BY ROCKET THROUGH SPACE

NEWNES

PRACTICAL MECHANICS

JANUARY

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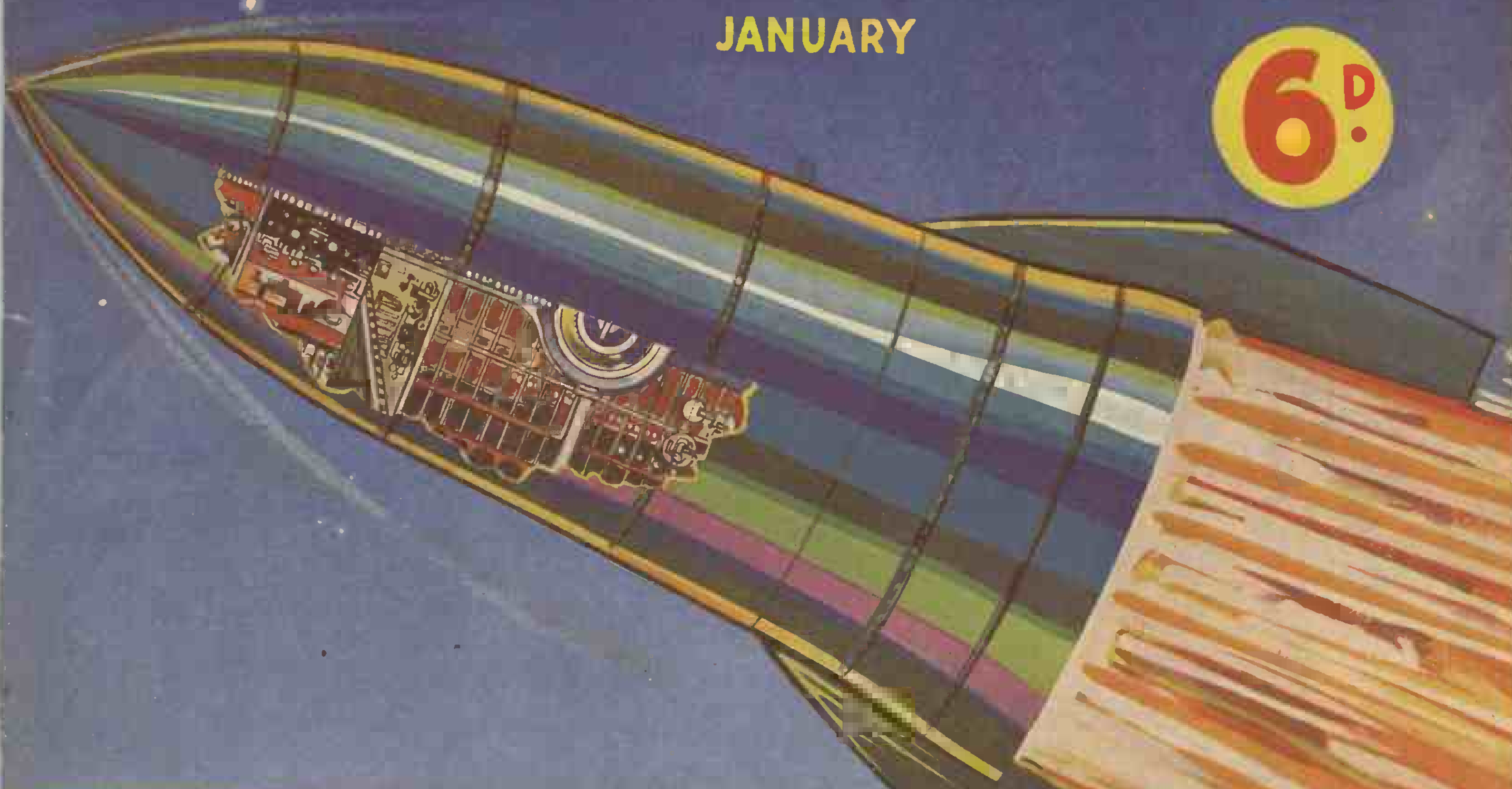

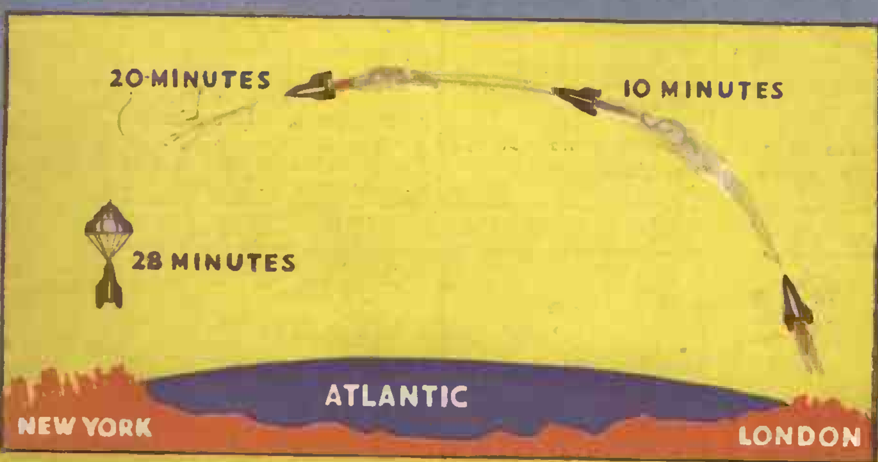

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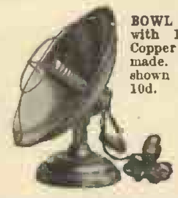

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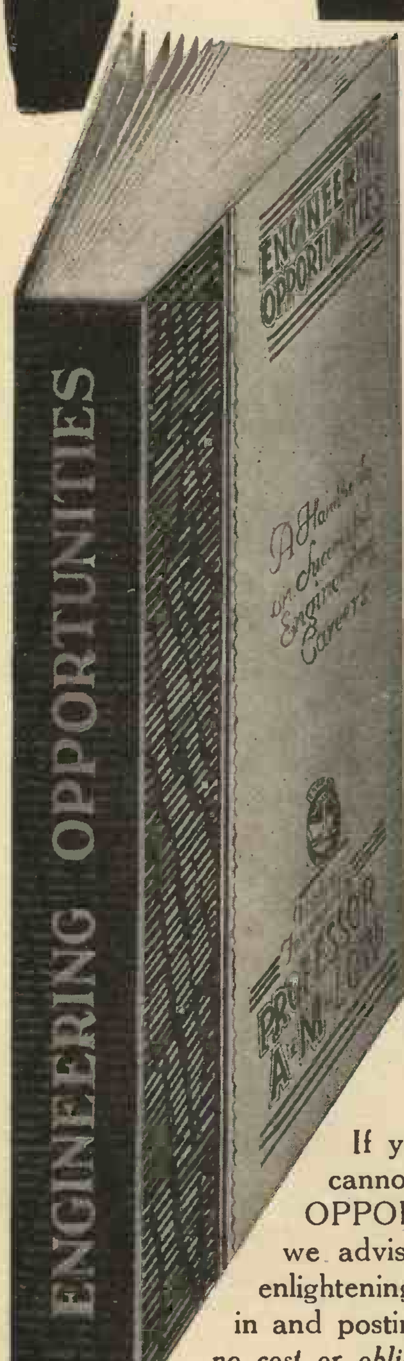

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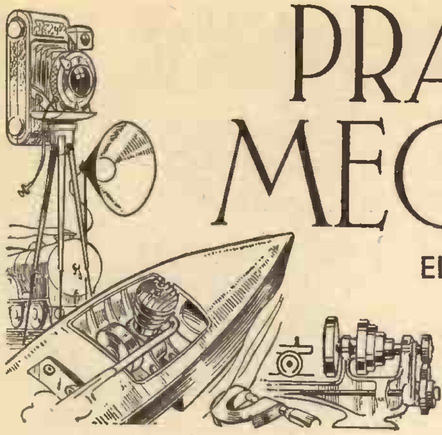
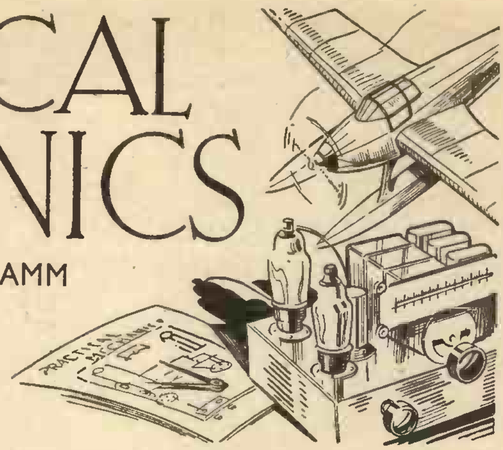


PRACTICAL MECHANICS



EDITED BY F. J. CAMM

VOL. IV. No. 39
JANUARY
1937

NOTES, NEWS, AND VIEWS

Studying the Stars

WE learn that France is to have, in due course, the most powerfully equipped astronomical observatory in the world.

Twelve New Air Liners

A £500,000 order for a fleet of 12 new air liners, which will set up new records for speed, size, and comfort has been placed by Imperial Airways with Sir W. G. Armstrong-Whitworth, Ltd.

Television Challenge

AMERICA is now answering Britain's television challenge. Four transmitters giving a public service are expected to be ready this year—two in New York, one in Philadelphia, and one in Hollywood.

Two New Aerodromes

WORK is now in progress on two new aerodromes at Dishforth and Driffield, in Yorkshire. They will cost £600,000, and are two of forty new aerodromes included in the R.A.F. expansion scheme.

Paint which Cannot Crack

PAINTWORK which is exposed to the weather always has a tendency to develop cracks after a time on account of the shrinkage of the raw base oils. By combining soya-bean and tung oils, and by subjecting the mixture to a special heating process before the colour pigments are added, it has been found that a base is produced which resists cracking and which has a much longer life than conventional paints.

Dustless Soft Coal

THE waxing of soft coal by a new process has been found to prevent the formation of dust, and makes soft bituminous coals as clean as the hard coals used in domestic fires. The soft coal is coated with a layer of petroleum wax which is produced as a by-product during oil refining and it is found that the waxed coal remains free of dust over an extended period.

Bearings which Smoke when Short of Oil.

THE addition of a small quantity of calcium to lead has been found to produce a new and valuable alloy for machine bearings. The new alloy has a much higher melting-point than the conventional lead-tin combination. When badly lubricated, bearings are liable to overheat and melt, but the new alloy is found to give off volumes of smoke before serious damage is done.

Captive Balloon Record

A NEW record of 92,000 ft. has been attained by a special captive balloon carrying research instruments for the study of cosmic rays. This record—nearly 18 miles—is over 2,000 ft. higher than the previous one, and the balloon had to ascend through 98 per cent. of the earth's atmosphere. Some day these researches will tell us what cosmic rays really are and may even lead to the harnessing of the tremendous energy which they possess.

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A Portable Bridge

A NEW type of tank has been developed by the Italians which carries a portable bridge that enables troops to cross small rivers. The span of the bridge is hinged to the front of the tank and wire cables can raise it clear of the ground for transportation. When an advancing column reaches a river or ravine, the tank crew lower the bridge into position and the soldiers can cross with little delay.

Monster Photographs

NEW possibilities in decoration are rendered practicable by the development of a process for printing photographs on walls. By means of compressed air sprays, the walls are first coated with a plastic paint containing asbestos. A light-sensitive emulsion is then applied and an enlarging lantern arranged to project the picture on the wall. Developing and fixing solutions are then sprayed on, and after being washed down the picture is given a final coat of protective lacquer.

Electric Machine-gun which is Silent

A MACHINE-GUN in which electricity replaces gunpowder has recently been developed, and since it is silent it can be used without betraying its location. It is stated to be capable of firing 150 bullets or explosive shells a minute. The projectiles are accelerated in the barrel by a series of electromagnets and the muzzle velocity is stated to be only slightly less than the ordinary Lewis gun.

The New Fairy "Battle"

THE new two-seater bombing aircraft has many remarkable features besides its great speed which is believed to be in the region of 300 m.p.h. One interesting point concerns the retractable undercarriage. For some unaccountable reason, pilots seem to be liable to forget to lower their undercarriage when coming in to land and several accidents have happened. In the new machine, the word "wheels" appears in illuminated letters on the dashboard when the pilot throttles back the engine, and an electric horn commences to sound. Not until the pilot has safely lowered the undercarriage does the horn cease to sound.

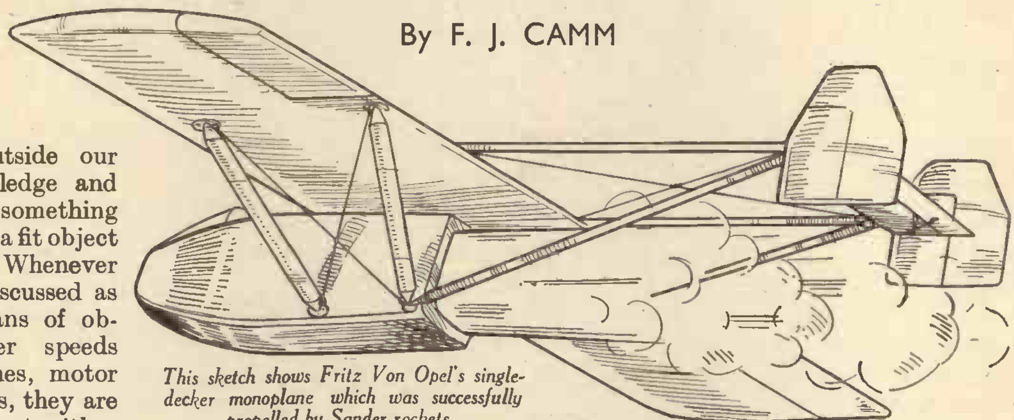
New Zealand Broadcasting

A NEW broadcasting transmitter, believed to be the most powerful in the Southern Hemisphere, has been ordered by the New Zealand Broadcasting Service. It will be erected on high ground near Tahiti Bay and will have a power of 60 kw. The aerial will be of the single-mast type, 700 feet in height, and the wavelength will be 526 metres.

ROCKETS—THE POWER OF THE FUTURE

It Would Seem that Practical Limits have been Reached in the Speeds of Cars, Aeroplanes, and Steam Ships. Is Rocket Power Feasible? In this Article We Show that it is More than a Qualified Success and and that Rocket Power will be Used in the Future.

By F. J. CAMM



This sketch shows Fritz Von Opel's single-decker monoplane which was successfully propelled by Sander rockets.

THERE is always a tendency to regard a new suggestion outside our present knowledge and experience as something grotesque and a fit object for derision. Whenever rockets are discussed as a possible means of obtaining higher speeds with aeroplanes, motor cars, and ships, they are dismissed almost with a snigger or considered as a piece of schoolboy fiction. It was so with wireless, and with television, with motor cars, and with aeroplanes. It has been so with rocket flight. We cannot, however, continue to so regard it in view of the facts which I place before you in this article.

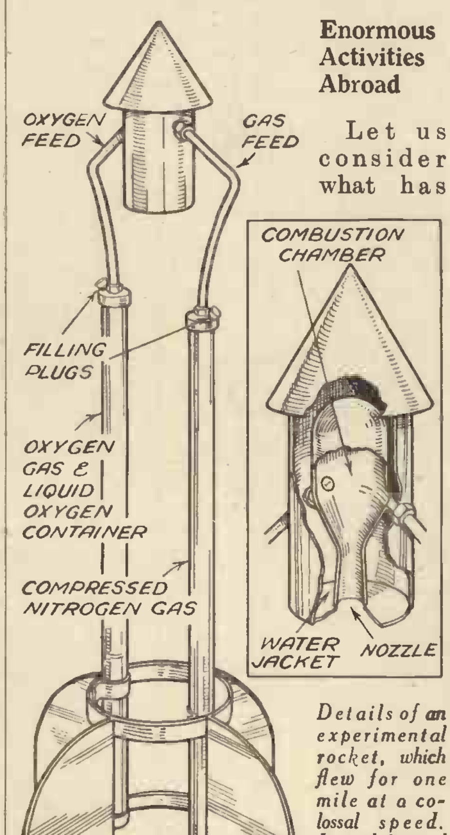
Prophetic

When George Stephenson named his early locomotive the "Rocket" he was more prophetic than he knew. The "Rocket" seemed like a rocket in those days, for it was faster than anything the public had known before. Mechanical travel was not then born. Speed is purely relative and what is considered fast to-day is considered slow to-morrow.

When an early motor car travelled at forty miles an hour it was considered that the ultimate had been reached. Doctors stated that a human being could not live at the speed of sixty miles an hour. Trains and aeroplanes have all travelled at speeds of over 100 miles an hour, and so we must consider in view of the practical limits set by modern methods whether even higher speeds are possible and, if so, how obtainable. We must not forget that it still takes nearly four days to travel from here to America. A long time! It takes at least seven hours to travel from London to Edinburgh. An eternity! Is there any limit to speed? Actually it is considered that speed cannot travel faster than sound, but we have a long way to go before we can travel at the rate of 1,100 ft. a second.

Enormous Activities Abroad

Let us consider what has been done with rockets. In America, Russia, France, England, and Germany there have been enormous activities in the development of the rocket engine with liquid fuel. Opel, Valier, and others have conducted successful experiments with rocket cars in Germany. Successful experiments with rocket aeroplanes and rocket boats have taken place in America.



Details of an experimental rocket, which flew for one mile at a colossal speed. It used liquid fuel.

It is chiefly in connection with air travel that the possibilities of rockets are being investigated. Already the Interplanetary Society is actively engaged on the problem. It has members in every country in the world.

Rocket Propulsion

The great point in favour of rocket propulsion is the fact that there is no engine in the ordinary sense of the word, the rocket body being propelled forward by the exploded fuel. Of course, such fuels as gunpowder and similar "firework" components were found to be both weak and bulky. The most suitable system up to now is founded on the ignition of a fuel such as petrol, benzine, or alcohol in an atmosphere of oxygen. The explosive force and power generated are simply terrific. If you look at the illustrations you will see the idea in diagrammatic form, the particular rocket there illustrated being designed to act like a shell, carrying a load of explosive substance in the forward compartment which would detonate on impact.

A Rocket Car

An illustration shows the same idea as used by the famous German experimenter, Max Valier, in 1930. This car, despite the simple nature of the power plant, developed nearly 200 h.p. and lapped the course at Tempelhof Aerodrome, Berlin, for seven circuits at an average speed of 90 miles per hour. It was an impressive sight as the vehicle tore along with a roar like artillery in action and a 6-ft. spear of white-hot incandescent gas shooting out behind it. Apart from the steering and brakes, the sole control was a lever which controlled the valves regulating the supply of liquid oxygen and fuel. Unfortunately the driver was killed some time after while experimenting with the use of oil, instead of spirit, as fuel. The rocket, as a successor to the engine, is, however, a tried and proven fact, and while not likely to supplant the latter for ordinary use, opens up an entirely new sphere of potential travel.

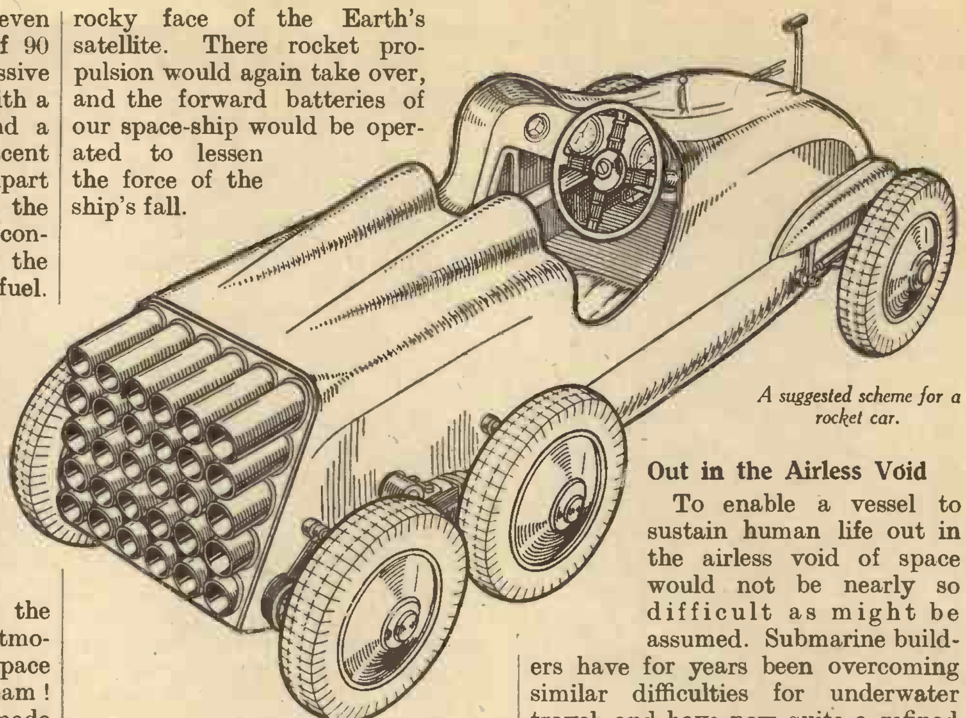
For the first time in history, the idea of travelling beyond the atmosphere and into the realms of space has become more than a mere dream! Already preparations are being made to launch a huge rocket moonwards; and here the fuel used will be still more powerful, being a jet of hydrogen gas burning in an atmosphere of oxygen. As every schoolboy knows, both these gases are now available in liquefied form, which means an immense volume of gas in a very small space.

Travelling to Mars

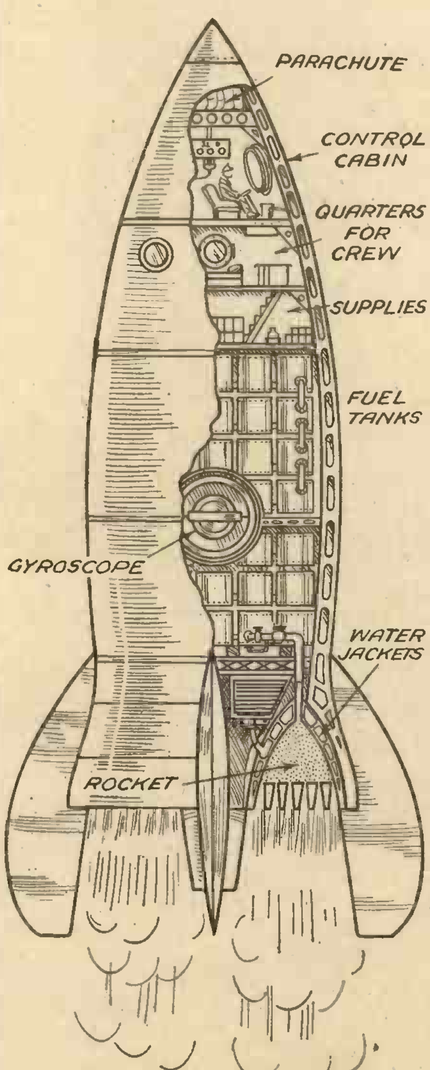
Before mankind is ready to step into a luxurious space-ship and voyage to Mars in comfort, many years may pass and much painstaking work must be done, but make no mistake, the possibility of space travel is in sight!

