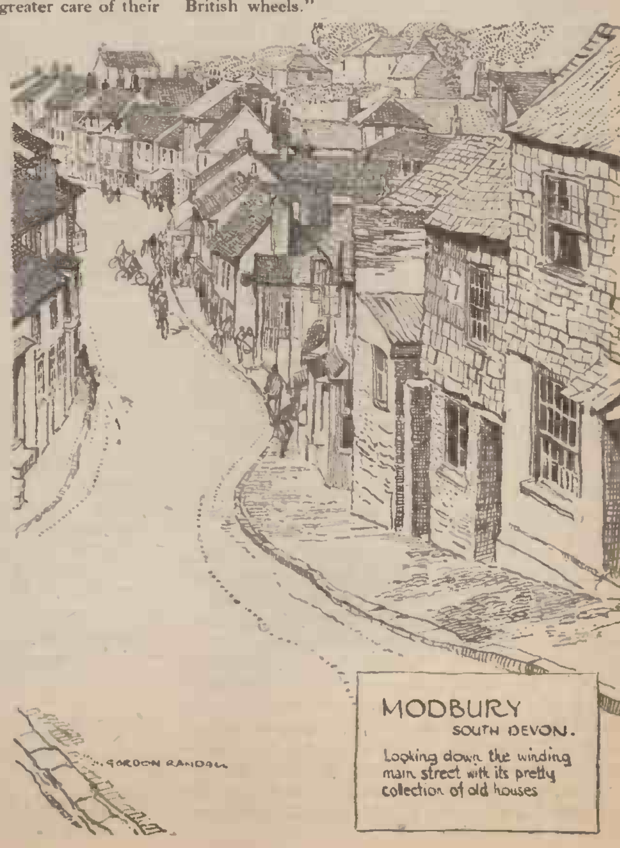
THE all-piercing flint is no respecter of persons. Ralph Dougherty, the famous Warwickshire crack, had three deflations in three-quarters of a mile when riding to start in an important event: B. Francis, another well-known Midlander, punctured twice in the first seven miles of an event making the eighth successive event in which he has met with tyre trouble.

A Super Ride

STANLEY BOULTER, Portsmouth North End, registered an amazing performance when he won the Regent C.C. Open "25" with the time of 1.0.52. In addition to winning the event by a three-minute margin, the performance represented a new course record over roads used extensively by clubs for the past twenty years and which includes many gradients.

South Yorkshire News

OF the 23 open events decided on a well-known local South Yorks course, 21 were won by South Yorkshire riders. Fifteen open events have been won by riders from the same area and more than twenty local men have ridden a "25" inside sixty-six minutes. Eleven of them beat sixty-four minutes and five beat sixty-three minutes. The best of the batch was Jack Simpson's 59 minutes 29 seconds.



MODBURY
SOUTH DEVON.
Looking down the winding main street with its pretty collection of old houses

Around the Wheelworld

By ICARUS

"Men and Women," or "Ladies and Gentlemen"?

"WHEN Adam delved and Eve span, who was then the gentleman?" This age-old question has been raised in the house journal issued by the C.T.C. to members. It is asked: "why on earth cannot we speak of ourselves as men and women?" Hickey, of the *Daily Express*, answers: "We can; but what are C.T.C. going to call their tandems—now d.g. (double-gents) and l.b. (lady-back)?" Why are C.T.C. members so resentful of being called ladies and gentlemen? Are they not ladies and gentlemen? Some of the cyclists I have seen disporting themselves in tea-houses are anything but that, and their conduct has been responsible for many notices which state, "No cyclists." Incidentally, why is it that the very lowest shacks are often selected as cyclists' officially recognised tea-houses? Some of them are insanitary hovels. I suggest that the C.T.C., so far from wasting its time debating whether a cyclist is a man or a gentleman, might do something to improve the status of cycling.

B.L.R.C. Progress

IN spite of all the hot air spoken by N.C.U.'ites, R.T.T.C.'ites and C.T.C.'ites against the British League of Racing Cyclists, and notwithstanding the vacuous nonsense spoken by ill-informed journalists at club dinners against this modern and much-wanted development in cycling sport, the league continues to progress. In December, 1942, it had 210 members. In December, 1943, there were 384 members, in December, 1944, 527 members and at August, 1945, 752 members. It is confidently hoped that the first 1,000 mark will be reached by December of this year. As every member of the British League is vitally interested in road sport of the massed-start type and a high percentage of its members partake in those races, it has thus become a more representative body, as far as the sport is concerned, than the N.C.U., which exists to control track racing only and the few hundred licensed riders who indulge in this form of sport. The rest of the membership of the N.C.U. are not interested in track sport, but have joined as associates or private members so that they may receive the benefits of touring and legal advice. About 2 per cent. of the membership of the N.C.U. are interested in track racing. The league has been responsible during the year for promoting highly successful road events, which have received far greater publicity in the daily papers than any event promoted by the N.C.U. or R.T.T.C. and thus they have provided for cycling sport the publicity it has always needed, and which the narrow-minded, spiteful and parochial outlook of the National bodies (so-called) has failed to provide.