Just what are the obstacles to be overcome? Briefly, they are gravitation, the vacuum (so called) of space, and distance. When the first space-ship is launched its objective will undoubtedly be the Moon, as being the nearest celestial body and situated some 240,000 miles away, a mere nothing for inter-stellar space.

Yet that "mere nothing" is decidedly formidable, judged by Earth standards, for at 50 miles an hour—roughly the speed of the London-Brighton express—it would take over 200 days, or about seven months' continuous travelling to get to the Moon. Fortunately—once beyond the Earth's atmosphere—there would be no resistance and speed would pile up to a dizzy figure as the pull of Earth's gravity lessened and that of the Moon increased. When the neutral point between the gravitation of Earth and Moon were passed, difficulty would be to slow up, and so avoid crashing into the bleak and rocky face of the Earth's satellite. There rocket propulsion would again take over, and the forward batteries of our space-ship would be operated to lessen the force of the ship's fall.



A suggested scheme for a rocket car.



Section of a rocket-flying ship, which has been successfully demonstrated in Germany.

Out in the Airless Void

To enable a vessel to sustain human life out in the airless void of space would not be nearly so difficult as might be assumed. Submarine builders have for years been overcoming similar difficulties for underwater travel, and have now quite a refined and stable technique for providing heat, oxygen, light, food, and other necessities of life in a hermetically-sealed hull. In emergency, the driving of stale air through lime-water, and heating of potassium chlorate to liberate oxygen, will keep air breathable for quite a long time. Submarine practice, too, would be invaluable if once the Moon were reached; for air-locks could be built in the vessel's wall, for exit and entry without leakage of air on to the airless desert of the Moon, just as diving-locks on a submarine permit safe entry for divers while under the surface.

For exploration of the Moon's arid surface an adapted form of diver's suit and helmet could easily be evolved. The atmospheric pressure required by man is only 15 lb. to the square inch, while divers' suits are now made to withstand enormous pressures.

And after the Moon?

Why, Mars, of course! That nearest neighbour of ours who twinkles so redly at us, who has a definite atmosphere of some sort, and whose strange "canals" have puzzled astronomers for years, would be a goal worth reaching.

Is Mars Inhabited?

That question, which has been debated times without number, would be answered once and for all. As Mars is much smaller than the Earth, it is presumed to have cooled down millions of years before our globe did, and therefore the Martian intelligence may be assumed to be far ahead of

A rocket car capable of travelling at 80 m.p.h.

our own. Now, if Martians have developed on the same lines as the human race, and are so far ahead of us in evolution, why have they not, long since, solved the problem of interplanetary travel and visited our world ? Either they did so long before our globe came into the period of recorded history, and they have died out, as a race, long ago ; or intelligent life has developed on entirely different lines to that on Earth. It is feasible that intelligence may have been housed in an insect form, and in this case the instinct of travel, might never have been evolved.

A further step in the development will be mail rockets ; such a rocket could carry 1 cwt. of letters from London to New York in less than half an hour, and the cost of transport would be astonishingly small.

The rocket mail express service might therefore be not only a valuable innovation, but would also work very economically and provide an excellent source of revenue for the countries concerned.

Leaving the Earth

Whether it will be possible within any reasonable space of time to leave the sphere hemming in the earth, and rush onward to another heavenly body, by earthly expedients, cannot yet be determined. At all events, further attempts with liquid fuel must first lay the technical foundation for the further development of the stratosphere rocket.

In the literature on this subject expansive calculations and plans for future stratosphere airships have already been made. These would be composed of several large liquid fuel rockets, and would have to attain a speed of 7 miles per second in order to penetrate the heavy sphere round the earth.

Thus we see that the problem of travelling in the stratosphere is mainly a question of speed. And this is a question of fuel, and the rocket motor which converts it into energy.

The Stratosphere

The stratosphere and the empyrean beyond, with the constellations, stars, satellites, planets, and other heavenly bodies, have formerly been the special preserves of the astronomer, the realms pierced only by high-power telescopes, the object of skilled observation and conjecture based upon the recurrence of certain phenomena, and on which we have built our theses as to the constitution and order of the universe, of which the earth is but a minute and unimportant part.

The Rocket Ship

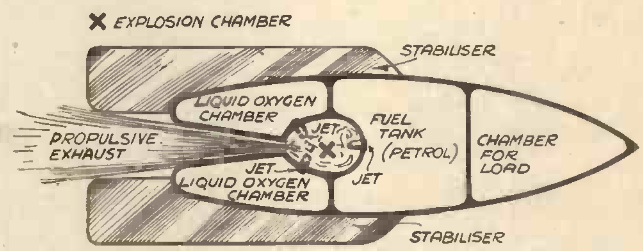
No lighter-than-air vessel could ascend for more than a limited altitude, the extreme limit being in the nature of 30 miles. Hence science has directed its attention to an entirely new type of space ship propelled on the rocket principle. It is necessary to remember that travelling in the upper regions requires much less power than that expended in travelling through the air, and ultra-high speeds for very small expenditure of power are thus possible once we leave the atmosphere. Fog and snow, lightning and storms do not exist in the stratosphere, and thus there must be additional safety in travelling at these high altitudes. If we could travel, via the stratosphere, a journey between England and Australia, which at the present time takes a matter of days by ordinary aircraft, would take but a few hours. In fact, the extreme limits of the earth could be reached in a maximum of two or three hours.

Speed in a Vacuum

The first practicable experiments in rocket propulsion or, to use a more accurate term, reaction propulsion, really commenced in the year 1919, when Prof. Goddard published the results of his experiments made with rockets propelled in a vacuum.

Briefly, he found that a pistol or rocket fired in a vacuum kicks back or recoils even more so than in the open air, and thus disproved the old idea that a rocket depended for its action by pressing back, so to speak, on the air. We have already seen that no form of space ship making use of an ordinary airscrew could function in a vacuum or the partial vacuum of the upper regions, since it could not produce tractive effort unless it operated in air ; and in this vital principle discovered by Prof. Goddard we have the basis of design for a space ship.

The recoil of a rocket or a pistol or a gun obeys Newton's Third Law of Motion—that action and reaction are equal and opposite. The momentum of a bullet fired from a pistol will be equal to the momentum of the recoil of the pistol. Momentum, it must be remembered, is the product of the mass (or weight) of the body times its velocity ; hence, since the mass of the pistol is considerably greater than that of the bullet, its velocity will be considerably less than that of the bullet. If you multiply the speed of its recoil by its weight this will be found to equal the weight of the bullet multiplied by the speed of the bullet. This principle of motion applies in ordinary air ; it is even more effective



Sectional view of a boat propelled by rockets. Small toys are available which demonstrate the principle.


Stratospheric rocket as developed in Germany. Would rise 15 miles and attain a speed of 600 m.p.h. with 200 lb. load.

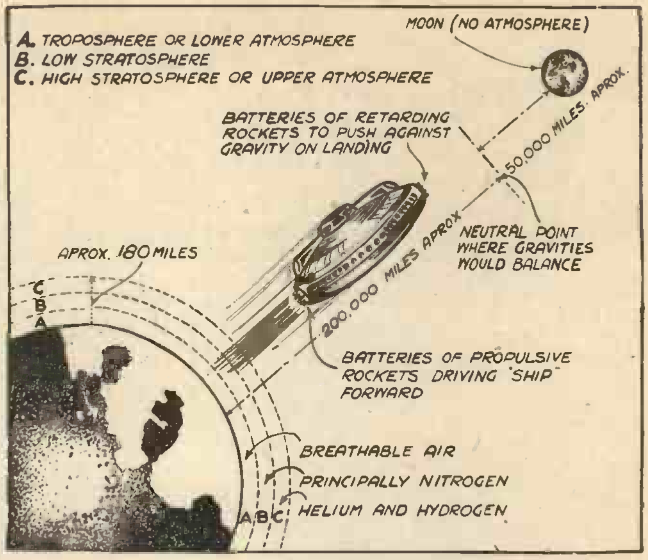
in a vacuum, and reaches maximum efficiency in it.

Reaction Propulsion

We have thus arrived at the point where it has been demonstrated that the only practicable means of travelling through the vacuum of space is by means of reaction propulsion. We have also seen that enormous speeds are possible in a vacuum with a very small propelling effort, and, in fact, an even rate of consumption of the fuel used to impart reaction propulsion will provide the ship to which such apparatus is attached with a velocity which increases every second.

No Sensation of Speed

Bearing this in mind, we must remember that Nature has apparently provided us in advance with the ability to travel at these colossal speeds of several hundreds of miles an hour, since it is well known that we do not possess any sensation of speed. This may sound startling, but if you recall that every moment of our lives every human being is travelling at a constant speed around the sun of 65,000 miles an hour, and that we are quite unaware of it, you will more easily understand the point. We are only conscious of speed when it exists in relation to something else. If you draw the blinds of a railway carriage in which you are travelling, you will be unable to say with certainty which way you are going, and if the train could be made vibrationless you would not feel any sensation of motion. We only become sensitive to changes of speed. Once your car has attained a certain speed and is kept at that speed, you cannot feel the pressure of the back of the seat. Directly the car slows down, you are aware of the fact by a tendency to shoot forward, and if you violently accelerate, your back presses hard against the back of the seat. You experience a somewhat similar sensation in a lift, either when it is starting or when it is slowing down. But during the *constant speed* portion of its travel you are unaware of its direction of motion.



The rocket principle will probably be applied to space travel. If rockets cannot propel the craft beyond the neutral point, it would be marooned there.

The Limit in Speed

Thus, we have now demonstrated two important facts: firstly, that reaction propulsion is possible and has been demonstrated; and secondly, that human beings are able to travel at enormous speeds without danger. Without going into mathematics, it can be stated that the limit of human endurance in speed is the free falling velocity of 32 ft. per sec./per sec. which for a period of 5 minutes mounts up to 6,000 miles an hour. The problems to be solved in high speed space flight are thus those of starting and stopping, and there is really no limit—*in space*—to the speed at which a human being can fly. There is a practical limit to speed through *air*, and this limit is set by the friction of the machine passing through the air and the heat generated by it. But, this friction would not exist for more than a few miles—at most 50—and representing a few seconds, it can therefore be ignored. In support of this fact, it must be remembered that a meteor or falling star does not become visible until it enters our atmosphere, thus proving that in its descent it must pass through a vacuum, and hence no friction is generated. This alone causes it to glow as soon as it enters the atmosphere.

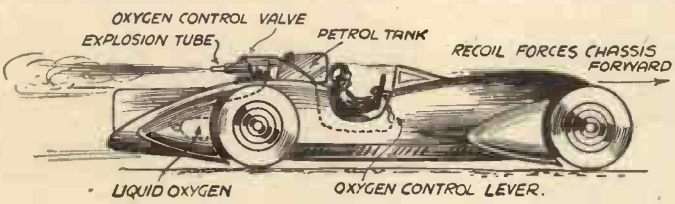


Diagram showing the arrangement of Max Valier's car, successfully demonstrated in Berlin in 1930. It attained a speed of 90 m.p.h. The combustion chamber was no larger than a soda-water bottle.

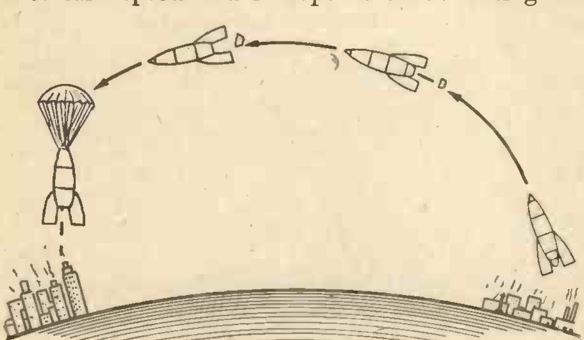
Actually, the density of the air becomes rarefied at an altitude of about 5 miles. At 8 miles the air density is so low that it causes the blood to ooze from the pores of the skin and from the ears, the eyes freeze, and usually there is loss of consciousness.

Sounding balloons, equipped with delicate recording apparatus, have ascended without a pilot to an altitude of over 22 miles, and provided valuable data without risk to life. One important fact is that the density of air decreases by a half for every $3\frac{1}{2}$ miles ascended, and that temperature drops 1° Fahrenheit for every 900 ft. ascended.

It is, therefore, easily calculated that when the lower fringe of the stratosphere is reached, the density would be only about one-tenth of the density at the surface of the earth, whilst at the top of the stratosphere it would be only one sixty-seven-thousandth.

These facts are here set on record to enable the reader to understand the principles upon which future stratospheric ascents and space flight will be based, and to indicate that, as a result of the pioneer work already done, such are now within the realm of practical possibility.

We must grow accustomed to the thought that all travel to-day is relatively slow, and that the tendency is for everything to be speeded up. There is no other means of creating faster travel, except to use the stratosphere. The world grows smaller as the speed of travel increases, and who can say that, when all nations live in closer time-proximity to one another, the problems which beset the world will thus be solved?



The proposed rocket mail. Calculated time for London-New York, 28 minutes. Landing effected by means of parachute.

Rewinding an Armature

By Reason of Repeated Demands from Readers We now Publish the following Practical Article

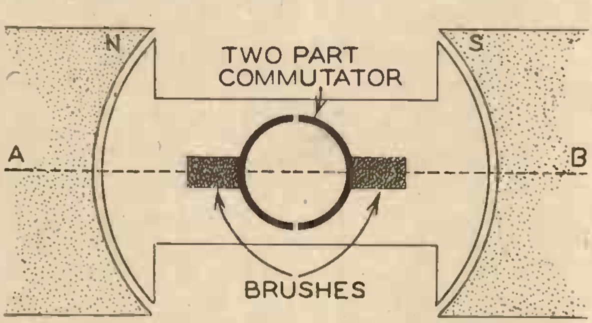
As the greater number of the electrical queries are on armatures of some form or other we are going to deal with this problem at some length and try and solve the problem for those readers who have found it difficult. In each case we will take a simple two-pole machine with the brushes in line with the poles. This will be understood by looking at the sketch, in which the brush line *A B* passes through the centre of the poles *N* and *S*.

Simplest Type

The simplest armature is the two polar or *H* type. As the name suggests, there are only two poles so that the armature is a rotating electro-magnet in its simplest form. Current is taken from the armature by a two-part commutator which has a segment opposite each armature pole. It is often said that the output from such a machine is not suitable for any direct current experiments such as battery charging and electroplating. This is quite wrong, as the output is D.C., but of a pulsating form that is not quite as steady as from an accumulator or a multi-polar dynamo. For experimental purposes we have used *H* type armatures for battery charging and electroplating, as well as many other experiments requiring D.C. This armature is wound from end to end with one length of wire, and the start of the coils, if we consider there to be one coil on each side, goes to one segment and the other end to the other. For practical reasons we put an equal number of turns on each side of the armature to balance it both mechanically and electrically. As this is a two-brush machine you might ask what happens when the brushes short circuit the armature twice each revolution. Actually nothing happens because when the brushes short each segment, the armature is in the neutral position. From this you will see that the brushes are so arranged that they collect the current when it is at a maximum, but actually the brushes are collecting the current while it rises to a maximum.

Tri-Polar Armatures

The tri-polar armature can be regarded as a modification of the above. It is used in self-starting motors and small toys, but has no real commercial application. The *H* type is extensively used in magnetos and similar machines, but where models are concerned it is not self-starting. This is a big disadvantage when we consider a model boat or electric loco. Here again each pole of the armature is wound to produce a magnet as before, but the work becomes a little more complicated. Take a tri-pole armature with a three segment commutator and arrange a segment opposite each pole. Wind each pole in the same direction with the same number of turns and gauge of wire, and mark the start and finish of each coil. Let us take coil 1 opposite segment 1, and so on for the others. The end of coil 1 is connected to the start of coil 2 and the two wires are then connected to the first segment; the end of coil 2 is connected to the start of coil 3 and the two wires are connected to the segment numbered 2, and so on for coil 3. If you happen to wind a coil in the wrong direction, instead of rewinding, just change over the connections, that is, connect the end where the start usually goes. The polarity can be determined by connecting up the ends to a cell and then using a pocket compass at each pole. When used in a dynamo, this armature gives a steadier output than the previous one, but is generally only used in small model machines.



A simple two-pole machine with the brushes in line with the poles. The brush line A B passes through the centre of the poles N and S.

A Drum Armature

If you can keep the above facts before you while considering the rewinding of a drum armature, it will prove quite a simple operation. As you know, the smaller the air gap in a magnet field the stronger the pull, thus, if in an armature we make it almost solid, it will have a greater number of magnetic lines of force passing through it than in the case of the *H* and tri-polar types. It is the laminated cogged drum that seems to trouble most readers when it comes to rewinding. This armature is used almost universally to-day, and is found in all small power A.C. machines, in car dynamos and starter motors and in larger commercial plants. We will not trouble readers with any complicated wiring diagrams for the more rarely used circuits, but will take a case from which it is possible to work out the connections for any type of machine. As before we will take a simple two-pole machine with the brush line across the poles. Let us take a 12-slot armature with a 12-segment commutator. It is easier to describe this type of winding than to make a sketch of it, because when a sketch is finished one never knows which wire is which and looks most complicated. Imagine a clock face on the armature with 12 o'clock at the top. The slots will be numbered round as the hours on the dial, and the segments will be numbered round in the same manner. Thus segment 12 will be under slot 12, and slot 6 will be opposite slot 12, etc. The first coil is wound from slot 12 to slot 6, and the wire half fills the slots. The start goes to segment number 3 and the end to number 4, and coil 2 is wound from slot 1 to slot 7, the start going to segment 4 where the end of coil 1 is connected, and the end goes to segment 5 and so on. When you get to the 7th coil you will find that slot 7 is half filled with coil number 1. Proceed as before, winding from slot 7 to slot 1 and connecting up the ends in order. You thus see why we only wound slot 1 half full of wire. When finished each coil will be connected up and each slot will appear to have two coils in it. If, for some reason the brushes lay on the 12—6 o'clock line what are the connections? Just as before, but turned through half a circle. Coil 1 is wound from slot 12 to slot 6 the start now goes to segment 12 and the end to segment 1 and so on. This method of winding can be used for any number of slots and segments. On A.C., however, it is customary to employ an armature with say, 12 slots and a commutator of 24 or 36 bars or segments. This is treated exactly as if it were an armature of *as many slots as segments*. Thus coils 1 and 2 are wound in the first slot, coils 3 and 4 in the second, and so on, and the ends are connected up as before exactly the same as if the armature were 24 slots and 24 segments.

A Practical Case

Having dealt with the necessary theory of rewinding, let us take a practical case. A vacuum cleaner burns out, and on examination, the armature is a mass of burnt and charred wire, insulation, etc. Dismantle very carefully, making a note of the number of turns in each coil and the coils per slot, etc. This may not be possible for each coil, but if you try it on several you will get to know the original winding data, now find the gauge of wire by measuring with a micrometer or wire gauge or if you do not possess the necessary instruments send us several samples. The gauge is measured on the bare clean wire, but don't stretch the wire or clean it with sand paper. Having obtained the new wire try and put on the original number of turns in each slot or coil. If at the first attempt you only get about half the number of turns on, don't be disappointed but try again putting more tension on the wire and laying the turns neatly side by side. Having found the maximum number of turns possible re-insulate each slot and wind the complete armature, marking the ends of each coil so that no mistakes can be made on connecting up later on.

If, however, you find it impossible to get the original number of turns per coil it will be necessary to add a small resistance in the external circuit, which must be wound on a small mica former and secured in the base.

MAKING A VERTICAL ENLARGER

By "Home Mechanic"

A Piece of Apparatus that will be Appreciated by all Amateur Photographers

Fig. 1.—The finished vertical enlarger.

An enlarger of some kind is an absolute necessity to the amateur photographer and nothing rivals one of the vertical variety for simplicity and ease of working. To purchase one of these, however, is an expensive matter, but you can overcome this difficulty by constructing your own. The cost should not exceed twenty-five shillings, including a new 4½-in. condenser so perhaps constructional details might interest readers.

The general arrangement can be seen from Figs. 1 and 4. If there is no need to move the enlarger, it can be screwed to the floor, but those who feel disinclined to do this can build it on a thick wooden baseboard, so that it can be moved wherever it is most convenient. It is wise, in this case, to use as short a focus lens as possible, so that the uprights can be made fairly short and so avoid making the whole affair top-heavy.

The Runners

The runners consist of two lengths of 3 in. × 1 in. deal. Deal was used throughout, on account of its cheapness, but if funds permit, oak or some other hard wood can be used and will be more durable. Fasten the runners ⅜-in. apart, edge to edge, by screwing a small piece of wood at each end, as shown in Fig. 2. Fasten the uprights perpendicularly to the floor (or baseboard, as the case may be) with strong iron brackets.

The easel is best made from a piece of 7-ply wood about 18 in. × 16 in. Select it with a soft enough surface to enable you to stick pins therein. Fix the easel to the uprights with a pair of brackets, the height from the floor, of course, depending on your own requirements. To make it quite rigid support the two outer corners with two pieces of wood, about ¾-in. square, and of such a length that the easel is perfectly level when they are in position.

The Lamphouse

Before starting the actual construction of the lamphouse, buy a double-convex condenser to cover the largest negative you are likely to enlarge. Obtain one that has a diameter of not less than one of the diagonals of your negative. For a 3¼ in. × 2¼ in. negative you will require a 4¼ in. condenser, and for a quarter-plate, one of 5½ in. diameter.

The lamphouse is just a square wooden box, 10 in. deep. Make it about 7 in. square (the exact dimensions are unimportant so long as there is ample room for the condenser) and make two of the opposite sides to project 4 in. These projections are to hold the wooden blocks in position on which the lamphouse slides. Make the projecting sides of 3-ply, but the other two of ½-in. wood. Use glue and screws to make a strong job. Cut a rectangular hole, 4 in. × 3 in. in one side of the lamphouse, and between two clean quarter-plate glasses sandwich two or three sheets of red paper such as is used to wrap plates. Bind the edges with passe-partout binding and fasten the paper "sandwich" over the hole in the lamphouse by means of four narrow strips of wood. Two small brass turn buttons will prevent the glasses falling, and the light given through the red window will be found useful in the dark room. Make a wooden lid to fit the top of the lamphouse in order to keep all white light from the room.

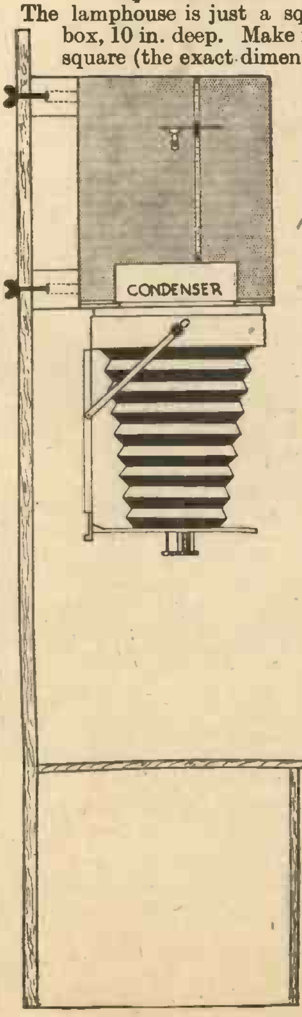


Fig. 4.—A side elevation of the enlarger with the side of the lamphouse removed.

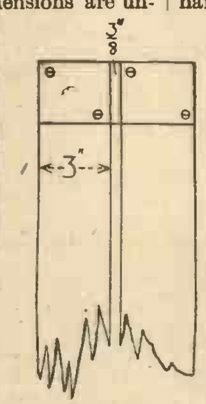


Fig. 2.—Details of the runners.

Projecting Sides

Cut two pieces of 4 in. × 2½ in. wood of such a length that they fit tightly between the projecting sides of the lamphouse. In the centre of the narrower side of each piece drill a 1 in. hole 2¾ in. deep, and continue drilling right through the wood with a ⅜-in. drill (Fig. 3). Now obtain two 3-in. ⅜-in. Whitworth carriage bolts, complete with large steel washers and wing nuts. Push one of these bolts through each hole in the wooden blocks, so that the head goes to the bottom of the wide part and the threaded part projects the other side. To prevent the bolts turning round, glue a piece of 1 in. dowel in each hole and hammer it well home. Fasten each block, complete with its bolt, between the projecting sides of the lamphouse. Fix one at each end, using glue and screws, because the blocks have to carry the weight of the whole enlarger.

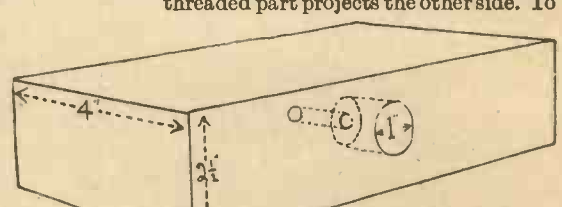


Fig. 3.—The lamphouse.

To make a holder for the condenser, cut a square piece of ½-in. wood to fit tightly into the bottom of the lamphouse, and in the centre of this cut a circular hole ¼ in. less in diameter than the outside of the condenser. Cut a similar piece of wood in 3-ply, but make a hole in this the same diameter as the condenser. Glue these two pieces of wood together on top of one another, and screw them in position at the base of the lamphouse with the larger hole inside. This will keep the condenser in place, as seen in Fig. 4.

You can now fit the complete lamphouse to the runners, by pushing the protruding bolts through the space between the uprights, and putting on the washers and wing nuts. The lamphouse should now slide easily up and down, and it can be securely locked by tightening the wing-nuts.

The Bellows and Negative Carrier

I was particularly fortunate in having by me a set of bellows and a negative carrier from an old enlarger, so that it was but the work of a minute to screw them on to the lamphouse ready to use. But it is equally simple to adapt an ordinary plate camera to slide on to the lamphouse, and so obviate the necessity of buying a set of bellows. If your camera has wooden book-form dark-slides, take one of them, and remove both the sheaths and the metal division. You will find that one side of the slide has a raised lip around the well where the plate is held, to ensure the slide being light-tight. Remove this lip with a sharp chisel, and fix two small brass turn buttons on the edge of the well.

This forms the carrier for your negatives, and it is shown in Fig. 6 on the back of the camera, with a negative in place.

Fix the other side of the slide centrally and squarely on the condenser holder on the bottom of the lamphouse. By placing a negative in the holder and closing it, you can slide your camera on to the lamphouse in a suitable position for operating the enlarger. If you have a camera with single metal slides, you can cut the back out of one, screw it on the lamphouse, and it will serve to hold negative and camera as effectively as a wooden slide.

Illumination

The lighting arrangements depend to a great extent on your own individual circumstances. The original model was equipped with a gas-filled pocket-lamp bulb and a four-volt accumulator. The exposure works out at about thirty seconds at f.8, with a negative of normal density, enlarging 3¼ in. × 2¼ in. to 10 in. × 8 in. on a fast bromide paper. If you have electric light in the house, you can work from this and still further decrease the exposure. In that case, the size of the lamphouse must be increased considerably and some ventilation provided, as a fair amount of heat is generated, even from a low-power bulb. The holder for the lamp

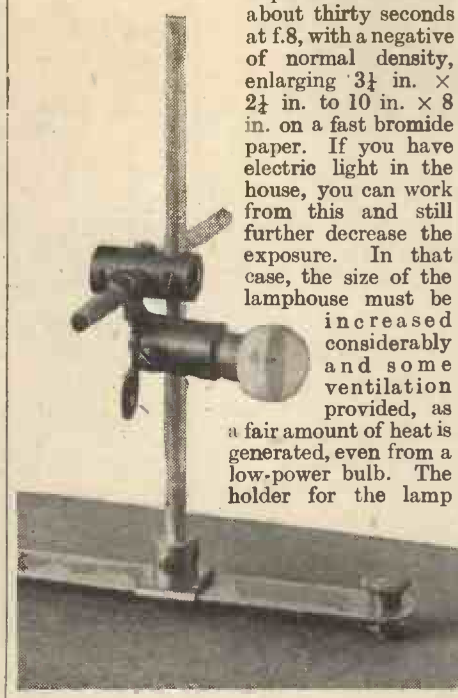


Fig. 5.—The holder for the lamp.

can be seen in Fig. 5, which should clearly show the construction. It is constructed in such a manner that the light can be accurately centred on the condenser and then locked tightly in position. A long strip is fixed inside the lamphouse by a terminal at each end, in the position marked in Fig. 4. The lamp slides along this strip to vary the distance between the light and the condenser. Fasten a switch on the back of the runners at a convenient height for your hand and wire it up to the lampholder with lighting flex.

We are now ready for a test. Connect up an accumulator, and fit a 3·5 volt bulb in the bulb-holder. Now fix your camera on to the lamphouse and switch on the light. Adjust the position of the lamp until a clear circle of light is thrown on the easel. Put a negative in the holder and focus it up sharp. You will probably find that the distance between the condenser and the lamp needs adjusting to secure the maximum illumination.

The enlarger is now complete and ready for use. Space will not permit me to give you hints on enlarging, and probably most of you are old hands at it.

Fig. 6.—A wooden dark slide converted into a negative carrier. It is shown on the back of a camera with a negative in position.

STAINLESS SAFETY-RAZOR BLADES

STAINLESS cutlery has for many years withstood the inroads of the enemies of steel. There has now appeared a process for the production of safety-razor blades with corrosion-resisting properties. These blades are made from a chromium steel to which has been imparted a thin protective coating of nickel or nickel cobalt alloy. The heating incidental to hardening is conducted in a reducing atmosphere after the protective coating has been applied to the steel. This treatment should increase the longevity of the safety-razor blade. It may reduce the number of those discarded blades, the disposal of which is a problem which appears to be a source of worry to many folks.

THE 1937 IDEAL HOME EXHIBITION

ONE of the most majestic spectacles ever presented in London will be offered to the people of this country, and the multitudes of Coronation visitors from abroad, when the Ideal Home Exhibition celebrates its coming-of-age at the new Earl's Court next year.

To give London's visitors, as well as the exhibition's hundreds of thousands of regular annual devotees, the opportunity of enjoying this great popular event, the organisers have decided to open the exhibition at a date which will cover the period of Coronation celebrations, and for a run of ten days longer than is usual.

250-ft. Span

The 21st Ideal Home Exhibition will, therefore, open on April 22nd and close on May 29th.

As is fitting, it will be an exhibition in which grandeur will be the keynote, and it will make its own appropriate gesture of loyalty to the Throne.

To this end the great centre arena of the new Earl's Court building—with a breathtaking roof-span 250 ft. wide, at a height approximating to that of the Nelson Monument—will be the scene of one of the most impressive displays 1937 will offer the public—The Golden Hall of Homage.

Entering the vast new building—in itself a thrilling sight—from the main vestibule, the visitor will find himself plunged into an atmosphere of golden splendour.

Facing him, and dominating even the vast proportions of the arena, will tower a statue in heroic scale of the King, set amid a magnificent panorama of London.

Gleaming Cavalcade

At each side of the arena gigantic friezes will be set in which, bearing gifts appropriate to their lands, the peoples of the Dominions and Colonies will march in a great gleaming cavalcade to pay homage to their King.

In each panel of these friezes the figures will be three times life-size, and each, with typical scenery, will be set in three planes, so contrived and illuminated that they will appear to be carved in solid gold.

The full-length statue of King Edward, made by Sir William Reid Dick, K.C.V.O., R.A., for next year's *Daily Mail* Ideal Home Exhibition, is grandly conceived, a superb embodiment of royal dignity without arrogance.

The attitude is simple, avoiding any suggestion of pose or stiffness. The sweeping folds of the Garter robes conceal but at the same time skilfully suggest an athletic, wiry frame.

The head, finally, remarkably true in every feature, bears an intelligently thoughtful expression which justly characterises a King.

Sir William has numerous triumphs to his credit. The lordly lion over the Menin Gate at Ypres, the Kitchener Chapel in St. Paul's Cathedral, the vast eagle spreading its wings on top of the R.A.F. Memorial on the Embankment, the large statues of Lords Irwin and Willingdon at Delhi, are among his notable achievements.

Fair Comment

The Stability of Science and Mechanics

IN the modern welter and turmoil when thrones rock, dictators dictate, and oak trees grow from the acorns of small issues, it is comforting to reflect that the world of science and mechanics goes on its way untroubled and untrammelled. Scientists and inventors, like artists, are outside the pale of nationality, for art knows no nationality nor creed. It is indeed fortunate for the world that the things which really count are due to individual efforts of those who suffer abnegation in order to produce some particular device which will benefit mankind. It is true that the world is unsympathetic towards inventors and scientists, and usually dismisses them as mental cases until they stagger the world with some new discovery or some new device. It is a tragic reflection that those who have improved the lot of the human race most have, as a reward for their pains, merely trod the thorny paths of penury. It may even seem that those who can invent a device which will kill the greatest number of people in the shortest possible time may have silver and gold to their hearts content. It is not really so, however, for self-preservation is the first law of nature, and however much we may desire peace in the world, we must consider how difficult it is in this modern Tower of Babel to secure unanimity of thought on a particular point. It does, indeed, seem a pity that the politicians of the world cannot learn a lesson from the world of science, in which there is no discord.

Scientists of all nations interchange opinions and experience and are at peace with one another. Education is the greatest peacemaker, and so let us hope that eventually science by peaceful penetration will eventually solve, not some abstruse problem in the laboratory, but the more pressing need of world-wide amity. Science does not deal alone with germs, retorts, chemicals, and mathematics. Knowledge is power, or as the latin tag has it, *scientia est potentia*—not power of the mailed fist sort but power for good. Everyone who is interested in science or mechanics is thus unconsciously playing his part in the creation of the eventual millennium.

Skill at a Premium

I HAVE received an enormous amount of correspondence from skilled men as a result of my recent paragraph drawing attention to the shortage of skilled workmen. Some of these letters are most illuminating, and interweave into the problem the age-old question of whether a man is too old at forty. Some of these readers tell me that many employers are of this opinion, and sack them as soon as the first thinning of the scalp, the presence of the first few grey hairs indicate the passage of two-score years. Fatuous nonsense! A man's experience is most mellow from that age onwards. What is the use of absorbing experience and skill if when you have got it you are considered too old to use it? Stability of outlook and sanity of thought cannot be associated with mere youth. Experience is not something which can be bought or even absorbed from books; it can only be obtained from the university of life. It is the one thing you cannot buy and it is one of the few things which you cannot give away, as well as being probably the only thing which cannot be taken away from you. At the age of forty a man is in his prime, and from that age onwards he accumulates experience and enriches his skill. Prior to that age he is like a lawyer "eating his dinners," and it is merely sensible to assume that after it he brings to bear a well-nourished mind on his particular job. Wisdom comes with age only. It is easy to mistake the vivacity and verve of youth for knowledge and experience, when it is merely the effervescence due to the untroubled part of an individual's life.

There is a movement on foot to-day to "give the young men a chance." It is somewhat pathetic to think that many of them are quite unfitted for the chances that are there. The mere absorption of book knowledge and the acquisition of the elements of the three R's, subsequent matriculation, and the obtaining of a degree are merely jejune. They are valuable, of course, as indicative of a standard of education, *but not as a standard of experience*. That can only be obtained by direct contact and wrestling with the problems of a particular job and the hurly-burly of life. At forty a man has had the rough corners knocked off him; he has learned from his failures what to reject and what to accept. He has learned, for example, that circus posters do not always speak the truth. He has learned to segregate the truth from the verbiage, and to superimpose *judgment* on his experience. Judgment and experience are not gifts, like a good voice or a man with double joints; it has to be obtained, and the obtaining is a slow process. The ripest experience and the wisest judgment only comes with age.

The youth of to-day is, of course, in a more fortunate position than his forbears, and it must be agreed that he attains the age of discretion earlier owing to the higher standard of education and the improved school curriculum. But we must not be blinded into thinking that the bump of knowledge is all that is necessary to be able to file a piece of metal *flat* (a highly skilled job), to make a press tool, or conduct a chemical analysis. I strike a subtle distinction, you see, between knowledge, experience, and judgment. The sum total of all these qualities is *wisdom*. The latter necessarily, though not always, connotes age. Perspicacity is an unstable ability and the prodigies merely provide another example of the exception proving the rule.

The March of Television

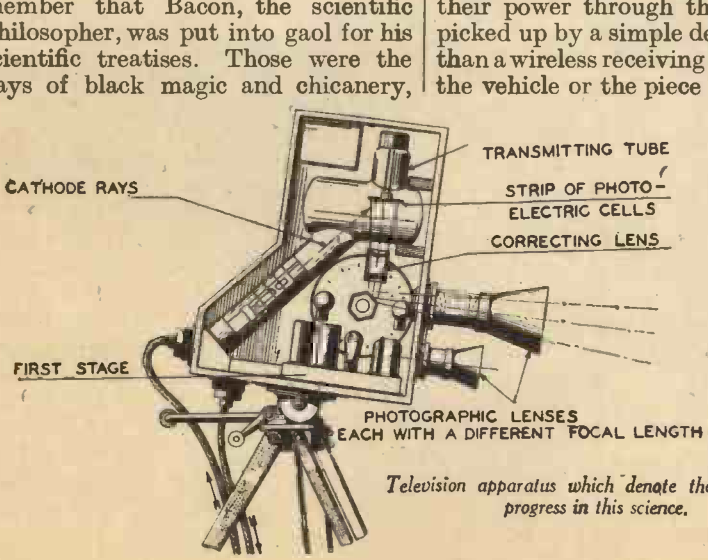
YOU have noted how television gets into the news almost every day. Have you pondered the remarkable developments of the science of radio in the comparatively short space of ten years? The impossibility of to-day is the practicality of to-morrow. Who could have thought ten years ago that it would be possible to perform the miracle of splitting up a picture or a scene into narrow strips, converting them into their electrical equivalent, and transmitting them through space so that you can see a scene enacted miles distant? A couple of centuries ago anyone who dared even to suggest such a possibility would have been promptly put into gaol as a philanderer and a charlatan as well as an enemy to society. You merely have to remember that Bacon, the scientific philosopher, was put into gaol for his scientific treatises. Those were the days of black magic and chicanery, and it may have been difficult in those days when people could scarcely read and write to separate the wheat from the tares. The way of the pioneer is indeed hard. He must pass through the various stages of being publicly rebuffed as a fool, suffer the sniggers of the crowd during his experiments, and then to the acclamation which comes from success. Television started off on its career in a more advanced stage than did wireless. It is expensive now because the demand is small and only one station is working. As soon as more stations are erected, and at least nine will be erected in various parts of the country, the demand will grow, output will catch up, and prices will go down. We live in a remarkable age which has seen the birth of the aeroplane, wireless, the motor-car, television; which has seen old processes go, superseded by better ones. A miracle ceases to be such when it is performed a second time. The first operation under chloroform was regarded as a miracle. To-day it is commonplace. We marvel at television the same as twenty-seven years ago we marvelled at Bleriot crossing the channel on his crude 15 h.p. monoplane. Science, like Alexander the Great, is always seeking fresh fields to conquer, and I have long ceased to consider anything as impossible. An idea may seem fantastic to-day, to-morrow it becomes a reality.

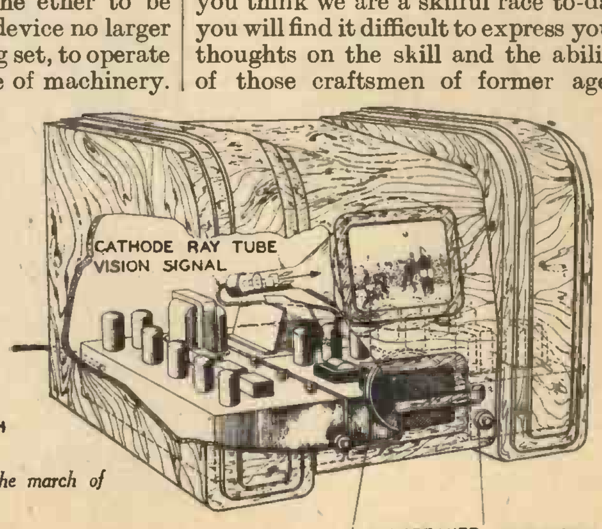
Wireless Transmission of Power

THERE is one field of science which is inevitable although it has not made much headway; but recent experiments have shown the idea to be a practical success. I refer to the wireless transmission of power, in which system a number of central stations, such as wireless transmitters, radiate their power through the ether to be picked up by a simple device no larger than a wireless receiving set, to operate the vehicle or the piece of machinery. Don't dismiss the idea as fantastic, because it isn't. Think of some of the benefits which this system would confer. Noise of petrol engines would be abolished, for everything would be electrically driven. You would, of course, take out a licence as at present, the tax being fixed according to the amount of power you are going to use. Piracy of the ether would be rampant as in the early days of wireless. Imagine the great advantage of merely having to erect an aerial and earth in order to set the wheels in motion. If you do think the idea grotesque, it is something worth thinking about. Do not imagine that there is little left for inventors. We are merely on the fringe of things. A century ahead the public will look back on the year 1937 and wonder how we managed, just as we look back a century and pity the conditions obtaining at that time. Verily we live in a remarkable age.

The Science Museum

THE Science Museum at South Kensington is the nation's storehouse of past ages. Here you may inspect in comfort and at your leisure the early mechanisms, the early carriages and locomotives, the early aeroplanes, spinning machines, weaving machines, printing machines, bicycles, motor-cars, watches and clocks, and, in fact, everything having a scientific bearing. Remarkably complete catalogues giving the history of the various exhibits are available for a small sum. I advise every reader who has not done so to spend several afternoons there. You will marvel at the skill of some of the old craftsmen who had to depend upon manual processes for operations which to-day would be performed by a stroke of the press or the turning of a handle. You cannot fail to be interested in a visit, and if you think we are a skilful race to-day you will find it difficult to express your thoughts on the skill and the ability of those craftsmen of former ages.





Television apparatus which denote the march of progress in this science.

Showing the attractive lines of the finished model.

A Model Super-Duration Biplane

by S. R. Crow

IT is suggested that the fuselage be made of $\frac{3}{32}$ in. balsa for normal use, although the original model utilised $\frac{1}{16}$ in. balsa.

It can be constructed in the same way as the autogiro fuselage (details of which are given on pages 137 and 138 in last month's issue), with the exception of the built-up nose formers and the additional sections of $\frac{1}{16}$-in. sheet balsa through which the bamboo motor plug goes (see side elevation). Negative incidence to the tail-plane is built into the fuselage; therefore construct the latter with the greatest care, as a model with the wrong incidence in the tail-plane will perform unwanted aerobatics.

Tail-plane

Pin a length of $\frac{1}{8}$ in. × $\frac{1}{4}$ in. balsa on to your drawing for the leading edge and then construct the trailing edge ($\frac{1}{8}$ in. × $\frac{1}{16}$ in. balsa) in the sections shown, as grain direction is important. Follow this by placing into position the 7 ribs which have been cut from $\frac{1}{32}$-in. balsa. Two bamboo strips bent in steam and held in position by pins until dry are cemented on to complete the tail-plane.

Fin

For both leading and trailing edges use $\frac{1}{8}$ in. × $\frac{1}{16}$ in. balsa with bent bamboo for the tip. A length of $\frac{1}{16}$ in. × $\frac{1}{16}$ in. balsa is cemented across the top of the fin for strength, which being single surfaced, does not require ribs. On taking up the fin outline, cement the trailing edge between the two sides at the end of the fuselage, and the leading edge to the top fuselage spacer.

The detail drawing of the undercarriage will simplify the construction of the latter. Bamboo legs plugged into note-paper tubes will give a detachable unit (see autogiro undercarriage), the wheels also being made by the same method as for the autogiro.

Make an aerofoil template of plywood to the given section and cut 22 ribs of $\frac{1}{32}$-in. and 6 of $\frac{1}{16}$-in. balsa. The four wing-tip ribs can be made without a template.