I can inform my readers that daily papers do not look with favour upon the cycling organisations because of the splenetic and phrenetic attitude which these bodies have adopted and it says much for the conduct of the league that it has been able to break this Gordian knot.

The Victory Race, organised by the league, was a great success, and everywhere the police co-operated. During the race an address was delivered at Buckingham Palace to the King and it has been suitably acknowledged. The dire results of running massed-start races on the roads, prognosticated by that small coterie who want to act as the dictators of the sport have not eventuated. How stupid they now look. There is a move on foot to heal the split. If there was a split it should be hailed, for it has at long last broken the shackles which have held cycling sport down and driven it into the hole-and-corner furtivity, which aptly describes time-trial methods. Cyclists have spent years "fighting for their rights" and yet have never had the courage before to insist upon their right to conduct time trials overtly. They have preferred the covert methods of the felon who is afraid of the police. That sort of outlook, so long continued and so long supported by the apostles of the past, must be expunged in the enlightened days of 1945.

Speed Limit in Built-up Areas

AS was expected, with the general restoration of street lighting, the Minister of War Transport has removed the speed limit of 20 miles an hour on roads in built-up areas during hours of darkness. The speed limit of 30 miles an hour on those roads now applies to hours of darkness as well as of daylight.

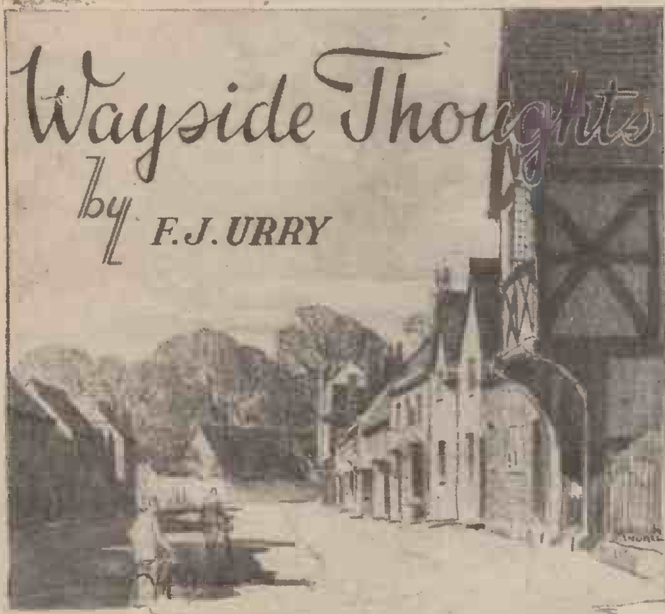
THE BRITISH ALL-ROUNDER COMPETITION—RESULT

1. J. Allison, Musselburgh Road Club						
Johnstone Wheelers	"50"	Sept.	6	2. 4.48	24.038	
West of Scotland T.T.A.	"100"	July	8	4.24.40	22.670	
West of Scotland T.T.A.	"12"	Aug.	19	250 m. 280 y.	20.875	
						22.528
2. A. Overton, Kingston Road Club						
Velma Road Club	"50"	July	1	2. 7.55	23.453	
Calleva Road Club	"100"	May	21	4.26.17	22.532	
Scuth-Western Road Club	"12"	July	8	281 m. 1,560 y.	20.990	
						22.325
3. D. Scott, Crawick Wheelers						
Clarion C. & A.C. (West of Scotland)	"50"	July	1	2. 4. 6	24.174	
Clarion C. & A.C. (West of Scotland)	"100"	July	29	4.40.11	21.415	
Ayrshire and District C.A.	"12"	July	22	245 m. 384 y.	20.434	
						22.008
4. A. E. G. Derbyshire, Calleva Road Club						
Barnsley Road Club	"50"	Aug.	12	2. 6.35	23.700	
Broad Oak Road Club	"100"	July	15	4.31.59	22.060	
Broad Oak Road Club	"12"	Aug.	19	240 m. 1,434 y.	20.067	
						21.942
5. D. K. Hartley, Dukinfield Cyclists' Club						
Stretford Wheelers	"50"	May	27	2. 6.54	23.641	
Bath Road Club	"100"	Aug.	6	4.32.25	22.025	
Manchester and District T.A.	"12"	Aug.	19	237 m. 770 y.	19.786	
						21.817
6. D. Hepplestone, Yorkshire Road Club						
Huddersfield Road Club	"50"	June	10	2.10.56	22.912	
Bath Road Club	"100"	Aug.	6	4.28. 2	22.385	
Polytechnic C.C.	"12"	Aug.	26	241 m. 234 y.	20.096	
						21.798
7. T. Love, Fullarton Wheelers						
Johnstone Wheelers	"50"	Sept.	16	2. 6.46	23.666	
West of Scotland T.T.A.	"100"	July	8	4.34.32	21.855	
Ayrshire & District S.A.	"12"	July	22	238 m. 22 y.	19.834	
						21.785
8. R. J. Maitland, Solihull C.C.						
Belle Vue C.C.	"50"	July	22	2. 7.42	23.493	
Leamington C. and A.C.	"100"	Sept.	16	4.37.19	21.636	
Birmingham T.T. League	"12"	Sept.	9	242 m. 44 y.	20.168	
						21.766
9. A. C. Harding, Middlesex Road Club						
Barnsley Road Club	"50"	Aug.	12	2. 8. 4	23.425	
Bath Road Club	"100"	Aug.	6	4.31.10	22.127	
Yorkshire C. Federation	"12"	Sept.	23	233 m. 45 y.	19.417	
						21.657
10. V. Callanan, Norwood Paragon C.C.						
Velma Road Club	"50"	July	1	2. 8.57	23.365	
Calleva Road Club	"100"	May	21	4.33.36	21.930	
South-Western R.C.	"12"	July	8	234 m. 1,258 y.	19.559	
						21.585
11. E. J. Whythe, Bath Road Club						
Marlboro A.C.	"50"	May	27	2.11.47	22.765	
Bath Road Club	"100"	Aug.	6	4.33.14	21.959	
Birmingham T.T. League	"12"	Sept.	9	239 m. 636 y.	19.946	
						21.557
12. N. A. Howe, Dukinfield Cyclists' Club						
Clarion C. and A.C. (Manchester)	"50"	June	10	2.10.41	22.956	
Bath Road Club	"100"	Aug.	6	4.34.47	21.835	
Manchester Wheelers	"12"	Sept.	9	238 m. 560 y.	19.859	
						21.550