A Full-size Drawing must be Made or Obtained from the Offices of this Journal, as the Model is built on the Drawing

Upper Wing

Both wings are made in two halves; this will necessitate tracing and reversing the half shown on the drawing. Lay down the $\frac{3}{16}$ in. × $\frac{1}{16}$ in. main spar and cement on the ribs. The leading edge is made of $\frac{3}{32}$ in. × $\frac{3}{32}$ in. balsa and the trailing edge of $\frac{1}{8}$ in. × $\frac{1}{16}$ in. Bamboo tips bent in steam can now be cemented on.

The centre section of the top wing is made separately, the two wing halves being cemented to it. Dihedral is gained by sloping the two ribs of the centre section slightly inwards.

Lower Wing

This differs from the top wing only in span, as you can see from the drawing. Build it in the same way as the upper wing, but be sure to slope the centre ribs *outward* slightly to bring them vertical when the dihedral is steamsed in (see front elevation). Bamboo strips, $\frac{1}{16}$ in. × $\frac{1}{16}$ in. are cemented underneath the leading edge, main spar, and trailing edge. The dihedral is now steamed in. Make two wing struts of $\frac{1}{16}$-in. balsa and push them into their respective places. Make sure the wings are true before letting the cement dry.

MATERIALS REQUIRED

- 12 lengths of 3 ft. × $\frac{3}{32}$ in. × $\frac{3}{32}$ in. sq. (or if built as original, 8 of $\frac{1}{16}$ in. × $\frac{1}{16}$ in. and 4 of $\frac{3}{32}$ in. × $\frac{3}{32}$ in.).
- 1 length of balsa $\frac{1}{8}$ in. × $\frac{1}{4}$ in.
- 1 blank of $\frac{1}{16}$-in. sheet balsa.
- 1 block medium-hard balsa, $9\frac{1}{2}$ in. × $1\frac{1}{8}$ in. × $\frac{3}{4}$ in.
- bamboo.
- 2 lengths of $\frac{1}{16}$ in. × $\frac{1}{16}$ in. balsa.
- 3 lengths of $\frac{1}{8}$ in. × $\frac{1}{16}$ in. balsa.
- 1 block balsa 2 in. × 1 in. × 1 in. (nose block).
- 1 doz. cup washers.
- 6 in. celluloid tubing to take 20 S.W.G.
- 2 brass bushes to take 18 S.W.G.
- 2 sheets of tissue for wings.
- 2 sheets of tissue for fuselage, etc.
- 1 tin banana oil.
- 1 tube glue.

Nose Block

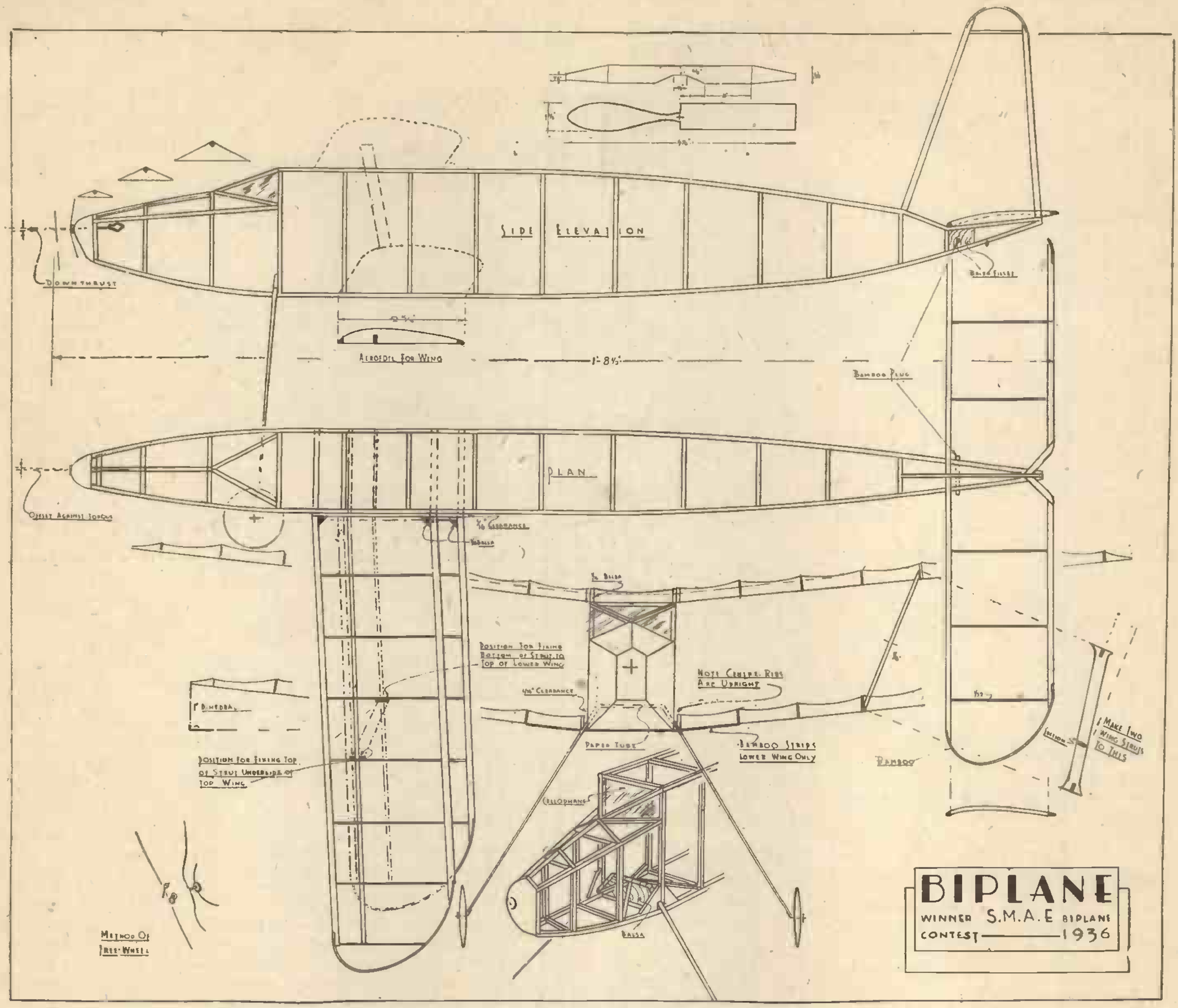
Make the nose block from hard balsa, sanding a finish with fine sandpaper. Before drilling a hole for the brass bush, cement a portion of $\frac{1}{4}$-in. flat balsa behind the nose block to keep the latter in position. 18 S.W.G. piano wire is bent to shape for the prop shaft. To make the free wheel, shape the hook end of the shaft and then pass the shaft through the nose block and propeller, bending the loop in the end with sharp-nosed pliers. A ratchet of 20 S.W.G. piano wire held by a pin completes this unit, and the ratchet must be free (see free-wheel detail.)

The Propeller

A block of medium-hard balsa, size $9\frac{1}{2}$ in. × $1\frac{1}{8}$ in. × $\frac{3}{4}$ in., is marked as shown on drawing; by using a plywood template symmetrical blades can be easily marked. Cut to shape with a fretsaw. Next the blank must be cut as shown on the side elevation of the propeller drawing, carving and finishing being done with a penknife, or spokeshave and sandpaper. The brass bush should be inserted before carving is started.

Covering

Cover the model with superfine tissue, dope or paste being used for adhesive. Stick the paper only round the outline of the fuselage and wings, as this gives it more chance to stretch after steaming. A coat of banana oil is now given to the whole covering of the model. (Coloured papers improve the appearance if the right scheme is used.)



Fireproof Concrete

PROGRESS, particularly in industrial heating engineering, demands also new building materials better able to withstand heat than those in customary use. Many therefore, are the improvements in this sphere, and anyone desiring a survey of these should visit the Building Fair held in connection with every Leipzig Spring Fair. The next of these, which will be held from February 28th to March 8th, will have plenty of interesting articles to show, in particular a new fireproof concrete which is produced under the name "Pyrodor." This new material has given excellent results in actual practice, and from it many special mortars have been developed which serve the most varied purposes, all of which are ordinary water-setting concrete mortars, hardening completely within twenty-four hours. This material fulfils all the demands which can be made on a so-called "concrete mortar" as it hardly shrinks at all during the hardening process, a disadvantage which was unavoidable with the clay bound mortars used hitherto. "Pyrodor" concrete is supplied in various granulations from fine ground masonry mortar to a coarse grained material with grains up to 1 in. Its use expedites the carrying out of many jobs and represents a saving in cost. "Pyrodor" will keep in storage for years.

Items of Interest

The specific gravity is 1·700, but can be reduced to 0·900 if required.

Newspaper Wrappers

AN annoying expense factor in the newspaper establishment is that of applying wrappers in the despatch-room. There have not been many satisfactory mechanical solutions of this problem up to now, and a speeding up of the work only meant engaging more hands with a consequent increase in the wage bill. Now, however, the problem has been solved and once more an expense factor in the newspaper establishment has been eliminated. The solution is provided by a new machine which will be exhibited at the forthcoming 1937 Leipzig Spring Fair from February 28th to March 8th, amongst the machinery for the graphic industry along with other innovations and improvements.

One operator with this new machine can paste on about 80 wrappers in a minute, each wrapper receiving a clean gum application, and after a short, but intensive pressing the newspapers are piled on to the conveyor belt ready for despatch. The machine is of the simplest imaginable construction and can very quickly be adjusted to the required size for any kind of newspaper or periodical. The wrappers themselves are placed correctly and neatly around the package. The automatic feed and delivery of the newspapers and wrappers is effected so correctly and reliably that losses in wrappers need no longer be taken into consideration.

Air News

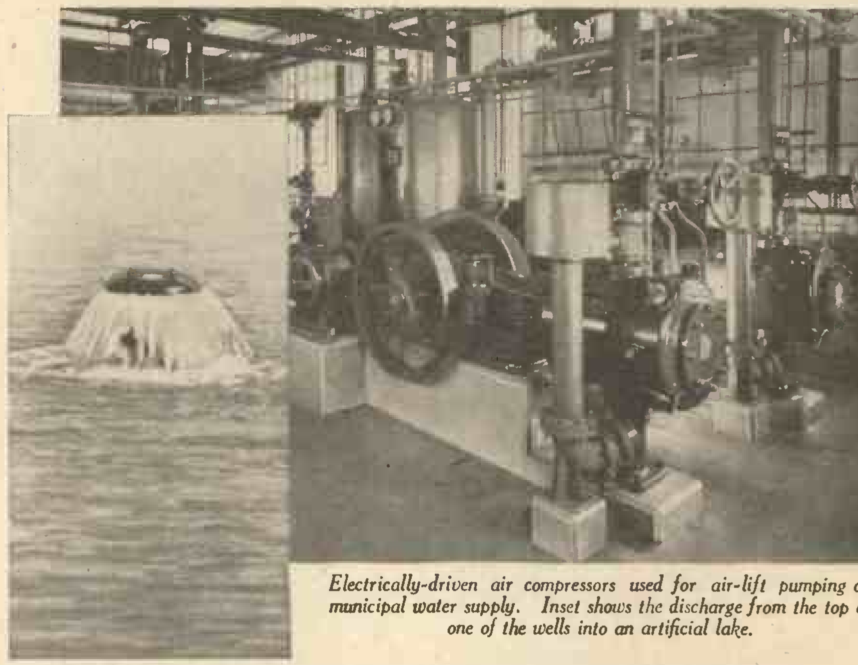
A STRIKING development in the United States recently has been the increase in the operation of air-taxi services. Nearly every air-port in America now has its special-charter service. Landplanes, seaplanes, and amphibians are included in the air-fleets, and are provided with radio and instruments for blind-flying.

. . . .

A new direction-finding wireless station has been completed at Basra, and will shortly be in regular operation. The river and flying-boat basin are now being dredged, and a slipway is also to be provided. These improvements are expected to be available for use within the next few months. The new air-port building, including a well-appointed hotel, will be ready shortly.

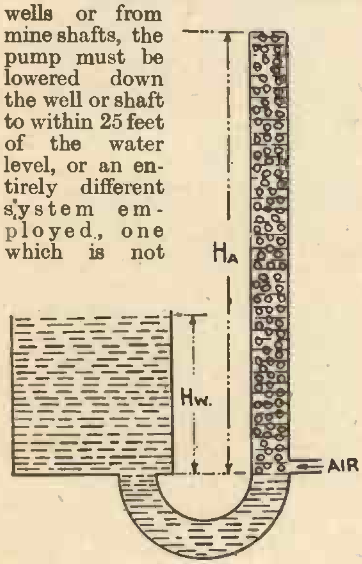
Pumping Water With Compressed Air—By Stuart Young.

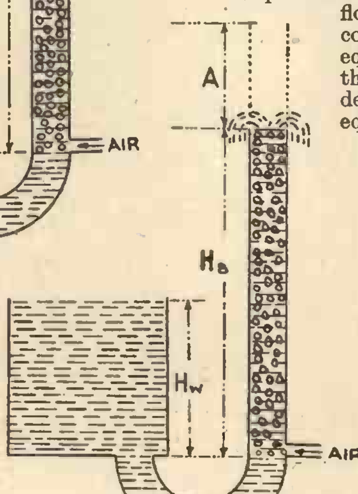
The Air-lift System of Pumping Water from Deep Wells depends entirely on Bubbles of Compressed Air entering a Column of Water.



Electrically-driven air compressors used for air-lift pumping on municipal water supply. Inset shows the discharge from the top of one of the wells into an artificial lake.

PUMPING water by plunger type or centrifugal pumps has serious limitations due to these pumps not being able to suck up water from depths below 25 feet. When they attempt to do so, a vacuum is formed and the pumps fail to draw water. If it is desired to raise water from deep wells or from mine shafts, the pump must be lowered down the well or shaft to within 25 feet of the water level, or an entirely different system employed, one which is not limited to a suction lift of 30 feet. Such a system is air-lift pumping.





Figs. 1 and 2.—(Above) Raising water with compressed air. (Right) By cutting the pipe the mixture of air and water no longer balances in the column.

Raising Water

This method of raising water with compressed air is shown in Fig. 1. If the tank is filled with water it is clear that water will rise in the vertical column to the same level as that in the tank. Now suppose that a quantity of compressed air is allowed to flow into the pipe through a connection at the bottom of the vertical pipe, the mixture of air and water in the pipe, because it is lighter (of lower density) than the water in the tank, would rise and continue to rise until the pressure represented by the head of air and water (Ha) was equal to the head of pure water (Hw). There would then be a state of static balance—no water is flowing. Now assume that, after the static position has been reached, a section of the vertical pipe is cut off, say, amount "A," (Fig. 2), now the mixture of air and water no longer balances in the column, the head of pure water in the tank and the result is a flow of water up the vertical column. The actuating force is equal to the unbalanced force of the column of mixture due to deducting "A." This force is equal to the pressure exerted by the head of pure water (Hw) less the pressure exerted by the head of the mixture (Hb). Provided water is flowing into the tank and air is supplied at the bottom of the vertical pipe, water will continue to flow from the top of the column, having been raised a distance Hb—Hw.

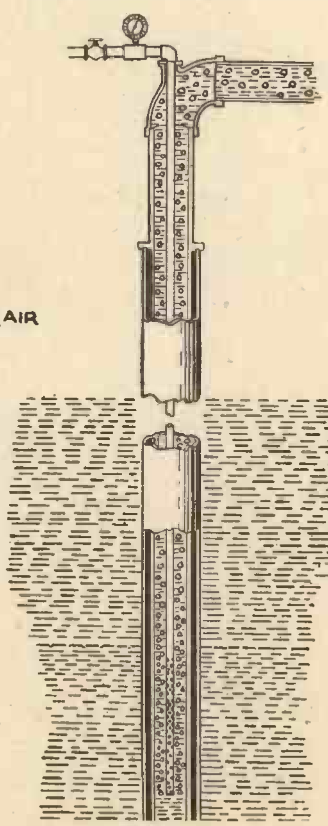


Fig. 3.—Pumping water from a well.

From a Well

This method of pumping water as applied to raising water from a well can be followed by reference to Fig. 3. Compressed air at a suitable pressure is generated in a compressor which may be driven by steam, oil-engine, or electric-motor, and is forced through steel pipes to the head of the well where a valve is fitted so as to control the flow of compressed air. The air pipe is lowered down the well deep into the water—the actual distance for good efficiency (most water discharged for minimum supply of compressed air) is calculated from certain formulæ. This air pipe is surrounded by a pipe of much larger diameter, in fact as large as the well will allow, this outer pipe being used to conduct the water up the well when the air is turned on. This water pipe, known as the rising main, is continued beyond the top of the well and given a right-angle bend so as to lead the water away. In order to split up the air into small bubbles it is only allowed to perculate through a series of small holes at the bottom of

Fig. 4.—Demonstrating the air-lift method of pumping water.

the air pipe. This system will work quite well when simply allowing the air to flow out of the open end of the air pipe—it will, however, need more air than would be required if the air is split up as suggested.

Air Pressure

The compressed air must be at such a pressure that when the air valve at the top of the well is opened, air will rush down the well, displace the water from the air pipe, and be forced through the small holes at the bottom. The air pressure should be a little greater than the pressure due to the head of water above the bottom of the air-pipe—actually ·434 lb. for every foot. Once the air bubbles out of the small holes into the water in the rising main, the density of the water-air mixture will be less than that of the water in the well and the column in the main will rise, more water will be aerated and soon a steady flow will be discharged through the bend at the top of the rising main. The process is continuous and will go on as long as water is present and the compressed air is being pumped down the well.

It requires only very simple apparatus to demonstrate the air-lift method of pumping water. In Fig. 4 we see a simple demonstration using only two pieces of tube and one's mouth as the compressor. Such an arrangement will at least illustrate the simplicity of the method.

The Air-lift System

The air-lift system of pumping is required to raise water from deep wells, to de-water flooded mine shafts and also to raise oil from oil wells when the natural flow has ceased. For it is claimed simplicity, large capacity of water, and low maintenance cost. All the necessary plant is above ground and there is very little that can fail.

Many large hotels, office buildings, industrial plants and municipal water boards rely upon air-lift pumping for the whole of their water supply. Water for domestic purposes is improved by aeration; one reason why water raised by air-lift is preferable for a large number of uses. Many hundreds of wells in Great Britain are in constant use, depending on little bubbles of compressed air to raise many millions of gallons of water to the surface to serve our varied needs.

STONE POLISHING FOR AMATEURS

Valuable Information on a Fascinating Process

WHEN you visit any of our seaside resorts a close scrutiny of the sands and shingle may reward you with what usually is termed a " pebble," though not always will it have that rounded form we associate with the word.

Pebbles may be recognised by their translucency and colour, and most commonly are forms of silica to which such names as agate, carnelian, jasper and chalcedony are applied. They include also cairngorm and amethyst, though these two are local and rare. The south and east coasts are happy hunting grounds for the pebble hunter.

Now, having found your pebble, you will want to cut it, in other words to reduce it to a regular shape, and give it polish to bring out its colour and markings.

Tools Required

Just what tools are required will depend upon what is to be done with the stones. If it be desired to only grind and polish a single face to bring out the colour and markings, very simple appliances will serve. The rough grinding will be done on a grindstone or emery wheel, if either is available, and if not, then the more arduous process of rubbing down by hand on a slab of sandstone, or wood charged with coarse carborundum powder and water, is the next best way.

Having ground the stone to a fair surface free from pits and other blemishes, the next thing is to repeat the process with a new tool and a finer grade of carborundum, until the surface shows no sign of scoring, and takes on a surface that may be compared with ground glass.

The Polishing Process

It will then be ready for polishing, which may be done on a pad of felt, tacked to a slab of wood and charged with putty powder and oil. The polishing process demands patience, and must be continued until the polish remains after the surface has been washed free of oil. If the utmost brilliancy be desired, the polishing may be continued with jeweller's rouge on a surface of pitch, using the rouge wet, but allowing it to become nearly dry as the process approaches completion.

Should the stone be of such a shape or size that it cannot be held in the hand, it may be cemented to a block of wood, so as to give a better hand-hold.

Mounting the Stones

Stones polished in this way have a certain amount of interest as mineral specimens, but there is no very useful purpose to which they could be applied. If it be desired to mount the stones either in jewellery or as surface decoration, say, to a box lid, then the polishing process must be adapted to the production of a regular convex surface. This may be done by the use of the simple appliances illustrated.

Fig. 2 shows a spindle made from dowelling on the centre of which a cotton reel with bore enlarged is fixed; at the top a wire nail

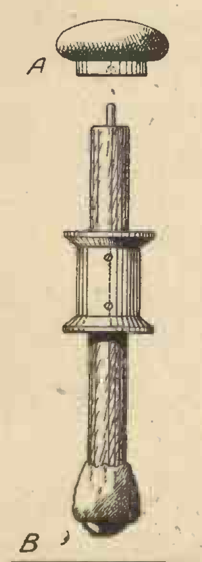


Fig. 3.—This arrangement, whereby an Archimedean drill is used, can also be adopted.

Fig. 2.—(Above) The apparatus used in stone polishing. Fig. 4.—(Right) The stone should be cemented to a short handle when the lapping board is used in the lathe.

Fig. 1.—The process in operation.

is driven in, the head cut off and the nail filed to a rounded point. The pebble is cemented to the other end of the spindle as shown. A knob handle, shod with a plate of brass in which a central socket is drilled, must be made, as shown at *A*. This spindle is rotated with a bow, pressure being put on with the handle held in the left hand, whilst the pebble is sunk in a hollow gouged in the slab of wood *B*, carborundum being used as the abrasive. It is with this simple appliance the lapidaries of India cut and polish their gems. Fig. 1 shows the process in operation.

An Archimedean Drill

If the worker has an ordinary drill stock with expanding chuck, the arrangement shown in Fig. 3 might be adopted with advantage. The stone is cemented to a short piece of dowelling, into which a stout screw is driven and its head cut off with the hacksaw.