TEAMS

1. Calleva Road Club							
A. E. G. Derbyshire	—	—	—	—		21.942	
D. S. Burrows—							
Marlboro A.C.	"50"	May	27	2. 9.16	23.208		
Westerley R.C.	"100"	Aug.	19	4.34.40	21.845		
South-Western R.C.	"12"	July	8	232 m. 1,754 y.	19.416		
						21.490	
L. C. Dunster—							
Barnsley R.C.	"50"	Aug.	12	2.11.32	22.808		
Bath Road Club	"100"	Aug.	6	4.33.43	21.920		
Birmingham T.T. League	"12"	Sept.	9	233 m. 1,648 y.	19.494		
						21.407	
							21.613
2. Altrincham Ravens C.C.							
C. Farebrother—							
Liverpool T.T. C.A.	"50"	Sept.	9	2. 7.24	23.548		
United Doomers	"100"	Sept.	16	4.36.36	21.692		
Polytechnic C.C.	"12"	Aug.	26	230 m. 1,100 y.	19.216		
						21.485	
R. Redford—.							
Norwood Paragon	"50"	July	2	2.11.14	22.850		
Broad Oak R.C.	"100"	July	15	4.39.27	21.471		
Manchester Wheelers	"12"	Sept.	9	238 m. 1,190 y.	19.889		
						21.407	
E. Woolley—							
Velma R.C.	"50"	July	1	2. 9.16	23.208		
Manchester Wheelers	"100"	June	24	4.38.30	21.544		
Polytechnic C.C.	"12"	Aug.	26	230 m. 1,046 y.	19.216		
						21.323	
							21.405

The foregoing is a provisional result, subject to official confirmation of certain performances, and to adoption by the R.T.T.C.—S.A.C.A. Joint Committee.



The Future Travel

I SEEM to recollect that, some years ago, when people in this country were beginning to see "the end of the beginning" of the late war, many of them were very optimistically talking about a fuller life with the standards of well-being marvellously extended. I read of these things and occasionally heard them expounded by people who seemed to think the gaiety of living was only a postponement and would arrive in full flood directly peace was declared. For the life of me I could not see that state of Utopia occurring, but, also, I was not greatly concerned for the well-being of my compatriots, always providing they on their side were prepared to face the facts and play the game to the rules those facts laid down. I think I said then that we should all be poorer when the war was history, but emphasised the notion that such a condition need not make us unhappy unless we allowed it to; and I still feel the same way about things, probably because my way of living has been on the simple side through following cycling. This subject came up recently among a group of friends, the majority of whom were bemoaning the recent statement by the Minister of Fuel that petrol supplies may be restricted because of the difficulty of paying for the stuff now that Lend-Lease has ended. Most of that group of friends were younger than I am, and when I mentioned cycling as an alternative means of pleasure travel they seemed shocked by the advice, just as if they had been invited to adopt a condition of movement which entailed a loss of dignity. It is to me a curious reaction of mind that dignity goes with wealth, or, at any rate, with a form ostentation that possesses neither healthy activity nor a kindly and comfortable observation of beauty. But then I suppose cycling and all it connotes is bred in me.