Grinding and Polishing Pebbles

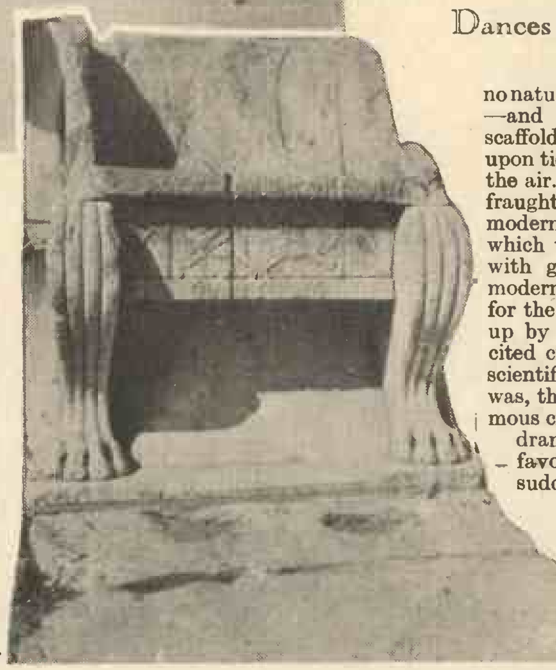
Those who possess a lathe may use it for the grinding and polishing of pebbles, chucking the wood block *B*, Fig. 2, and mounting the pebble on a short handle as shown in Fig. 4, but they must be warned not to allow the abrasive to get into the lathe bearings.

The process obviously can be better conducted with the lapidaries' wheel, which rotates horizontally. This tool may also be adapted to slitting and faceting stones, and, in fact, to every process connected with the cutting and polishing of precious and other stones.

The World's First Theatres

By George Long, F.R.G.S.

The first Theatre was built in the Sacred Enclosure of the Greek God Dionysos. Greek Dramatic Art developed from Primitive Religious Dances held in his Honour



(Above) The Greek circular modern dance. (Right) The high priest's seat at the Theatre of Dionysos.

THE theatre is one of the most important of all the agencies which have been fashioned for the amusement and instruction of the people. Its influence upon human thought is only second to that of the printed word, and it may presently take first place, owing to the enormous development of its modern offspring—the cinema.

It was in the lovely land of Greece that the human mind first broke free, and it was beneath those azure skies that the world's first actors declaimed the immortal dramas of the great Greek poets.

It is a striking and significant fact that the words we use to-day in relation to the theatre, and its details, are *wholly* Greek. "Theatre" (or "theatron") (θέατρον) in the original means "A place for seeing." "Komedia" needs no explanation, neither does "orchestra"; and even the word "scene" comes from Greek "skene," through the Latin word "scena."

The first Greek theatres were not buildings at all. They were marked-off dancing-places, of flat firm ground, at the foot of natural semi-circular hill-slopes.

There are a few very worthy and pious people who firmly believe that both *acting* and *dancing* are sinful; but as a matter of fact *both* had their *origin in religious worship*! Bible students will remember the incident described in the Old Testament, where King David danced before the Ark of Jehovah; and from the dawn of time, primitive peoples have expressed their religious emotions by ceremonial dances.

World's First Theatre

It is a significant fact that the world's first theatre was built in the sacred enclosure of the Greek god Dionysos, and there is no doubt that Greek dramatic art developed out of the primitive religious dances held in honour of the god. These festivals of Dionysos began before the dawn of history, and it is probable that the first theatre was in use as early as the seventh century B.C., though we have no actual mention of such earlier than the first half of the sixth century.

We have mentioned that at first the spectators stood or seated themselves on the bare hillside, but as the crowds increased in numbers, efforts were made to accommodate them by erecting wooden benches running up the slope.

As the theatre increased in popularity, a demand arose for performances where no natural hill-slopes existed, and so at Athens—and perhaps elsewhere—lofty wooden scaffoldings were set up, which provided tier upon tier of wooden benches rising high into the air. Such structures have always been fraught with danger, and both ancient and modern history is filled with disasters, in which these flimsy benches have collapsed with grave loss of life. Even with our modern knowledge, it is difficult to provide for the unknown stresses which may be set up by the pushing and shoving of an excited crowd, and in the sixth century B.C. scientific calculation was unborn. Hence it was, that one day at Athens (when an enormous crowd had gathered to witness a great dramatic festival in which three public favourites were taking part) the seats suddenly collapsed, burying hundreds in the ruins. The laughter and cheers of the people were changed to shrieks of terror, and when the debris was removed it was found that many had been killed and injured. But the lesson had been learned.

Marble Theatres

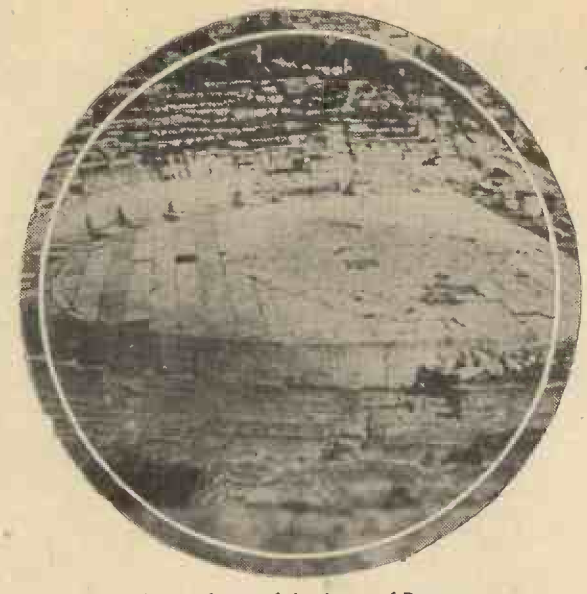
No more scaffoldings of timber were allowed, and low benches on sloping ground were first substituted, to be followed later

The situation of the Theatre of Dionysos, below the Acropolis.

by magnificent theatres of marble, which could accommodate thousands of spectators with perfect safety. The largest of the Greek Theatres is said to have had seats for fifty thousand persons; while the first of these—the Theatre of Dionysos at Athens—had a seating capacity which has been estimated by different experts as from seventeen to twenty-seven thousand.

This glorious structure, with its seventy-eight tiers of white marble seats, and its dazzling sculptures chiselled by the greatest artists the world had known, was built between 350 and 325 B.C., and is a most impressive sight even in its ruin to-day.

Its situation is superb. Its semi-circle of seats are hewn in the living rock that rises in a gradual slope to culminate in the majestic cliff that men call the Acropolis, crowned with the most glorious group of temples the world has ever seen. Below and beyond stretches the far-famed Attic plain, dotted with temples, enriched by vineyards and gardens, and the far horizon is bounded by those classic mountains where dwelt the gods of Greece.



A general view of the theatre of Dionysos.

The *plan* of this theatre has given us the pattern for every theatre in the world. The seats rise in a horse-shoe curve above the orchestra and the auditorium. Here we have a raised platform or stage, separated from the orchestra by a marble wall, enriched by statues, and provided with steps called the "proscenium" ("proskenion" in Greek). The history of this development is very interesting.

The Earliest Theatres

The earliest theatres consisted merely of a flat dancing-place, overlooked by seats or slopes. As the theatre developed it became necessary to provide a dressing-room for the actors, and this at first was a hut or tent called "skene," placed at some distance from the orchestra. Presently it was placed close to the orchestra, and a wall or ornamental pillars was erected in front of it, called the "proskenion"—which means "front of the tent."

When the marble theatre of Dionysos was built this plan was further developed. The "proskenion" became a lovely line of marble statues, with a flat stage above, reached by steps. The players entered by "wings" at the ends, just as they do to-day. In later Greek theatres (as that at Syracuse shown herewith) the players entered by tunnels, so that—as on the modern stage—their approach was unseen. The Syracuse theatre is one of the largest in the world, but was not built till nearly a thousand years after that of Dionysos.

Stage machinery was crude and primitive but effective. There was a kind of net, suspended by a rope like a simple crane, by which gods descended *from*, or heroes ascended *to*, Heaven.

Among the ruins of some Greek theatres are pits or caves, which were probably used for a similar purpose.

There was also a machine, called in Greek "ekkyklema," whose exact use is unknown, but it is believed to have been a kind of wheeled platform, upon which gods or heroes could be mounted, and the whole dragged on to the stage by ropes. We know that warriors in chariots could drive their vehicles on to the stage.

The Thundering Machine

"Noises off" were provided by an invention called by the Greek writers "The Thundering Machine." Hides were inflated, filled with stones, and beaten against metal plates.

We have spoken of the theatre—what of prices? For many years admission was free, and when a charge was made Pericles had a law passed which ordained that the charges were borne by the State. These prices were amazingly low, when we remember that the performance lasted for a whole day for a charge of 3*d.*! The great three-day Festival of Dionysos cost one drachma, say 9¾*d.* And for this the spectators could sit enthralled, and listen to the masterpieces of Sophocles, Aristophanes, and Euripides two thousand years before Shakespeare was born. As with us to-day the front seats were the best. They were very ornate carved marble chairs. One of the best of these belonged to the High Priest of Dionysos, and has his name on it (see illustration). Others in this row were reserved for distinguished visitors, ambassadors, generals, and—note this—children of heroes fallen in battle. Although the prices were so low, salaries of actors were high, and some of them compare even with the emoluments received by film stars to-day. The great Polus is said to have received £240 for a two-day performance, but then—as now—the chorus and supers were poorly paid.

Seating Capacity

In the space available I cannot describe other Greek theatres, but I will just mention a few figures. The largest in Greece was that of Megalopolis, with seating capacity variously estimated from twenty to forty-four thousand. Outside Greece, the theatre of Syracuse was one of the greatest. The seats formed more than a semi-circle, 147 yards in diameter. Forty-six tiers of seats still remain.

The theatre of Ephesus was said to accommodate fifty thousand spectators, but scarce a vestige of its splendour remains to-day.

The most beautiful of Greek theatres is the far-famed structure at Taormina in Sicily. Its seats are hewn in solid rock, the diameter of the seating is 357 feet, and that of the auditorium 115 feet. The stage is very ornate, and well preserved.

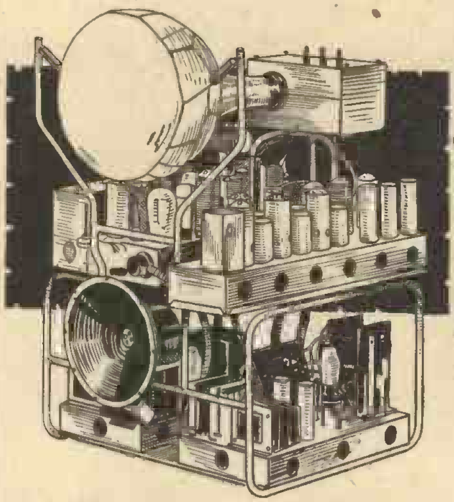
(Left) The Greek theatre at Syracuse. (Below) The proskenion theatre of Dionysos, showing damaged carvings and steps to the stage.

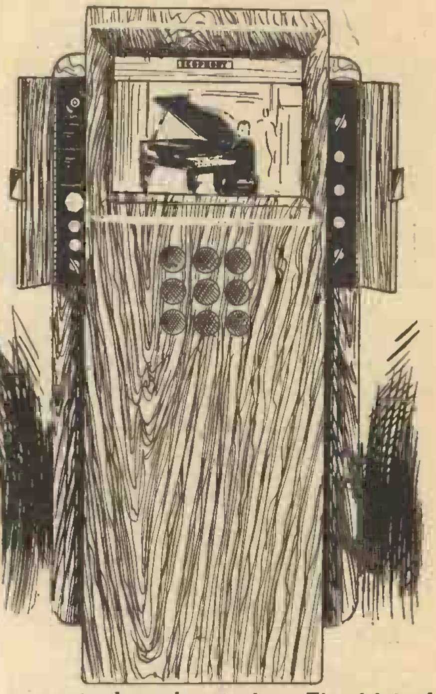
TELEVISION TOPICS

Receiving Signals Radiated from Alexandra Palace; Public Television Shows; a New German Television Camera

Mechanical Systems

QUITE a number of people are still pinning their faith to mechanical systems for the reproduction of high-definition pictures on home receiver screens. No modification of disc scanners is capable of giving the results desired, but the application of mirror-drum scanners is being pursued by inventors who see in this method a way to produce projected pictures. The bare principles seem to be based on two rotating members with the required number of reflecting facets. One of these corresponds to the line frequency and the other to the frame or picture frequency. Sometimes an echelon or staggered formation of reflecting mirrors is included to reduce the number of actual rotating facets. The modulated light source is an improved form of Kerr cell which proved so popular in the days of low-definition television. One of the greatest drawbacks to any mechanical form of receiver is the existence of two standards of picture transmission, and some designers have already stated that sets of this type will not be marketed until the Television Advisory Committee have made their promised recommendations for a single picture standard, a point alluded to by Lord Selsdon in his speech at the opening ceremony.





Here are two examples of the different systems as mentioned in this article. The left-hand illustration shows a cathode-ray receiver, and the right-hand illustration is a mechanical receiver, no details of which, have, however, been released by the makers.

Television Rediffusion in Miniature

FOR the purpose of the television demonstrations at Radiolympia this year, the E.M.I. Service Company tried out a scheme which proved very satisfactory. For receiving the signals radiated from the Alexandra Palace, a single half-wave dipole type aerial reflector was located at the top of a tall mast on the roof of the building, and the eight separate booths in which were installed the television receivers were fed via short lengths of feeder cable from a central distribution amplifier. It was this amplifier which was the subject of the supposed sabotage two or three days prior to Olympia's opening, and since this coincided with the temporary breakdown of the ultra-short-wave radio transmitter on the occasion of the Press visit for a preview, the opinions then expressed were not as favourable as they should have been. During the whole of the Exhibition period, however, this miniature rediffusion scheme worked quite well, and a few days ago a direct development of this arrangement manifested itself in a block of Mayfair flats, the full details of which have appeared in our companion journal *Practical Wireless.*

A corner of one of the photographic rooms at the Crystal Palace where research work was undertaken in connection with television.

A New Outlook

A CLOSE study of the activities of the cinema industry shows quite clearly that they are very much alive to the development of television, and are taking steps to see that where possible the advantages of the new science are incorporated in their own cinema designs. For example, all new cinemas now being erected or contemplated are having much larger projection boxes than before. This is for the purpose of installing big-screen television projectors, it being felt, although no concrete plans have been formulated, that the equipment essential for this purpose will be of the front projection type and can be accommodated side by side with the standard film machines. At the moment the development of the intermediate-film projection receiver seems to be the most likely to fit in with this scheme, and it is already being asked whether equipment of this nature will be available in time for cinema patrons to see the proposed televising of this year's Coronation. Another way in which the so-called "challenge" of television is to be met is to give added importance to thedegree of comfort, luxury, and attractive appearance as far as the actual cinema building itself is concerned. In this way the architect feels he will be able to offset the temptation of people to stay at home by the comfort of their own firesides.

Public Television Shows

THE publicising of television shows by the installation of sets in restaurants, cinemas, stations, etc., is proceeding along normal lines, but it is now learned that the Performing Right Society is endeavouring to claim fees for this. They maintain that any place where television is used to attract the public should be compelled to pay the society a fee for the privilege. The enforcement of such a rule would make a very material difference to the featuring of television in certain places. It only applies, however, where the public pay either directly or indirectly to be entertained, so that stores and free exhibitions should be exempt.

A New German Television Camera

BOTH for the televising of the Olympic Games, and also during the Berlin Radio Exhibition, a direct pick-up electron camera was used with marked success. Based on the original researches of Farnsworth and built for the German Post Office by Fernseh A.G., the camera in question is shown on this page. The complete unit is very similar in external appearance to a film camera, being built up on a light tripod stand so that the camera can be panned very readily in any desired direction. This is effected in a horizontal direction by the straight handle shown at the back, while movement in a vertical plane is carried out by rotating the handle on the left, a reduction gearing giving a smooth, steady motion.

In the front of the camera case is a telescopic lens system of such dimensions and design that in the case of the Olympic Games, events taking place on the opposite side of the Stadium could be transmitted with sufficient detail for items to be recognised. The television section of the camera consists primarily of an evacuated cylindrical glass container as shown, which has incorporated at one end a photo-electric cathode. The preparation of this photo-electric layer is of such a character that it is capable of emitting electrons from its surface in direct proportion to the intensity of light to which it is subjected.

Optical Image

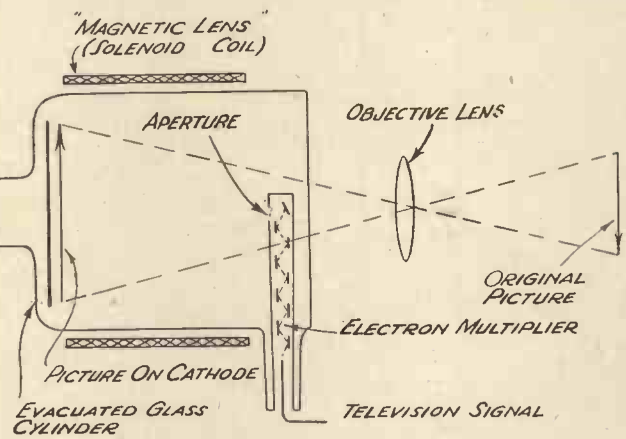
IN use, therefore, the lens, of large aperture, forms an optical image of the scene to be transmitted on the flat surface of the prepared cathode. From every point of the surface electrons are liberated, corresponding in density to the brightness of each point of the optical image. Thus, an invisible electron beam is emitted from the cathode, the application of a positive potential at the far end of the tube ensuring that the electrons proceed forward at high speeds.

To produce an undistorted electron picture, however, an external solenoid coil surrounds the glass cylinder. By a suitable adjustment of the strength of the direct current passed through this coil it is possible to make the resultant magnetic field act as a magnetic lens, and produce in what is known as the target plane an electron picture which is an exact replica of that originally produced at the cathode surface. This coil is shown diagrammatically on this page.

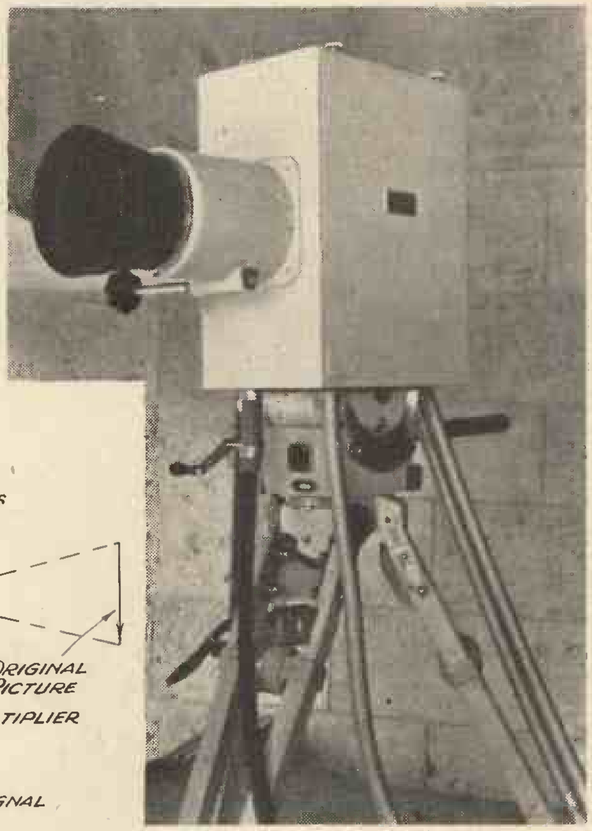
In the target plane of the electron picture is a small square scanning aperture, the size of which corresponds exactly to one picture element. That is to say, if the picture size produced in the camera is 4 in. $\times$ 4 in. and the degree of definition one of 240 lines, then the aperture would be $\frac{1}{60}$ of an inch square.

Scanning

AS readers know, scanning is really a case of relative motion whereby every element of the picture is explored in turn so as to produce an equivalent electrical signal. With this electron camera the aperture, is fixed in position, and the electron picture is made to move in two directions, that is horizontally (line scan) and vertically (frame scan). This is brought about by passing currents of a special shape through two pairs of coils mounted at right angles to one another external to the tube. The resultant dual magnetic fields impose a movement on the beam so that every point of the electron picture is passed over the fixed aperture in closely adjoining lines.



A simple diagrammatic representation of the German electron television camera.



The direct pick-up electron camera which in operation resembles that of a cinema camera.

Electron Density

THE density of the electrons passing into the aperture at every instant corresponds exactly to the brightness of the picture element to be transmitted at that moment. These electron currents, which are extremely minute, are amplified within the aperture tube by means of secondary emission. For this purpose the electrons are directed along a special path, so that they are caused to strike a series of electrodes, the surfaces of which have been treated in a certain way. The impact of every electron hitting a surface of this kind knocks away several so-called secondary electrons, and these in turn add to the original electron stream, causing a marked amplification of the original aperture current. The dissected picture current produced in this manner is further amplified in a normal thermionic valve amplifier before being made finally to modulate the ultra-short-wave carrier of the television broadcasting station.

Flicker Eliminated

THE pictures produced by this electron camera were shown to an interested public on cathode-ray tube television receivers at the Berlin Radio Exhibition, and the results were stated to be quite satisfactory, whether fed by line or radio to the sets in question. In addition to pictures produced by this camera by consecutive sequential scanning, another electron camera of the same type was on view. This produced a picture having a definition of 375 lines, but in this case the scanning was interlaced. First the odd lines and then the even lines were traced over the fixed aperture, giving a total of 50 frames of $187\frac{1}{2}$ lines per second interlaced, so that there was a total of 25 complete pictures in one second, each of which had a total definition of 375 lines. In this way flicker was reduced to a negligible quantity, a fact borne out by observation on the receivers operating in conjunction with this second electron camera.

Telegraph Poles

AMERICANS do most things quickly—even the planting of telegraph and power-line poles. An Illinois company has developed a special trackless tractor which is fitted with an earth borer and a pole-lifting boom. With a crew of eight men, a hole 5 feet deep can be bored, the pole raised, set in position, and consolidated in less than three minutes!

Mr. D. A. Russell's petrol-driven low-wing monoplane awarded first prize in the Concours d'Elégance at the Lancashire Model Aero Club's Rally.

MODEL AERO TOPICS

Indoor Flying at the Albert Hall

AS announced in the last issue, indoor model flying competitions are taking place at regular intervals at the Albert Hall. I attended one recently and must congratulate the organisers on planning a most interesting evening. There were dozens of models, including a model ornithopter, in flight during the evening. None of the models exceeded ½ oz. in weight, and all were flying most successfully. It certainly is fascinating to watch these ultra-light models flying at speeds of about 4 miles an hour with the propeller just turning round. The result of the competition was as follows:

R. Copland	200 sec.
S. R. Crow	145 „
T. Ives	108 „
W. L. Henry	94·8 „

Additionally E. A. Ross created a record for indoor fuselage models of 151·6 sec. The best flight of the evening was 7 min. 15 sec.—not, of course, in the competition.

Wheels for Petrol Models

NOT the least important part of a petrol-driven model is the chassis, and the most important parts of the latter are the wheels. A well-designed chassis is of no avail if the wheels collapse. Many of the disc wheels formerly sold were weakly designed at the hub, and two or three side landings usually caused the latter to rip out of the aluminium discs. Later, rubber balls were used, and were entirely satisfactory.

I have received from the Model Aircraft Stores, 127B, Hankinson Road, Bournemouth, a pair of their new "B.B." Air Wheels, which they have designed specially for petrol models. They have the advantage that they are British made and they are obtainable only through them, although they are prepared to supply any member of the trade who cares to stock them. The 4½-in. wheels retail at the low price of 4*s*. 6*d*. per pair. The tyres will not knock off in use, and were, under test, extremely difficult to remove. The hubs are of hardwood, and bored for either ⅛-in. or 3/16-in. axles. They can easily be bushed in any desired way, but they can be used quite satisfactorily as supplied. A little oil can be inserted in the bore, and will efficiently lubricate the bearings. They will stand up to an enormous amount of hard use without appreciable wear. The wooden hub has been so designed that the complete wheel complies with the requirements of minimum air resistance and a streamlined air flow. The tyres are, of course, pneumatic, and the firm tell me that they will add other sizes from about 1 in. to 6 in. in diameter to complete the range if there is sufficient demand. The weight of the wheels is less than any other air wheel on the market of the same size, but if any aero modeller requires specially light wheels the firm will supply balsa hubs and with aluminium bushes. The wheels are really well made and I can thoroughly recommend them.

A Large Petrol-driven Monoplane

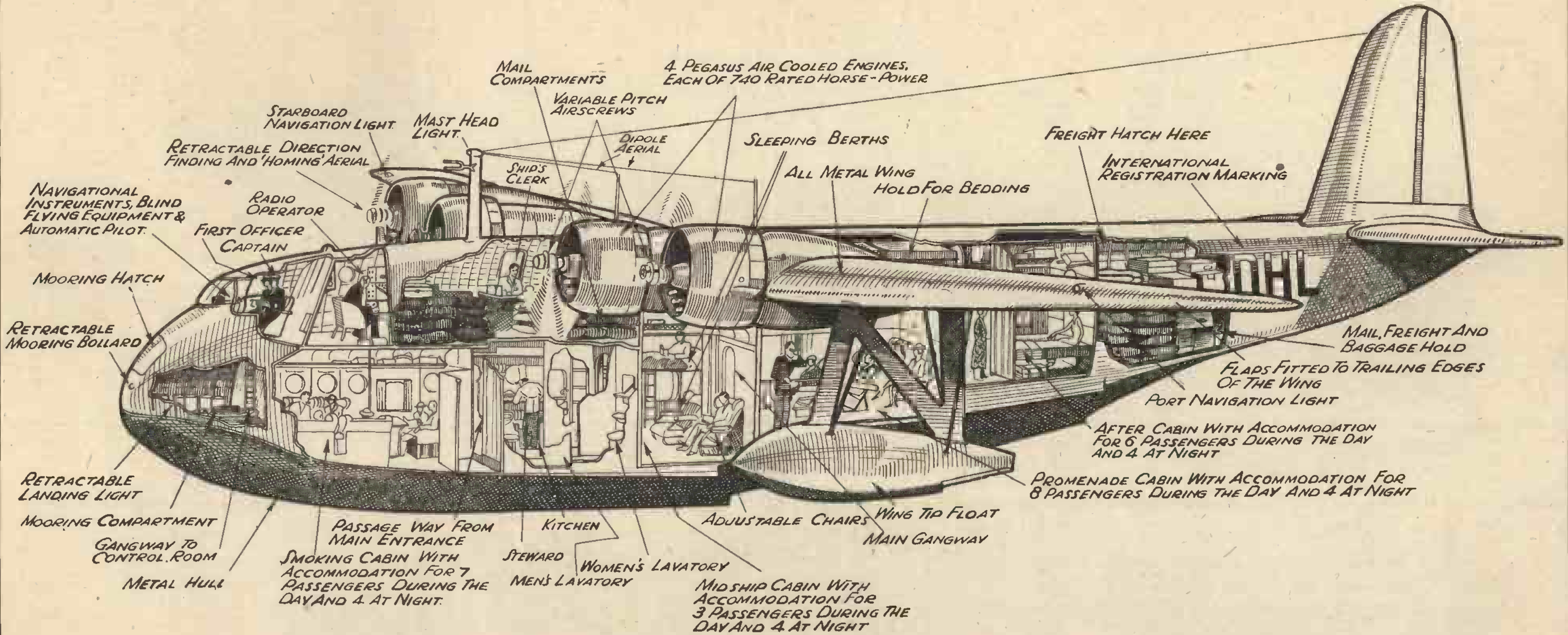
THE photograph at the top of this page shows a large petrol machine built by Mr. D. A. Russell. The photograph was taken at Manchester Airport on the occasion of the rally of the Lancashire Model Aircraft Club. The machine was awarded first prize in the Concours d'Elégance. The string used for controlling the model during test hops may be seen in the illustration.

The Pioneers

I NOTICE that a contemporary is enquiring regarding the whereabouts of some of the pioneer aero modellers, such as E. W. Twining, and makes a suggestion that a reunion dinner should be held. Mr. E. W. Twining was the first winner of the Wakefield Challenge Cup, and it would have been a nice gesture had he been invited to the dinner which was given by Lord Wakefield to the victorious Wakefield team when it returned from America this year. Most of the early pioneers have entered the aeronautical profession. C. R. Fairey and A. V. Row are two names which are household words to-day. What has happened to R. F. Mann, who with his schoolmaster formed a company which marketed the Mann Racing A-Frame Monoplane? Few will remember the full-size twin-screw chain-driven aeroplane which he built. V. E. Johnson was another pioneer who did a vast amount of experimental work. I saw him not so long ago and he was full of enthusiasm for his old hobby. It is an excellent suggestion to make that these old hands should meet at a convivial gathering just to let the newer generation know the source from which they obtained their knowledge. There was no heritage of knowledge in the early days. Experimenters had to find out by bitter experience. Those were the days of the Kite and Model Aeroplane Association, with Mr. W. H. Akehurst as the energetic secretary. This association dissolved owing to the War and the various cups and trophies were forgotten until I started a campaign for their recovery when I was the Model Editor of *Flight*. Those efforts resulted in most of the cups being recovered. It was at my suggestion that the London Aero Models Association changed its title to the Society of Model Aeronautical Engineers, altered its rules so that it became national in character, and approached the Royal Aero Club to receive recognition as the body to govern model aeronautics in this country. This was done. It is just as well that these facts should be set on record, for they are likely to be forgotten in some quarters. The meeting at which I made the suggestion was held in Great Windmill Street, Piccadilly, where the meetings of the L.A.M.A. were held. I delivered several lectures to that club and acted as judge for many of their competitions. If any of those to whom I have referred should read these notes I hope they will get into touch with me, or with Mr. York of The Model Aircraft Supplies, Ltd., 171, New Kent Road, London, S.E.1. I can then estimate whether a reunion dinner is feasible.

F.J.C.

A MODERN HIGH-SPEED AEROPLANE



THE IMPERIAL AIRWAYS EMPIRE FLYING BOAT

This Illustration is Useful in That it Shows Representatively the Vast Strides Which Have Been Made in Aircraft Construction. This Aeroplane Was Built by Short Bros. and it is Equipped with Bristol Engines

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Length: 88 feet. Height from water-line: 24 feet. Speed: 200 m.p.h. (approx.). Span: 114 feet. Weight fully loaded: nearly 18 tons. Crew of 5. Passenger accommodation: 24 on day stages and 16 on night journeys.

Twenty-eight of these are now being built.

James Prescott Joule at the age of forty-five.

MASTERS OF MECHANICS

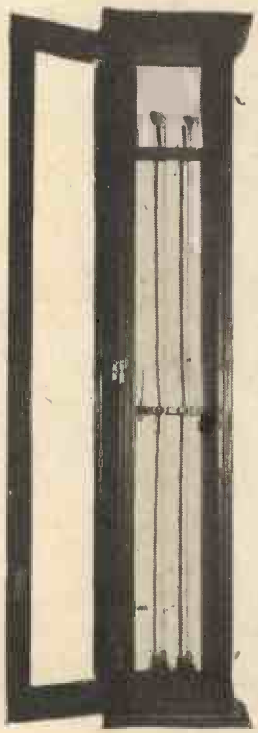
No. 17.—James Prescott Joule, the Apostle of Heat and Energy

EVER since Man began to construct mechanical devices and contrivances, he has dreamt of one day building a machine which, once set in motion, will continue working for ever or, at least, until its essential parts wear out. There are, even at the present day, people with inventive minds who occasionally give themselves over to the task of constructing a perpetual-motion machine, despite the plainly demonstrated impossibility of the principle. In days past, that is to say a century or more ago, almost every mechanician made at least one attempt to solve the problem of perpetual motion, for the possibility of building a machine which would run for ever was believed in as implicitly as the old alchemists placed their faith in the ultimate success of their search for the "Philosopher's Stone," a hypothetical article which would turn base metals into gold.

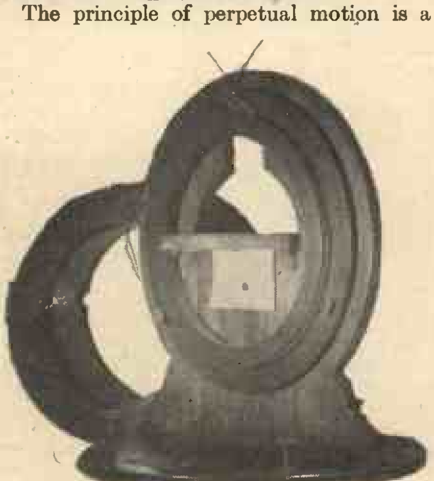
Perpetual Motion

To-day, if you attempt to patent a perpetual-motion machine, you will find your patent application rigorously declined. Time was when the patent offices of the world were inundated with specifications of mechanical devices which would supposedly run for ever. Since, however, mechanics has been placed upon a firm scientific basis, the utter impossibility of ever constructing a perpetual-motion machine has been widely recognised and, as a consequence, patent examiners deem it a waste of time to deal with would-be patent specifications which aim at the unattainable.

The principle of perpetual motion is a false one because it contradicts the great fundamental Law of the Conservation of Energy. This law of Nature, to put matters briefly, tells us that we can never hope to extract more energy out of a machine than we put into it. If a mechanical device were to go on working for ever, we should be obtaining energy for nothing. Indeed, we should actually be creating energy, for the machine would be working of its own accord without energy being supplied to it. It can be plainly demonstrated in many ways that Nature never gives us anything for nothing, particularly in the energy line, and accordingly, for the reasons stated above, perpetual motion is and ever will be a mere imaginative figment of the ingenious inventive mind.



The actual thermometers employed by Joule in his fundamental experiments on heat and energy. They still remain the most sensitive thermometers in the world.



The original galvanometer used by Joule in his experiments on the heating effects of electricity.

Born in 1818

In the industrialised city of Salford, Lancs., was born on the Christmas Eve of the year 1818 the individual whose scientific mind and clear perception of fundamental mechanical principles was ultimately to comprehend the true nature of the laws of heat and energy and to give to the world the sublime mechanical generalisation of the Conservation of Energy. James Prescott Joule was his name. His father was a successful brewer and although Joule in his early days worked at the paternal brewery from 9 in the morning until 6 in the evening his mind eventually began to dissociate itself very much from the profession of brewing.

Young Joule was sent to learn chemistry from the famous John Dalton, of Manchester, the originator of the modern atomic theory of matter. Although, at this time, Dalton was aged and suffering from the effects of a paralytic stroke, his scientific habits of thought fired the imagination of his pupil. Joule persuaded his father to set up for him a home laboratory and in this apartment the amateur scientist pursued his experiments whenever opportunity allowed. Usually, at this period of his life, Joule had to fit in his experiments before going off to work in the mornings and late in the evenings, after his day's duties were over.

We have termed Joule an "amateur scientist." The expression is a truthful one. At no period of his life was Joule dependent upon his scientific work for his livelihood. When, in later years, his father disposed of his brewery concern, Joule found himself in a position of comfortable affluence and thenceforward he lived a retired life, devoting himself entirely to investigations into his beloved mechanical science.

An "Electro-Magnet Engine"

One of Joule's earliest mechanical efforts comprised the construction of what he termed an "electro-magnetic engine." This was really one of the first electric motors in the world. It refused, however, to run satisfactorily. Joule, in investigating the cause of its erratic running, was led from one problem to another in mechanical science and finally to those mechanical researches for which his name will ever be famous, to wit his investigations into the

Joule's "electro-magnetic" engine constructed in 1837. It is one of the earliest electric motors known.

nature and significance of heat and mechanical energy.

At first, the accredited scientists of the day looked askance upon Joule's work. The Royal Society habitually refused his papers, although eventually (in 1870) it was glad to award him its highest honour—the Copley medal—in appreciation of his work.

The first paper of importance which dealt with Joule's work on heat and energy was read by Joule himself on August 17th, 1847, before the Cork meeting of the British Association. The paper was entitled "On the Calorific Effects of Magneto-Electricity and the Mechanical Value of Heat." Joule's communication was received in silence. Its import was too revolutionary for even the scientific mind of the day to appreciate. A lesser-minded man than Joule would have been discouraged by the cold reception of his scientific message. Not so James Prescott Joule, however. After the British Association meeting, he returned to his home near Manchester full of the resolve to continue his work and to extend and amplify the conclusions which he had arrived at in his British Association paper.

Heat Energy

The first great natural principle which Joule discovered is that of the "Mechanical Equivalent of Heat," which principle states that for a given amount of mechanical energy expended an equivalent amount of heat is obtained. You strop your razor, for instance, and the strop becomes warm. From whence has the heat of the razor strop been obtained? Joule's principle asserts that the mechanical energy of stropping has not been destroyed but has, in very fact, become completely changed over into heat.

Joule was the first to demonstrate conclusively the fact that energy cannot be destroyed. In his own words: "The agents of Nature are, by the Creator's fiat, indestructible, and whenever mechanical force is expended an exact equivalent of heat is always obtained."

In other words, although you cannot destroy energy, you can change it from one form into another. Usually, our methods of converting energy from one form into another are very wasteful ones and one of the problems of present-day mechanical science is to discover less wasteful methods of energy conversion and to apply them to the economic production of power.

Famous Apparatus

Joule's most famous apparatus which he used in his discovery and determination of the mechanical equivalent of heat comprised a vessel full of water in which a paddle wheel was caused to revolve by the falling of weights through a set distance. In the vessel was placed a very delicate thermometer capable of reading to hundredths of a degree. Joule had a number of these thermometers made by a very clever mechanician and optician of Manchester, John Benjamin Dancer by name. These thermometers, which measure more than 3 ft. in length, were, at that time, the most sensitive ones in the world. Two of them, at least, still remain the world's most sensitive thermometers, for the couple of Joule's thermometers which are retained as permanent exhibits by the Manchester Literary and Philosophical Society have been compared with the most modern and accurately constructed products of thermometer making and no error can be found in them.

The friction between the revolving paddles in the vessel of water raised the temperature of the water and Joule found that the heat imparted to the water was an exact counterpart of the mechanical energy expended in rotating the paddles. In order that one unit of heat could be formed, Joule discovered that 772 units of work (foot-pounds) had to be expended. Thus 772 ft.-lb. is the mechanical equivalent of 1 unit of heat.

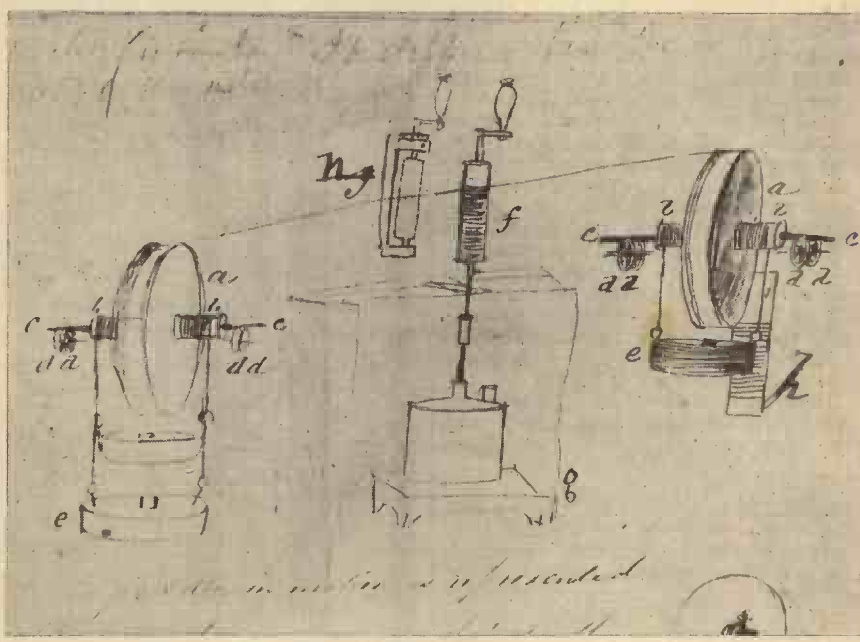
Carrying on his experiments by means of carefully observing the heating effects of electric currents, Joule made clear the fact that when electrical energy is converted into heat, it follows exactly the same laws as mechanical energy, *i.e.* that the heat generated is an exact counterpart of the work or energy expended.

Law of the Conversion of Energy

It was through his experiments on the mechanical equivalent of heat that Joule, working quietly in his home laboratory, was led to enunciate the Law of the Conservation of Energy. Joule first gave tangible utterance to this law in an informal lecture which he gave on the subject of "Matter, Living-force and Heat," in St. Ann's Church Reading Room, Manchester, on April 28th, 1847. Soon afterwards the Conservation of Energy Law was more scientifically expressed. Also it was verified in various ways.

To the general reader, Joule's lifetime may seem to have been spent in scientific research into abstruse problems. On the contrary, however, most of Joule's work was of enormous practical import from a mechanical and engineering viewpoint. True it is that Joule did not invent any particular form of engine or working machinery. He grappled, rather, with the underlying factors of heat and energy which are associated wth the functioning of all mechanical devices and, bringing them to light, he showed conclusively that all these factors are governed entirely by one or two laws.

Joule's mechanical experiments were not always carried out without opposition. The laboratory of one of his residences was situated in an adjoining coach-house and in the latter building Joule installed a 1-h.p. steam engine of experimental design. Unfortunately for Joule, however, a worthy alderman happened to live near him and this latter individual, taking exception to the gentle purr of the steam engine, threatened to raise the legal deities if Joule did not at once cease to operate the engine on the premises. A clause in the lease of the premises was referred to and the alderman was found to be within his rights. Joule abandoned his steam engine experiments, intending to return to them after he had changed his residence. He never did so, however. Removing into the country near his native town, Joule settled down to experiments of another kind. At this time, though, his energies were well-nigh expended. He gradually sank into ill-health and finally died at Sale, Cheshire, on October 11th, 1889. A statue of Joule stands within the vestibule of the Town Hall at Manchester. It is a finely executed statue and it forms posterity's permanent reply to the puny alderman whose spiteful action against Joule deprived English mechanical science of the benefit of so many experiments.



A page from Joule's laboratory notebook, showing his sketch of the apparatus for the determination of the mechanical equivalent of heat.

RAILCARS WITH PNEUMATIC TYRES

SOME interesting facts are quoted by our contemporary *The Engineer* regarding the development of railcars which are becoming more and more popular for certain types of service. A new one which is fitted with pneumatic tyres is now undergoing tests by the L.M. & S. Railway.

Specially Constructed Tyres

The engine is an Armstrong-Siddeley of 275 h.p. The car is carried on two eight-wheeled bogies and all the wheels are fitted with rapidly detachable tyres of special construction. In order to keep the wheels on the rails, they are fitted with a flange which carries a rubber inset. Each wheel is fitted with a puncture-warning device and in the event of loss of pressure, a spring-loaded plunger completes an electric circuit which gives audible warning to the driver. Loss of pressure is, however, a very rare occurrence and statistics over a long period show an average of only one tyre failure for every 37,700 miles.

THE CHEMISTRY OF

An Interesting Discourse upon Nature's Ligh
Practical Details of the Preparation of a N

Making luminous compounds. The tin (with the lid tightly closed) containing the mixed ingredients being placed in the middle of a fire.

IT is well-known that all our sources of artificial light are, to say the least, extremely wasteful ones. We feed electrical energy into, say, a 60-watt electric lamp, and for every hundred units of current which pass to the filament of the lamp, only about two units are converted into useful light. The remaining ninety-eight units are utterly wasted in the form of heat. We cannot, in our artificial way, obtain light without heat. And, moreover, when we do obtain light, it is always accompanied by a superabundance of unwanted heat.

Nature, however, has arranged her own artificial lighting schemes much differently. There are to be found a number of living creatures which possess the property of exuding light-emitting substances. Also, in the inorganic or inanimate world, there are quite a number of materials which are capable of emitting light. Some of these latter materials act by storing up, as it were, light rays which have been impressed upon them ; others give out light by reason of some energy-conversion which is made to occur within them.

" Cold Light " Production

The great point about all these methods of " cold light " production is that the energy which goes into their working is, to all practical intents and purposes, completely converted into light. There is no accompanying heat. Hence, Nature's luminescent materials provide light which is truly cold and which, if we could only produce it in a more intensified form, would utterly revolutionise our present-day methods of artificial illumination.

Only two luminous insects are to be found in Britain. One is the well-known glow-worm, a species of beetle ; the other is the luminous centipede which makes its occasional appearance as a streak of wriggling light after a damp stone has been upturned in the garden on a summer's evening.

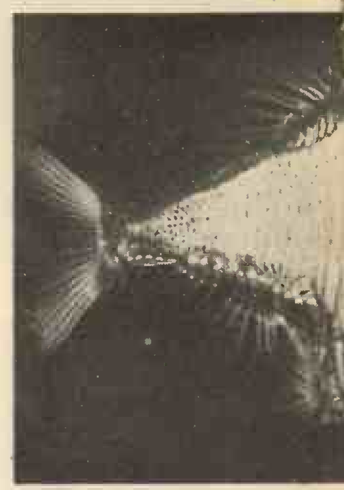
Around some of the south coasts of our country the waves appear brilliantly luminous at certain times of the year. This luminescence is due to the presence in the seawater of myriads of tiny globular organisms to which the name *noctiluca miliaris* (" candle grains ") has been given.