Differences

THE point I want to make here, as I did with my argumentative friends, is that the bicycle is almost entirely a native product. A bit of rubber, cotton, and maybe a trifle of leather are all the foreign substances it need contain. And the same thing can be said of the car, which is the reason why both articles are of such industrial value, representating, as they do, a high percentage of wages. The difference between them occurs when they are put in service. The bicycle may cost 2d. a month for lubricant, and a few coppers for lighting; but the car needs great quantities of petrol and oil, the major portion of which has to come from overseas. Now there's nothing wrong about that until the question of import economy is discussed, and then the car is not quite the valuable acquisition to Great Britain some people would have us believe. Most folk do not stop to think of the car in these terms, but they may have to yet. If only we could find a native fuel, as is the case in U.S.A., this problem would disappear. It is in this sphere that atomic energy may yet prove of greater value to us than the oil-producing countries. In the meantime I think if I were a cycle manufacturer I should add something to the slogan of "Ride a bicycle for health and pleasure," by stating "and for the benefit of your country." At the present time it is certainly another little satisfaction cyclists can legitimately claim, they are buying British and using British power. Were the positions reversed I feel quite confident that some motorists would "rub it in," and even go so far as to suggest the abolition of cycling. I want to see expansion of travel freedom everywhere provided it comes in fairness to all forms of road users; but naturally, being a cyclist, it automatically follows that these facts call for mention.

Poorer, but Happy

ACTUALLY, I do not think any great hardship will happen to the motoring fraternity, but I am still of the opinion that the enormous increase in such traffic we are told will occur to the private owner is just nonsense, Individually we are all poorer than was the case in 1939; I think that is the answer in a nutshell. But, as I said before and I repeat, that is no reason why we should be less happy, and a very good reason why we should be more healthy if we take to cycling and, having mastered that pastime, stick to it. I have been fortunate, for the service of a car has always been at my disposal since 1910, but except for really urgent journeying I have not the slightest use for it. It gives me no sense of pleasure, rather of boredom, similar to the boredom flying men say is their condition when the excitement of combat is over or non-existent. But put me on a first-class bicycle properly positioned and geared to my liking, and I'm a happy and healthy man. I think the reasons are manifold, but the overriding one is certainly activity, the pulse of the blood, the aliveness of the individual, and the mental awareness. It is symbolic of cycling to the fit rider, this freedom from purchased power, this sense of self-sufficiency that brings a man to his journey's end with satisfaction and appetite as the material awards, and the inner spiritual condition that the approach to beauty has been perfect. The material things please the youngster more, but if he continues in this way of wandering he will find, as he grows older, it is the beauty of the way, the acquisition of its intimacy that keeps a man a cyclist to the end of the story.

Badly Needed

WITH September in I was compelled to look at my lamps and, as usual, I found all the rear light batteries gummed into the tin cases. I know it's my fault for not removing the batteries during the summer months; but I ask, in extenuation, who does? What we need, we battery users, is a type of container that will not corrode, with electrical connections sufficiently robust to withstand vibration. Nor are we asking for anything impossible. As things are these rear lamp cases are a cheap and nasty thing, cheap in first cost may be, but very expensive when their replacement seems to be necessary every winter. My last purchase was a new nameless type in aluminium with a well-riveted steel plate (in and out) bracket, and it cost me 2s. 9d. complete as against the 3s. 4d. for the tin-plate type. How it will act has to be proven, but at least it will not rust, and I should imagine the slight corrosion of the metal will not make much difference. For a headlight this winter I think I shall go back to the old "Holophote," a Lucas oil-lamp with brass body, all riveted, which has not been made for thirty years, but when it was in production, it *was* made. It seems as good as ever, and its inch wick gives me a beautiful mellow light covering the width of a country road, a glow which I can and do reduce when I'm town riding. Why not a dynamo? you will say. Well, perhaps I'm old-fashioned; anyhow, I don't like them (I've seen so many of them go wrong) and I'm prejudiced as to the power they need from me to make them function. Anyway, why should I carry a dynamo set about when I don't need even a glim, which is during six months of the year. Yes, a battery lamp is very handy, and with the aid of the Holophote I should be well served if I could only buy well-made rustless cases to house the batteries.

Time of Year

AUTUMN is falling late this year, as is usually the case after a dampish season. At the beginning of September there were few signs in the Midland woods that the year was so far advanced, and it was only when you obtained a glimpse of the bleaching stubbles that the country scene proclaimed the calendar. But what a lovely time to go a-touring; the quiet misty mornings, the search for mushrooms to aid the meagre breakfast rasher, the golden glory of sunshine over the shaven fields or carving sharp shadows in the glen, and the perfect sunsets with all the hills blue violet in the depths of distance, and the near things lit with flame. I always envy people with holidays to come, no matter what the time of year, but I think that envy is more pronounced at the "back-end" when one's own releases have gone the way of all time, and the perfect September weather rests with the resting earth. I do not think I have ever seen so much grain, nor finer crops, and even my farmer friends seem satisfied with this bounty of Nature in this year of grace; which, with a fairly long knowledge of farmers and their comfortable grousing, is a good portent for the immediate food problem. Nor have I noticed in my local wanderings that there is any delay in getting the crops. Nearly all the corn was in by the end of August, and at least some of this clearance was due to the combine harvester which cuts, threshes and bags the grain as the tractor moves forward. Looking back over the years of war, we are apt to forget the immense strides the farmer has made in the mechanisation of his business. Only in the uplands of Wales and the Highlands can you see the horse still king of the furrow. Sometimes one regrets this startling change until one thinks of the land now under cultivation, a feat which would have been impossible without the aid of the tractor.