Some bacteria, also, are capable of manufacturing light-giving substances. It is due to these minute creatures that decaying wood, twigs, leaves and putrefying fish sometimes shine with a bright light in the dark.

Tropical Regions

In more tropical regions, the luminescence of insects and other living creatures is more intense. The tropical firefly is well known. There is also in the Southern States of America a certain fly which, after sundown, exhibits a white light at the front of its head and a ruby-red light at the rear of its body. Needless to say, our American cousins, with characteristic aptness, have happily dubbed this not uncommon insect, the " automobile bug " !

The light-giving powers of deep-sea creatures are well known. Deep in the heart of the tropical oceans there exist fishes which are literally bedecked with unquenchable lanterns. Sometimes the entire body of the fish luminesces brightly, a fact which must result in the ocean depths being brilliantly illuminated by even a small shoal of these creatures.



A remarkable instantaneous photograph of a depth of half a mile. The photograp

It is only within very recent times that the secret of some of Nature's light-giving sources has been penetrated. Chemists have investigated a number of luminous substances obtained from the glands of insects and animals, and they have found such materials to consist, in the main, of two distinct substances of quite unknown composition. The first of these light-giving materials has been called " luciferin " and the other " luciferase."

Usually, in these natural light-giving exudations of living creatures, there is only a trace of luciferase. Luciferase merely acts as a " catalyst " or a speeder-up of a chemical reaction by means of which the luciferin absorbs oxygen from its surroundings,

The luminous centipede, found u

(Left) Luminous calcium sulphide glowing in the dark, and (right) luminous calcium sulphide shown in the light.

"COLD LIGHT"

t-giving Materials, together with Number of Luminous Substances

Packing the ingredients into a tin previous to heating.

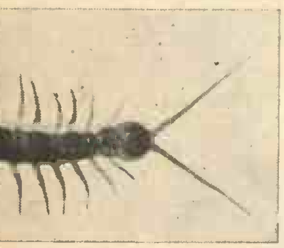
thereby becoming converted into oxy-luciferin. But this oxy-luciferin is not a stable substance. It quickly loses its oxygen and becomes changed back into luciferin.

During Chemical Changes

During the above chemical changes, light is given out continuously. If the twin compounds luciferin and luciferase could be made synthetically they would, no doubt, displace all other manufactured luminous compounds, radium materials excepted, since their light-giving action is a continuous one and does not suffer from fatigue.

a luminous fish taken under the sea at h was taken by the creature's own light.

Of the many inanimate light-producing substances, ordinary yellow phosphorus is perhaps the best known. This substance shines in the dark with a peculiar greenish hue and, being soluble in oils and other liquids, it is capable of communicating its phosphorescence to them. Phosphorus, however, is exceedingly poisonous, and it is also a very dangerous material to handle since it ignites at the least friction. Experimenters with luminous materials, therefore, are advised to keep away from phosphorus, for its light is merely caused by the slow oxidation of the material, and after that process has been completed the remaining phosphorus oxide is not luminous.



der stones in the summer-time.

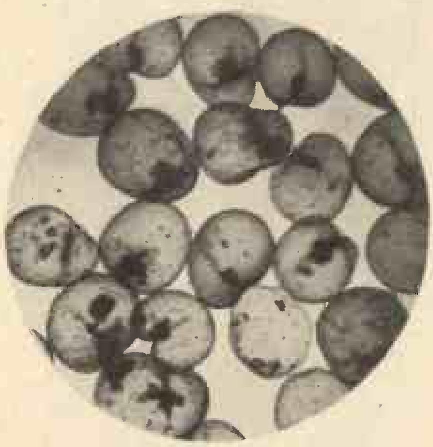
The best possible type of luminous material is zinc sulphide with which has been admixed a trace of some radium compound. The electrons shot out from the radium compound, impinging upon the zinc sulphide, cause the latter to glow brilliantly. Radium-containing preparations of zinc sulphide are permanently luminous. Moreover, they are self-luminous, that is to say, they do not require periodically "exciting" by exposure to bright light like many of the other luminous compounds do. Unfortunately, of course, the price of radium salts renders the preparation of these self-luminous materials prohibitive for the ordinary amateur.

A Luminous Material

Quite a satisfactory luminous material is calcium sulphide, formerly known as *Canton's phosphorus*. Some varieties of barium sulphide (formerly known as *Bolognian phosphorus*) are also luminous. Both of the above compounds must be exposed to sunlight or to a powerful artificial light before they will shine in the dark, and also, as mentioned above, this exposure must be repeated periodically.

It is possible to make a luminous compound by heating a few oyster shells in the fire until they become white and then by heating them to red heat in an old tin with twice their weight of sulphur for a few hours. After exposure to strong light, the resultant compound will become luminous.

The best way to make luminous calcium sulphide is to mix approximately one hundred parts of powdered chalk or limestone (or even ordinary lime) with seventy parts of flowers of sulphur and to add to the mixture a pinch of black manganese dioxide and (if available) a pinch of strontium carbonate. These ingredients should be mixed intimately and then placed into an old tin can. The latter is then set into the reddest part of a hot kitchen fire and left there for four or five hours. The tin, of course, should be provided with a well-fitting lid.



"Noctiluca miliaris"—a microscopic photograph of the tiny floating organisms which give light to the seawater around our coasts.

If the heating has been correctly carried out, the resulting product will appear light grey in colour. It should be powdered up finely and stored in well-corked bottles. The powder should not be exposed to damp air, or else its luminescent properties will be destroyed gradually. This powder, after a preliminary exposure to bright light, shines with a violet light.

A similar luminous material may be prepared by heating up under the same conditions a mixture of 100 parts strontium carbonate, 100 parts sulphur, and ½ part each of common salt, potassium chloride (or carbonate), and manganese dioxide. This material will luminesce with a yellowish-white light.

A mixture of equal parts of burnt lime and sulphur containing small traces of starch, bismuth carbonate (an ordinary bismuth digestive tablet will suffice), common salt, saltpetre, and/or potassium bichromate will, after heating in the above manner, produce a violet-luminescing material.

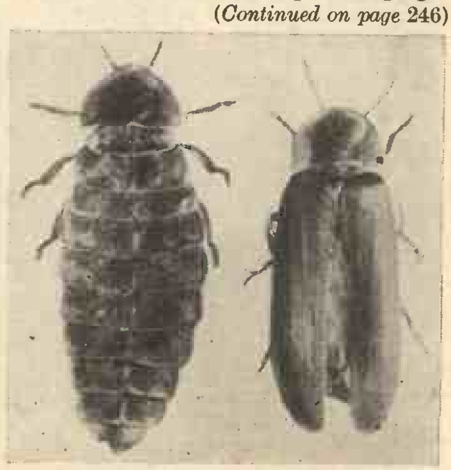
Colour and Intensity

It is interesting to note that the exact colour and intensity of the luminescence of these compounds is, in some strange and unknown way, governed by the nature and quantity of the "impurities" (*i.e.* manganese, potassium, sodium, and other compounds) which are admixed in small amounts with the main components of the mixture.

All the above luminous compounds can be made into paints and varnishes simply by being very finely ground and sieved and then by being stirred into a quantity of clear varnish. Spirit varnishes and cellulose lacquers give good results with such luminous compounds. Clear varnishes containing traces of lead compounds should not be used in the preparation of luminous paints for the traces of lead in the varnish are apt to destroy the luminosity of the paint very rapidly.

There are other ways of producing light

(*Continued on page* 246)



One of the only two luminous insects found in Britain. The glow-worm beetle—male and female.

STARGAZING FOR AMATEURS

A NEW SERIES

By N. de Nully

A GUIDE FOR JANUARY

ON July 3rd last year the Earth, owing to the ellipticity of its orbit, was at its greatest distance of 94,454,700 miles from the Sun, It has since been gradually approaching that luminary again at the rate of over 17,000 miles a day. On January 1st it attains its nearest in 1937—91,330,000 miles—or more than 3,000,000 miles closer than six months ago. That is why our winters are not so cold as those in the southern hemisphere, which occur when the Earth is at its farthest from the Sun. The sunspot cycle continues to progress towards maximum. Apparently insignificant spots, both isolated and in groups, are frequently to be seen through even a small telescope.

Mercury

The planet Mercury will be low in the south-west during the coming week and may then possibly be detected from about 5 p.m. until it sets in half an hour. After that period it will drift into the glare of sunset and become practically invisible. Venus is a conspicuous object in the same region and is setting later each night from between 8 and 9 p.m. Viewed through a telescope of only moderate aperture, the phase will be found to be "gibbous," i.e. like a miniature moon at last quarter. It is now less than 90,000,000 miles away and rushing towards us. Its disc will therefore get larger and tend towards the crescent shape. Mars is also drawing closer and getting brighter; but is still 155,000,000 miles off, and rather a powerful instrument is needed to perceive the dark-green and orange markings. It rises in the east at 1.45 a.m., and is therefore not conveniently placed for observation this month. Jupiter is lost to sight behind the Sun.

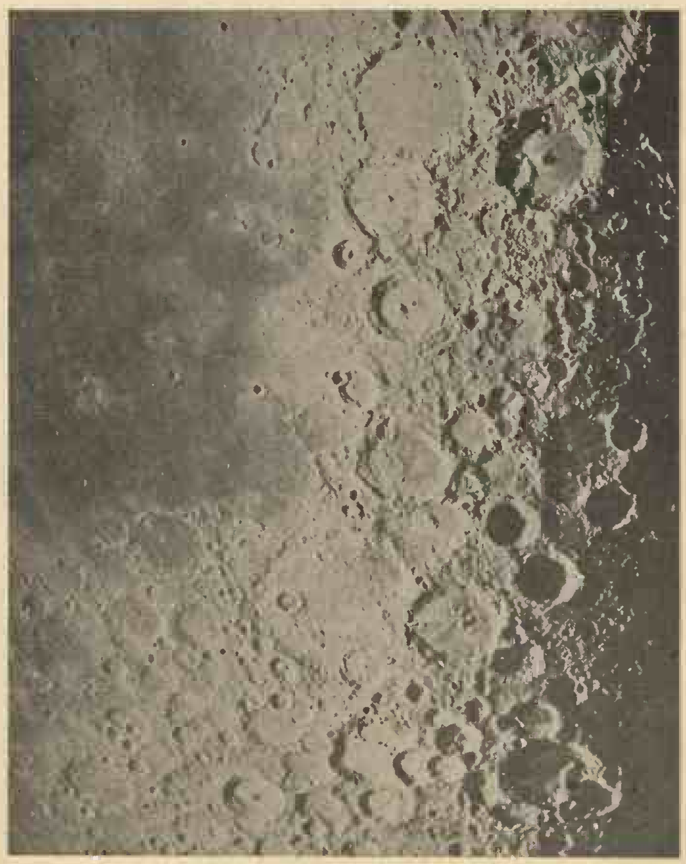
Saturn

Saturn may still be observed in the south-west from dusk until shortly before 10 p.m.; it sets twenty-five minutes earlier each week. The appearance of this planet has changed little recently, the rings being merely a streak of light. It is receding from us and is now 900,000,000 miles away. The remote world Uranus is in the south-west part of the constellation Aries (the Ram), which is in the zenith in mid-evening. The celestial latitude and longitude of Uranus is R.A. 2 hrs. 14 min. N. Dec. 13 deg., and its distance 1,770,000,000 miles. Even in quite a small telescope the planet exhibits a tiny greenish disc and its identity can be established by a slight displacement among the faint stars in the neighbourhood, after several nights. Uranus was discovered in 1781 by Sir William (then plain Mr.) Herschel, a music master and amateur stargazer in Bath. He used a home-made reflecting telescope of his own design and construction. This achievement should be an encouragement to those readers of PRACTICAL MECHANICS who have technical skill and an interest in the hobby of stargazing.

The New Moon

The Moon will be "new" on the 12th. Weather permitting, the thin crescent will be visible low over the W.S.W. horizon two or three evenings later. This not very frequently observed phase offers some striking features for examination under a rising sun. Among them is a magnificent chain of immense ring mountains stretching southwards from the lunar equator along a line running parallel to and not far from the edge of the disc. A map of the Moon (which can be purchased for a few shillings) will indicate that these formations have received the names Fraunhofer, Furnerius, Petavius, Vendelinus, and Langrenus. Though seemingly oval (in consequence of the effect of foreshortening) they are all approximately circular. They vary in diameter from 25 to 100 miles. North of the lunar equator lies the beautiful Mare Crisium, seen in the lower left-hand corner of the photograph in last month's article. It is one of the smaller of the Moon's dusky areas that were formerly believed to be seas, and probably represent their dried-up beds. The Mare Crisium is a comparatively smooth expanse of about 70,000 square miles, slightly depressed below the rocky highlands which border it. The latter extend as far as the north polar regions and are much pitted by numerous "craters." In forty-eight hours these features will be almost obliterated by the advance of morning sunlight; but they can be viewed again under afternoon illumination two or three days after "full." Meanwhile, many others, characteristic of our satellite's weird scenery, will be emerging from the blackness as the "terminator" creeps slowly forward.

The Ring Nebula in the constellation Lyra.



The Moon. A rugged section along the "terminator" in the southern hemisphere about first quarter.

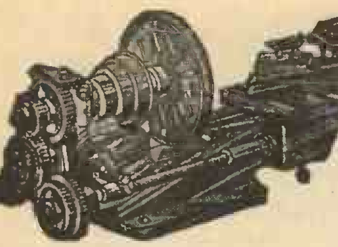
Evening Parades

The stellar heavens are commencing their impressive winter evening parades. High up in the south-east glitters the well-known Pleiades cluster forming part of the constellation Tauras (the Bull). With average eyesight six stars can be counted on clear dark nights, and a binocular will increase the number considerably. In large telescopes they amount to hundreds, and long-exposed photographs show the entire group to be immersed in a misty nebulosity. Close by glows the giant ruddy sun Aldebaran. It also is in Taurus, and was aptly styled by the ancient astronomers "The Eye of the Bull." Though many times the diameter of our Sun, Aldebaran has a much lower temperature, which accounts for its reddish hue. It is situated on the verge of the Hyades, a more scattered cluster, visible to the naked eye, but best seen through a binocular. Farther east, one of the most bejewelled quarters of the visible universe is coming into view; but this must be left until next month, when it will be more fully displayed.

Interesting Material

Meanwhile, the north-west sky still provides much interesting material for investigation. The constellation Lyra (the Harp) is easily recognised

(*Continued on page* 245)



Lathe Work FOR AMATEURS

PLANING IN THE LATHE

A RIG for planing in the lathe can be easily constructed so as to make use of the saddle and cross slide of the lathe—the one for the cut and the other for the transverse feed; while the rig is designed to hold the tool and provide the feed for the cut. The essential parts comprise two standards *A* and *B*, Fig. 1, which have bases to fit on the lathe bed and a depending tenon (shown in dotted lines) to fit between the ways and locate them firmly. They hold a bar *C* which should be of big diameter round Bessemer steel. It is upon this bar that the tool holder *D* is fitted.

The Tool Holder

This tool holder is shown separately in Fig. 2 and consists of a casting *A* bored at *B* to fit on the bar and slotted so that it can be gripped tightly by a bolt and nut *D*. The bar is held by the two standards and is prevented from turning in them by stout taper pins driven in taper holes *X*, *X*, through the standard and the bar. The work is bolted on to the cross slide of the lathe saddle, the top slide having been removed, and the traverse for the cut is given by the saddle moved along the bed by the lead screw or sliding shaft (if one is fitted) on the lathe.

Transverse feed for covering the surface is given by the cross slide and the feed of the tool is given by the tool holder *D*.

The two standards are of cast iron and should be of such a height that the centre of the top bores which hold the bar are 2 inches above the lathe centres. They are shown in Fig. 3 in side, front, and plan views. The tenon should fit the bed and the base should be extended sideways as shown to take a bolt for holding the standard down to the bed by means of a plate below. The top of the standards are slotted into the central bore and a bolt and nut is used to clamp the standard securely to the bar.

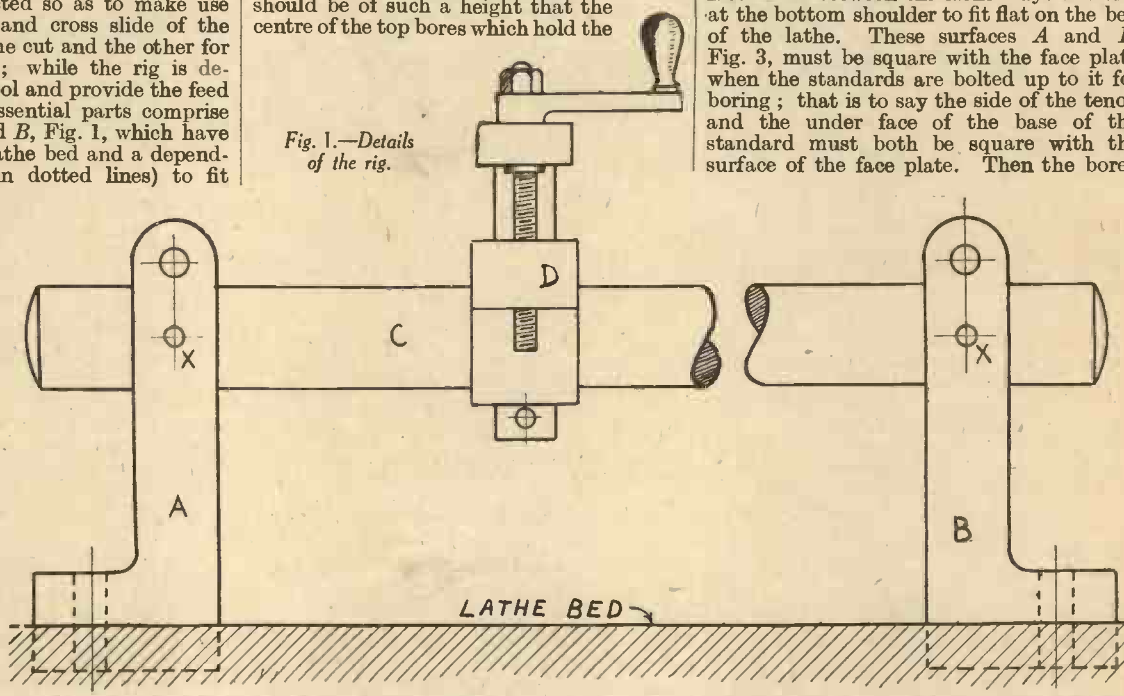


Fig. 1.—Details of the rig.

After all is fitted in place on the lathe, by the clamping bolt clamping the standards to the bar and the holding-down bolt clamping the standards to the lathe bed, holes *X*, *X*, are drilled right through each standard and through the centre of the bar as shown. These holes are reamered out with a standard reamer and standard taper pins are driven in.

This is to make doubly sure against the bar turning in the standards.

The Standards

The standards will be bored out to fit the bar by clamping them on the face plate and boring with an inside tool. The pattern will be the same as the job, and one pattern will be required only for the two standards which are identical. After boring the main hole the transverse holes *A* for the clamp bolts will be bored and then the slot cut which allows the bolts to clamp the standards on to the bar.

Before boring the hole for the bar, the tenon at the bottom of the standard will be filed to fit between the lathe ways and flat at the bottom shoulder to fit flat on the bed of the lathe. These surfaces *A* and *B*, Fig. 3, must be square with the face plate when the standards are bolted up to it for boring; that is to say the side of the tenon and the under face of the base of the standard must both be square with the surface of the face plate. Then the bored holes for the bar will line up parallel when the standards are bolted down on to the lathe bed.

The casting for the tool holder, Fig. 2, may be solid; the part *A* being sawn out of one block of wood.

The hole for the bar at *B* is first drilled, and by means of it the casting, lying on its side, can be bolted on an angle plate on the lathe face plate and the big bore for the

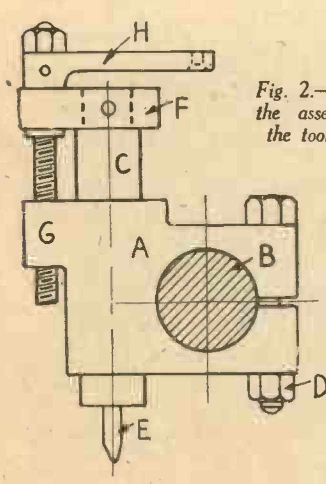


Fig. 2.—Showing the assembly of the tool holder.

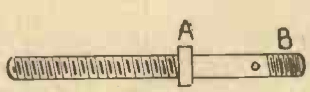


Fig. 4.—The construction of the screw.

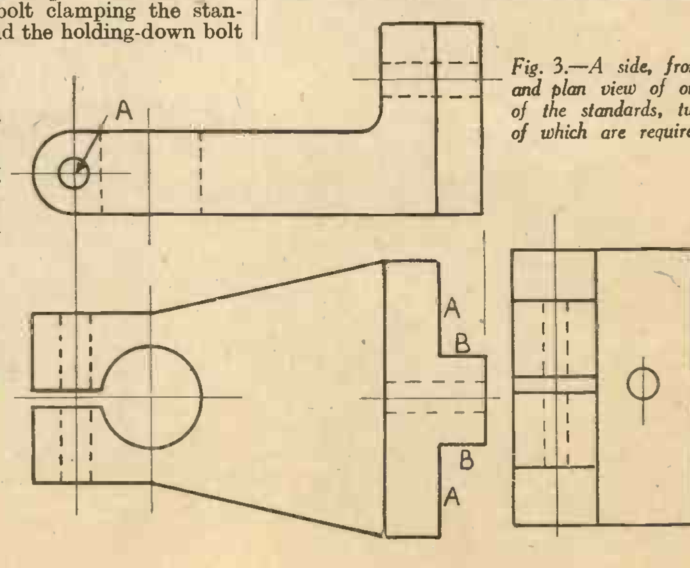


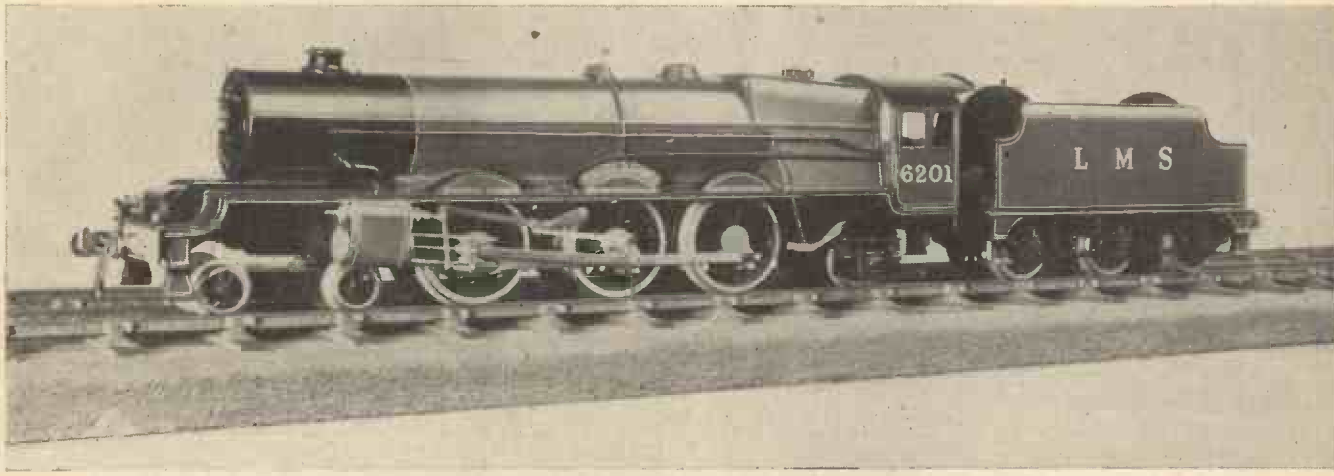
Fig. 3.—A side, front and plan view of one of the standards, two of which are required

tool holder *C* can be bored out. The tool holder *C* is a piece of Bessemer bar and is bored out at one end to take the cutter *E*. At the top end it is reduced in diameter, as shown by the dotted lines, to take the screw guide *F*, and the latter is fitted to it, by a taper pin shown in circle.