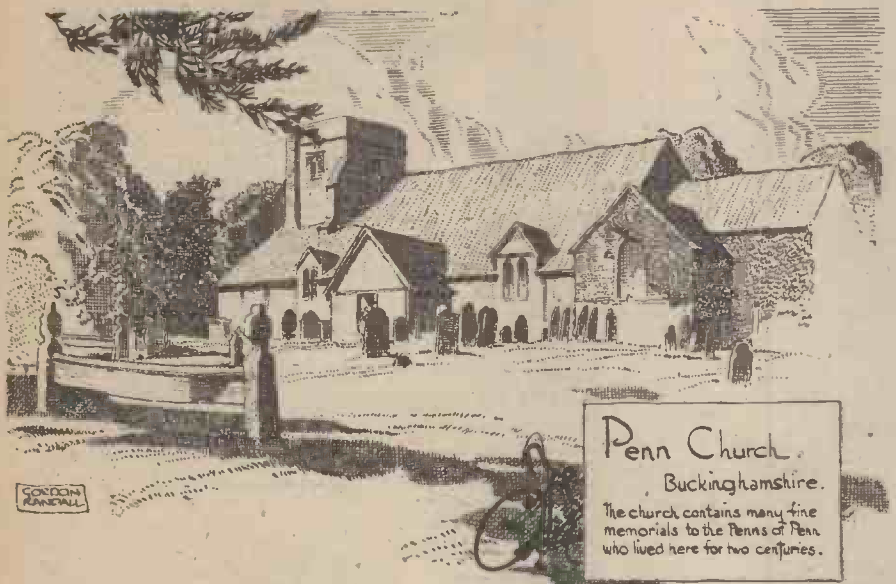
A Favourite

I HAVE just had my old John Marston Sunbeam "done up." In November it will be twenty-six years old, and as far as I can judge is running as sweetly as ever. Now that it has been rejuvenated it has the look of a high-class mount, though I am afraid it will be put to the low-class riding of the winter solstice. For when the days are wet and the roads are filmed with mud, the "little oil bath" case never makes a murmur at the conditions, the chain running as smoothly as it can only run under full protection, with an oil dip at each revolution. I have been lucky in this matter too, for some friends of mine had a pair of stainless steel rims to replace the old "Electron" which Dunlop made years ago, and which were worn out after more than a decade of winter roaming. Now I am searching for some good tyres to complete the process of rejuvenation, and no doubt I shall be lucky again, for I'm already promised help in this matter. Then I shall have a winter mount second to none in the world, for that was and is still my opinion of the old Sunbeam. One hopes that the new Sunbeam now made by the B.S.A. will equal or surpass the Wolverhampton products of five-and-twenty years ago, for there is a real need for such a mount. When supplies of the good goods are on the market again we shall see if the sound old name of Sunbeam reflects the glory of the past. At odd times I have been offered quite a lot of money for this particular machine, but no amount within reason would make me part with a bicycle that has served me so well at such little cost and with so small an expenditure of attention. That old bicycle has probably carried more mud home than any other machine I have owned, but whatever its appearance it has never grumbled or groaned, but just carried on with the job with a sweet response to the slightest muscular propulsion.

Low tide in the pretty little harbour.
YARMOUTH
ISLE OF WIGHT.
The boat is just leaving the pier-head for Lymington.

CYCLORAMA

By H. W. ELEY



Penn Church. Buckinghamshire. The church contains many fine memorials to the Penns of Penn who lived here for two centuries.

Back to the Clubs

ONE or two club secretaries have told me this week that quite a number of "the boys" are out of the Forces and have already made contact with their old clubs. And the returning boys would be made very welcome! One can easily imagine how eagerly they have been looking forward to a return to the old pastime and a reunion with their companions of the old days. Good luck to club life in these happier, better days which lie ahead. The coming winter may see quite a brisk revival of club functions, socials, dances, etc.—not forgetting the good rides along hard roads fringed with hedges fairy-like with rime and flanked by fields where patient cattle munch their winter meals of roots and hay.

Manufacturers' Post-war Programmes

A STUDY of the current advertisements issued by cycle and component manufacturers suggests that many programmes are well advanced, despite the fact that plenty of men are still to return to industry from the Services and despite the fact, too, that raw materials are not by any means in full supply. Inquiries among manufacturing firms indicate that whilst detailed plans cannot yet be publicised, a great deal has been done on broad lines . . . and makers have a pretty good idea what models they will concentrate upon and what the post-war policy of selling will be. Roll on the day when the full and complete programmes will be available and the retail shops well stocked with bikes, tyres and every type of accessory!

Those Rubber Plantations

EVER since Malaya fell into the hands of the Japanese, rumour has been rife as to what might have happened to the vast raw rubber plantations . . . source of a priceless raw material for all engaged in the rubber and tyre industries. There were those who imagined, somewhat curiously, that the Japs would have destroyed all the millions of trees. Others argued that as rubber was a vital munition of war, our enemies would have taken good care that the trees were carefully tended and nurtured, so that the Japanese military machine could be fed with good tyres made from natural rubber. Now that the Japs have been beaten, stories are filtering through and one published last week indicates that the plantations are in good fettle and that it should not be long before supplies of "crude" will be coming through . . . to the delight of the rubber industry and the satisfaction of a host of users of rubber products, who have always had a firm belief in the superior virtues of the "real thing."

In "Homely Hertfordshire"

THE gentle Charles Lamb hit upon just the right adjective when he described Hertfordshire as "homely;" it is a county innocent of rocky grandeur and the glories of crag and fell, but it has a peculiar charm of its own, and I fell in love with it again recently when I cycled around Ayot St. Lawrence—home of "G.B.S."—and rambled about the pleasant little town of Wheathampstead. Hertfordshire is homely indeed, and friendly too. I like its little inns, its lanes where just now the blackberries are ripe and luscious, its farms where, as far as cattle are concerned, the preference seems to be for the picturesque black-and-white British Friesian breed. And the good thing about Hertfordshire is that it is so easy to reach if you live in London. And it has plenty of history . . . those towns on the old North Road, like Baldock and Stevenage, are rich in historic treasure and tradition. Yes! when one cycles in this fair county one may well feel that the gentle spirit of Charles Lamb is near . . . .

"Faed's Monument"

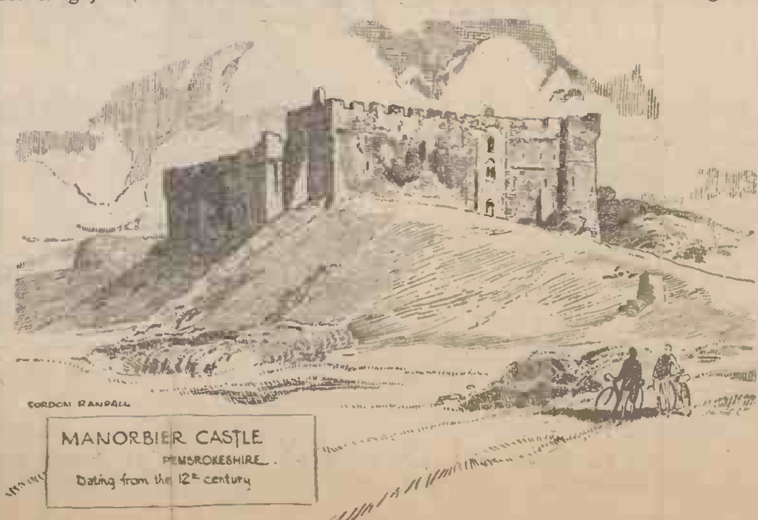
NOT a monument in stone or bronze . . . but a monument nevertheless . . . in the shape of the Motor and Cycle Trades Benevolent Fund, that great institution which has done and is still doing so much for those in the allied industries who may have fallen by the wayside or met with hard fate. I gather that the Secretary of the Fund is making a great drive in connection with a memorial fund to "A.J." and I wish him well in his efforts. The great work which A. J. Wilson put into this worthy cause must be carried on by those now engaged in the industry, and there could be no better way of keeping green the memory of a pioneer and a man who was beloved by all who knew him.

Price and Service

I WAS having a chat recently with a cyclist and we got on to the subject of cycle prices . . . and recalled the figures of pre-war days, made a few comparisons, and came to the conclusion that the British cycle, at its present price, represents extraordinarily good value for money. After all, when one buys a cycle one does not buy so much steel, leather, and rubber and vulcanite. One buys *service* . . . miles! And, remembering wages costs, overheads, prices of raw materials, and all the other factors which affect the final retail price of an article to the buying public, it would seem fair to say that a bike is jolly good value for money. The way to work it out is to try to "evaluate" the original cost to the length of service obtainable, the miles of travel, the great but indefinable pleasures which come from possession of a cycle . . . and if the matter is looked at in this way it will be found that the present figure, higher, of course, than the pre-war, is nothing to stagger one or to give one any sense of exploitation. "Cost-per-mile" is the true yardstick!

Autumn Glory

NOW is the time of the glory of the woodlands, the magical colours of the trees, and the autumnal beauty of hedge and coppice. A great time for getting out into the heart of the countryside . . . as beauteous as green springtime or lush summer. Even in a suburban road one may see the fire of the reddening creeper on the wall of a small villa and the gay colours of dahlias and Michaelmas daisies in the little gardens. But out in the rolling countryside . . . there is the autumn pageantry of Mother Nature in excelsis; browns and reds, and golds and russets, all blending in a blaze of glory which seems to tell us that the year may be on the wane and the fullness of summer gone.



MANORBIER CASTLE. PEMBROKESHIRE. Dating from the 12th century

Notes of a Highwayman

By Leonard Ellis

*Left.—
The Cloisters,
Hurley Priory.*

Britain's Touring Grounds (12)

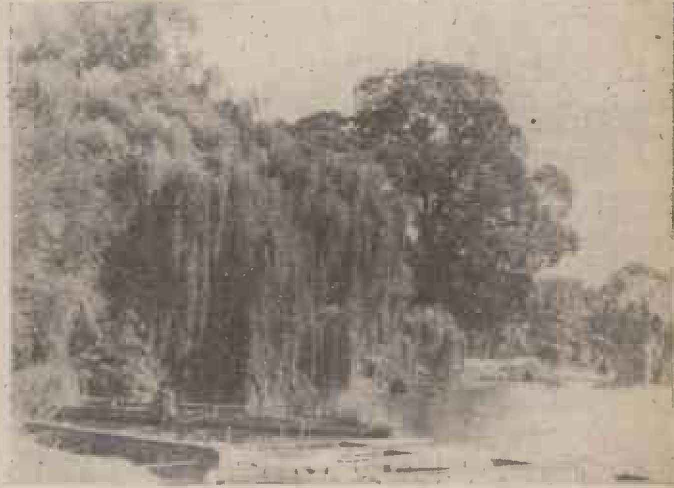
RECENTLY I was compelled to go to Brighton on business. After three hours of this "Queen of Watering Places" I was sitting on the railway station fretting for the train to take me away. My brief visit in no way enhanced my love for this type of holiday resort, but it certainly gave me an object lesson. I saw the milling crowds, the queues for meals, the tawdry shops and the so-called amusements, and I was sorely puzzled to know why thousands flock to Brighton, Southend or Blackpool. The answer is, of course, that one man's meat is another's poison. In a series of articles dealing with the touring grounds in Britain it is therefore unwise to be too dogmatic in stressing the beauties of one place as compared with another. It is naturally understood that these preferences are the writer's, although years of experience have told me what types of scenery the educated cyclist likes, and what places he avoids like the plague. One other explanation is that Brighton is so near to London. The sea has such a powerful fascination for many people that the surroundings do not exist in their myopic vision. The sea is enough.

Old Father Thames

I SUPPOSE in the same way we might look at the Thames Valley as a touring ground. I have to admit that I travelled north, south, east and west and over a good part of the Continent before I decided to spend a fortnight cycling in this charming area. I admit freely that the parts of the Thames that I visited are very lovely, but here again there is a large body of people who are content to shut their eyes to backgrounds providing the water at their feet or under the keel of their boat is the Thames. I honestly cannot say where the Thames Valley begins or ends from a holiday point of view. There are many who are content with a holiday quite near to London, and one does not deny that Richmond has a great deal to be proud of. Kew and Hampton Court are visited by thousands and the beauty of the gardens and the historic interest justifies their choice. Then there is a long stretch from Sunbury to Staines where thousands of jaded Londoners love to spend their weekends, and who can blame them? Windsor, of course, with all its associations is a focal point for tourists from every corner of the earth.

A Lovely Waterway

PERHAPS I would be right in saying that the touring area proper begins at Maidenhead. As a change from cycling I can recommend the boat trip from Boulters Lock, north of Maidenhead, via Cookham and Bourne End to Marlow. This is a lovely stretch of the river, and is best seen from a boat. The towpath can be followed, but it is not ideal cycling, considering the surface and the numerous gates. Marlow is a delightful old town, particularly when one is willing to spend time in searching out its old creeper-covered cottages in the back lanes. The scenery is just as fine from Marlow to Henley. Here again the boat may be used although there is a good road running north of the river and an alternative on the south side. Both are well worth following. The former passes through the charming village of Medmenham and a detour may be made to the pretty villages of Hambleden, Skirmett and Fingest. The south road, like the north, does not follow the river very closely, but steep and pretty lanes lead down to Remenham, Aston Ferry and Hurley. The latter is a delightful village with an old priory offering tempting glimpses to the photographer, and the exceptional width of the river and the numerous islands at this point make it a paradise for campers and swimmers. Southward we shall reach big and busy Reading and then, in a long, wide sweep northward, the Thames passes through lovely Pangbourne and between the twin villages—or should it be towns?—of Goring and Streatly. Still northward we reach Wallingford, a bright and prosperous-looking country town, quite close to the beautiful village of Dorchester (Oxon), and on to Abingdon. From here westward the river becomes less interesting, although there are many delightful stretches and many interesting villages and towns. Most cyclists have a love of bridges and in following the greatest of England's rivers there are scores of opportunities of adding to one's collection. West of Fairford the Thames still runs, but it seems that the age-old controversy regarding its real source is still raging. There is a Thames-head; and at Seven Springs, near Cheltenham, a plate boldly declares that this is the source of the Thames. Old Father Thames doesn't seem to worry where he was born, he just rolls along.



The Thames at Medmenham

Overheard

LADY motorist encountered at the roadside with a flat tyre: "I haven't had the car very long, but I'm sure I got a spare wheel with it." Having passed this remark to her companion, she resumed her search.

My Point of View: By "Wayfarer"

Beware!

IT is authoritatively stated that St. Paul's Cathedral is moving down Ludgate Hill at the rate of one inch in 100 years. All the more necessary for cyclists to look where they are going!

Expensive

ACCORDING to a writer in *The Daily Telegraph* a holiday on the Riviera this year may cost visitors about £10 a day. I have a feeling that the Riviera will not see me this year, my budget for holidays being nearer—much nearer—to 10s. a day.

People, Too

SOMEWHERE in the Press the other day I saw the hope expressed that dogs would again learn sense now that motor-cars, in bulk, had returned to the roads. I hope they will. I also hope that pedestrians will cultivate sense. There is ample room for improvement.

Immunity Badge

IN the large and enterprising factory which I illuminate with my presence daily, for a consideration, a scheme was recently inaugurated for the free injection of the workers (and drones), in the hope that thereby the time lost through the common (the very common!) cold would be materially reduced. When I was asked (rather mischievously, it is to be feared) whether it was my intention to submit to the series of injections (three in number), my negative reply lacked nothing in the way of emphasis. For many years now, I have been so regularly injected with the best possible anti-cold serum—to wit, fresh air, obtained in the course of a comprehensive cycling programme spread over the whole of the 12 months—that I do not consider it necessary to adopt other methods for outwitting and side-stepping the common (as before stated, the *very* common) cold. In practice, constant cycling acts as a sort of immunity badge.

"All Along o' Dirtiness"

SOMEBODY who met me the other day was sufficiently enterprising and observant to comment on the dirty state of the bicycle I was riding. I pleaded guilty, of course, saying that my purpose in having a small stud of bicycles was to ride 'em, and not to get hot and bothered and mucky in the unwelcome process of cleaning them. My policy has always been to ride, ride, ride: in Kipling's words, the policy is "all along o' dirtiness," and the fact that my cycling is always trouble-free constitutes a complete justification of my plan. The fact of the matter is that I have no time (in any meaning of that term) for cleaning operations. I prefer to devote my leisure to riding my bicycles and to miss out the cleaning process. Mind you, I look after the tyres and the transmission, leaving nothing to chance in those two respects.

Historic Meeting

AS I was dropping swiftly into Dolgelley a few days ago, I saw approaching me two elderly pedestrians, one with a white "knob" and wearing climbers' boots. Memories got to work quickly and recognition was mutual, and, in a moment or two, tongues were wagging. In the white-haired walker I recognised the office colleague from whom, over 50 years ago, I bought my first bicycle—a very secondhand machine which served me well for a time and then collapsed. Here, then, was the individual who started me on my career of crime as a cyclist! He, on giving up cycling, took to other pursuits, and it was good to hear that, at age 70, he was still climbing mountains. In a way, the meeting was a historic one for me. It is the case that if I had not bought a bicycle from him, I would probably have obtained one elsewhere. The fact remains, however, that he was the man who did the deed, thus actually pushing me off (though I was already a tricyclist, of sorts) in a life-long event which has endowed me with such wealth—taking the form of health, pleasure, and knowledge.

Good-bye to September

IN my part of the world the last day of September was a quiet smooth grey day without a bit of sunshine. But what a joyous cycling day it was: what a gorgeous colour scheme showed under the eternal drab canopy of the sky; what delightful air; what good views, even if they were limited in expanse! Between 10 a.m. and 8 p.m. I accounted for 67 miles, consumed two leisured meals, devoted half-an-hour to gathering blackberries, and bought the naked corpse of a rabbit, a jar of honey, some onions, and one or two other things to help the home larder.

Taking things all round, it was a jolly fine day—but *where were the cyclists?* I encountered none during the journey itself, which comprised main and secondary roads, and one long field-path, with six or eight gates to open and close. At the popular lunch-place, there were 10 other cyclists. At the also popular tea-place, there were five other cyclists. Where was all the rest of the wheeling brigade? I do not know. What I *do* know, however, is that those who were repelled by the greyness of the day missed a grand cycling occasion, which was made all the more acceptable thanks to the absence of those blustering winds that have been in such ample supply of late. Thus I said good-bye to September, and, at the moment of writing, am looking forward, with eagerness, to the remaining months of the 1945 cycling "season."

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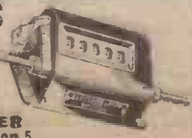

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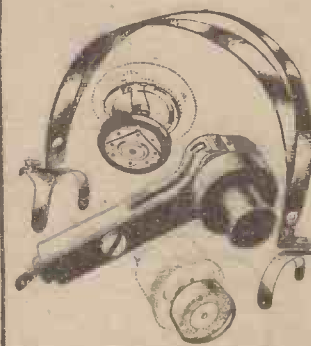

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