The Screw Guide

The lug *G* and the end of the screw guide *F* are drilled in line. This can be done by mounting all that is assembled on the angle plate on to the face plate again, and having the guide *F* close down on the top of the holder *A* and boring both tapping size for $\frac{3}{8}$ in. Whitworth thread. The hole in *F* can then be bored out full $\frac{3}{8}$ in. The hole in *G* should be tapped out to take the screw *G* shown separately in Fig. 4. This is made with a shoulder *A* and an end thread at *B*, the latter takes a nut which screws the handle *H* (Fig. 2) down, and when both are just down so that the screw will turn without shake in *F* the hole is drilled through the handle and the latter fixed by a taper pin driven through handle and screw.

The handle *H* can be made from a piece of $\frac{3}{8}$-in. by $\frac{5}{8}$-in. bar, with a $\frac{3}{8}$-in hole drilled for the spindle end of the screw and a knob handle turned and riveted in at its end. Centre of spindle hole to centre of knob hole should be about 2 in.



A model of England's record breaker—the L.M.S. "Princess Elizabeth," which did the journey between London and Glasgow in under six hours.

SOME INTERESTING NEW MODELS

EVERY season those interested in any type of model railway or model ship look forward to Bassett-Lowke's new catalogues, anything from 90 to 150 pages, with all the new productions described in full. This season both their railway section and ships section contain many interesting and attractive new models.

In the model railway list is the gauge "0" *Princess Elizabeth* (as illustrated), more up to date than *The Princess Royal*, which was so popular last year, at 8 gns. in either clockwork or electric propulsion. Then come the remodelled L.M.S. locomotive 5XP class *Conqueror*, and an entirely new L.N.E.R. 4-6-0 locomotive *Arsenal* in the colours of the famous London football club with a replica of a football on the driving plate. All these models are hand-made and have the high-class finish so well known among Bassett-Lowke productions. Among the less expensive models costing from 32*s*. 6*d*. to 54*s*. come the remodelled L.M.S. compound locomotive and a new 4-4-0 locomotive, the 2P 4-4-0 class No. 601. Bassett-Lowke are also placing on the market an inexpensive 0-6-0 goods locomotive in both L.M.S. and L.N.E.R. patterns at 28*s*. 6*d*. (clockwork) and 35*s*. (electric).

G.W.R. 2-6-0 Tank

Messrs. Bassett-Lowke have also remembered the G.W.R. fans again this year and have introduced an excellent scale model of a G.W.R. 2-6-0 tank No. 6105 as illustrated. This is very accurate in its external detail, and should satisfy those model railway owners who love the G.W.R. locomotives and sometimes feel they are neglected by model manufacturing firms. This model can be supplied in either clockwork or electric A.C. or D.C.

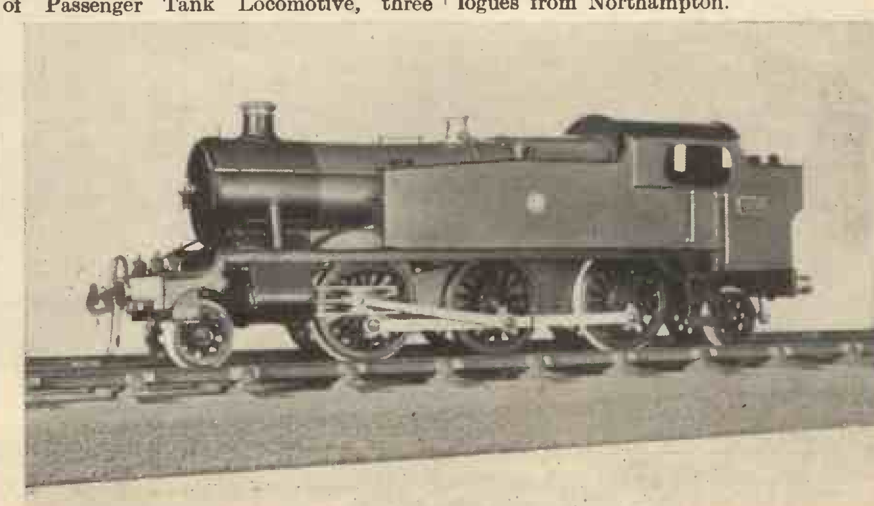
Twin Train Railway

The famous Twin Train railway in "00" gauge is now made in Northampton and has been entirely remodelled—the track, points, stations, and railway buildings remaining the same—but the locomotives are now available in both L.M.S. or L.N.E.R. colours, the bogie coaches are correct in design and colouring, 6½ in. long, and comprise Dining Car, First Class Corridor and Brake Third. The whole range of goods vehicles, including a Bassett-Lowke Private Owner's Wagon, are now available, fitted with automatic couplings. The track is mounted as before on a bakelite base, setting an entirely new standard in rail construction. Altogether the outfit makes a most fascinating and attractive Christmas gift. The Suburban Train outfit, consisting of Passenger Tank Locomotive, three Suburban Coaches, Oval of Track, Controller and Connections complete with instructional booklet costs only 35*s*. The Passenger and Goods Train Sets cost 45*s*. and 42*s*. respectively.

The Ship Section

In the Ships Section there are many new scale models and also sets of constructional parts. The *Normandie* and *Queen Mary* sets of waterline parts at 12*s*. 6*d*. introduced early this year have been supplemented by a 50 ft. to 1 in. model set of the famous Clipper ship *Cutty Sark*, and this sailing ship will be followed shortly by one of the *Great Britain*, the first single-screw steamer to cross the Atlantic, to the same scale.

Bassett-Lowke's permanent magnet motor still holds the field as the most efficient and powerful boat motor for its size and weight, and at the price of 21*s*. is excellent value. We should recommend all model enthusiasts to obtain these two new catalogues from Northampton.



A gauge 0 model of the G.W.R. 2-6-0 Tank.

PETROL FROM COAL BY THE ALL-GAS WAY

The Production of Petrol by Combining Two Simple Gases—Hydrogen and Carbon Monoxide

Where coal is turned into coal-gas and coke.

TWENTY years ago the idea of producing petrol from coal would have been scouted by all but a scientific few. But the chemist has worked greater miracles in producing explosives and fertilisers from the oxygen and nitrogen of the air, silk from wood, and hard plastic resins from mobile liquids. Added to the number of their triumphs is not one process for making petrol from coal, but several.

Already in PRACTICAL MECHANICS there have been described the Bergius process for hydrogenating coal as operated at the synthetic petrol works at Billingham-on-Tees, and low temperature carbonisation processes which make some petrol and provide a good yield of coal oil which subsequently can be hydrogenated to petrol. The latest triumph is the production of petrol in the all-gas way by combining two simple gases—hydrogen and carbon monoxide. This process is called the Fischer process.

Bergius Process

The starting-point of the Bergius process is coal and hydrogen made from coal. To change the complex solid chemical structure of the coal to the much simpler liquid structure of petrol, and to raise the proportion of hydrogen to carbon in the coal from the figure of one part of hydrogen to 17 of carbon found in coal to the 3 hydrogen to 17 carbon which holds for an average petrol, hydrogen has to be forced into combination with the coal. To effect this combination the influence of enormous pressure is used. The operating pressure of the process runs at about two tons to the square inch. The success of the process is as much a triumph for the engineers who have designed a plant to run at such a pressure, as to the chemists who have found the exact conditions of temperature and pressure and catalytic influence necessary for the best yields of petrol.

Fischer Process

But for eight years past Fischer, another German chemist like Bergius, has been tackling the problem in a more patient chemical manner. From coal and steam, with the heat energy which exists in coal, can be made in large volumes two simple gases, carbon monoxide and hydrogen. These gases contain the elements necessary for the synthesis of petrol, namely carbon and hydrogen, and by virtue of the oxygen of carbon monoxide, they have the heat energy which supplies the power necessary for the manufacture.

In fact there is nothing novel about the combination of these two gases. For over twenty years chemists have known that they would combine to give all sorts of compounds, and have actually used the gases to produce not petrol but methyl alcohol, which, like methylated spirits, has all manner of uses such as that of a lacquer solvent. They have known too that under certain conditions the carbon molecules of carbon monoxide could be linked one to another to give those long chains of carbon atoms which form the type of molecule which constitutes the liquids which are known as petrol. This type of molecule is called " paraffin " and petrol is a mixture of " paraffins " with carbon chains from eight carbons up to sixteen. Diesel oils have paraffins with still longer carbon chains, and in lubricating oils, the chains are again longer and at the end of the series we get paraffin waxes whose molecules consist of 70 or 80 carbon atoms strung together.

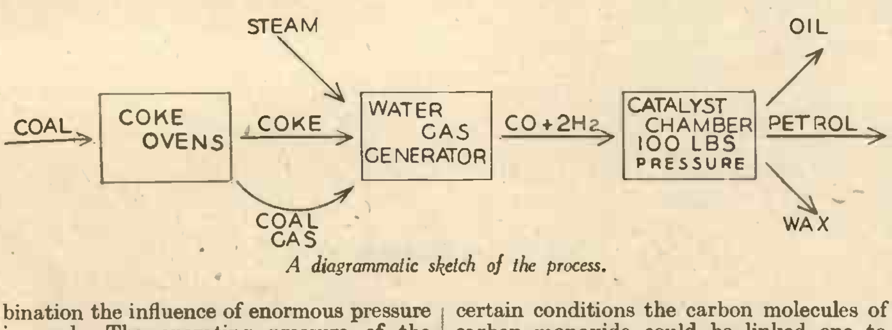
Fischer was the man who decided that the signs and pointers of other investigators were worth following. He would try an experiment, and obtain partial success or complete failure. Then in the light of that experiment try again. It was the only method of research possible in a field of this type. Gradually narrowing down in this way, he got better and better yields of petrol, and is now definitely able to state the best conditions for making petrol from carbon-monoxide and hydrogen.

The conditions are a temperature of about 200° C., a pressure of 100 lb. to the square inch and, of course, a catalyst. A catalyst is a body which helps a chemical reaction without undergoing reaction itself. In this case the catalyst is iron or perhaps nickel or cobalt, and it undoubtedly acts by attracting gases to its surface and holding them there while they react.

The results of combining hydrogen and carbon-monoxide under these conditions are certainly unusual. From the simple gases there result " paraffins " of every type, from the simplest which are gases, then petrol, diesel oil, lubricating oil and finally solid paraffin wax. It is rather amazing that from start to finish the coal should have gone the full cycle of solid down to gas and then back in the end to solid wax.

Full Scale Plant

The process has got to the full scale plant stage. Coal is the starting point. It is turned into coal gas and coke. The coke is then put into a generator where it is



A diagrammatic sketch of the process.

alternately blasted with air and blown with a mixture of steam and coal gas. The steam and coal gas are in this way turned into a mixture of hydrogen and carbon monoxide in the proper proportions needed of two parts of hydrogen to one of carbon monoxide. There is every possibility that this two stage process of dealing with the coal will be replaced in the future by a more compact machine which takes the raw coal and in one stage, with a blast of steam and oxygen, gives the gases needed.

After the gas mixture has been purified, it goes to the converters. These are steel vessels filled with the catalyst substance. Strange as it may seem, the two gases give off large quantities of heat as the petrol is formed. This indicates the readiness with which the petrol is formed. But it presents the designers of the full scale plant with a very difficult problem in getting the heat away and controlling temperature. For if the temperature rises by more than a few degrees the process goes wrong and petrol is not formed. The converter design and the exact nature of the catalyst are two secrets which we do not know in this country.

Removing the Petrol

Diesel oil formed is removed by condensing and cooling the gases, but the petrol will not condense under these circumstances. The peculiar powers of carbon absorption are therefore used. If gas charged with petrol is passed through a bed of specially prepared carbon, the carbon removes and retains the petrol completely, until it is itself as wet and soaked as if it had been dipped in petrol. It will, in fact, take up 30 per cent. of its own weight of petrol. When it is fully saturated in this way it ceases to absorb any more petrol so the absorber is shut off and stripped of its petrol by steaming it. The petrol comes away in the current of steam. Condensation of steam and petrol follows. The two liquids do not mix and the petrol is separated by running off the water.

The Products

As much as 50 gallons of petrol per ton of coal is said to be obtained. There is in addition about half this quantity of diesel oil, about a gallon of lubricating oil and 3 lb. of paraffin wax.

The petrol is extremely pure, but like all pure paraffin petrols it has a low anti-knock rating. But this can be cured by doping it with benzene, tetra-ethyl lead or alcohol. In this way it is brought up to the anti-knock rating of the best aero spirit.

Likewise the diesel oil has a low anti-knock rating, or putting it the other way round a high pro-knock rating. Though this is a disadvantage in a petrol, it is a highly desirable characteristic in a diesel oil. It means that the oil burns quickly and easily when injected into the cylinder, and so can be used in high speed diesel engines where to get the full power immediately, ignition must be fast. In view of the great future of high-speed diesel engines a big yield of a good diesel oil may in the future be more important than a good petrol yield. By very slight alterations of the Fischer process the yield of oil can be increased at the expense of the petrol.

The use to which the wax is put is important. Germany at the present moment is cutting down food imports so as to balance her exchange. She has to import fats for margarine and soap. By relatively simple chemical processes the waxes from the Fischer Process can be turned into the fatty constituents of soap and margarine. The process is therefore hailed in Germany as the solution of the fats problem, now and perhaps in the future event of war.

In England we have not been idle in investigating this way of making petrol. Much is known about it. Probably in the course of the next few years we shall see a large scale plant built working on the principles outlined. It has one advantage over the Bergius process, which recommends it. The working pressure is only 100 lb. to the square inch compared with the 2,000 lb. of the Bergius process. The designing, building and running of a plant to work at this modest pressure becomes an incomparably easier task.

IN THE WORLD OF SCIENCE

Complete Coal-to-gas Conversion

FROM Germany comes news of a revolutionary innovation in the manufacture of coal gas. When coal is carbonised in ordinary retorts, over half of it is left as coke. The coke may afterwards be made into water gas in a separate plant, but from start to finish there is a big wastage of the heat power of the original coal. In the new German plant the coal is charged into a converter, where it is treated with steam and oxygen at a pressure of 300 lb. to the square inch. The coal is completely converted to gas of a very suitable quality for ordinary use, and the only solid residue is a small amount of mineral ash discharged from the bottom of the converter.

High-pressure Gas

The gas coming off from the converter will be naturally at a high pressure. In this condition it is far easier to purify and to handle. As an instance, as much gas can be got through a 2-in. pipe as has to be handled on ordinary works in a 2-ft. main. The whole gasworks therefore shrinks down to about one-tenth the size of modern plant. Electricians have been hoping for some discovery which would reduce generating costs for them. Instead, it is the gas industry which has been favoured.

Self-soldering Joints

A NEW fitting which should interest the amateur plumber is the self-soldering copper-pipe joint, perfected for light-gauge copper tube. Fittings such as elbows, bends, and straight couplings are made an exact sliding fit into their proper gauge of tube. Inside the barrel of the fitting is a ring of solder. The tube to be jointed is cleaned off with sandpaper, smeared with flux, and pushed home into the fitting so that it butts up against a shoulder. The blow pipe is then gently and evenly applied until beads of solder just appear round the end of the joint. It is then allowed to cool, and as the barrel of the fitting tapers from edge to centre, the solder cools first at the edge and tightens up the joint. The device enables copper services to be run up more speedily and neatly than was formerly the case with compo tube and wiped joints, and all high-class work is now executed with it.

Anti-rolling Fins

A NOVEL type of anti-rolling device has been successfully tried out on cross-Channel steamers. From the bows of the ship under water two vanes project, which rotate so that they can be set at an angle upwards or downwards just like the hydroplane diving fins of a submarine. When one is set with its leading edge down, the other has its leading edge up. The rush of water acting on the vanes tends then to roll the ship.

The Gyroscopic Action

A gyroscope inside the ship sets the angle of the fins through hydraulic gear. It acts delicately and quickly. As soon as it detects an inclination of the ship to roll to one side, it sets the fins to roll the ship in the reverse direction. Thus it checks and damps a cross roll before it can start, and keeps the ship perfectly steady in all ordinary seas.

Modern Gasworks

THE modern electric power house has set a very high standard of industrial cleanliness by automatic stoking, ash-handling, and closed-in coal bunkers. Gasworks have not been slow to follow suit. At Southend there is a setting of vertical retorts which is enclosed in a concrete building with glass windows. The coal is never seen by the stokers in its travel from top bunkers to coke discharge at the bottom of the retorts; it feeds itself down automatically and continuously. Dust, dirt, and hot air are removed from the house and the working stages by vacuum cleaning and forced-ventilation apparatus. All discharged air is filtered and dedusted before venting outside. This is becoming a standard pattern of gas-making plant, and similar units are being built in other parts of the country.

New Low-temperature Carbonising Plant

A NEW coalite plant has just been put to work at Bolsover in Yorkshire. The new plant is the fourth of its kind in the country. It turns out smokeless fuel and coal oil. The coal oil amounts to about 20 gallons per ton of coal treated, which is about the usual yield for this type of plant. Only 3 gallons of this is petrol, suitable for internal-combustion engines. In fact, the majority of the oil output is sold to be hydrogenated to petrol.

Power from Sewage Gas

SEWAGE disposal is one of the biggest problems which face any modern city. The tremendous growth of housing in the areas of the west to London in the county of Middlesex have necessitated the laying down of the biggest and most complete scheme of sewage disposal in the history of any city. Centralisation is the key-note of the scheme. Many miles of vast underground tunnels bring the sewage to a central station. Some of the tunnels are over 12 ft. in diameter, that is, bigger than the tube tunnels of London's Underground Railway system. There the sewage is aerated and treated in tanks holding over 20,000,000 gallons of material.

Bacterial Life

Bacterial life is added to the sewage, to work on it just as yeast works in a fermenting process. Air in the form of millions of fine bubbles is blown in, and gradually the sewage is purified into a pure sparkling harmless effluent, and a heavy sludge which is dried, bagged, and sold as fertiliser. Perhaps the most interesting feature of the process is that the whole of the power for pumps and machinery is obtained from generators driven by gas engines. The gas for the engines is obtained from the marsh gas given off in the fermenting tanks of the sewage beds.

A Model G.W.R. Broad Gauge Locomotive—Part 1

By E. W. Twining

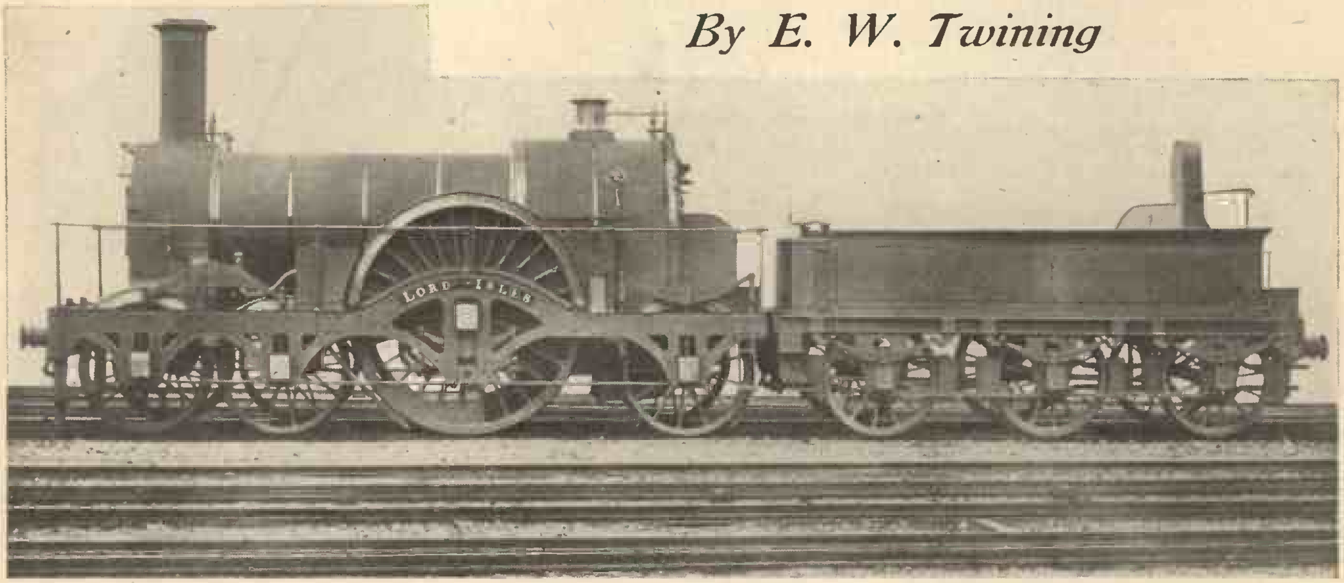
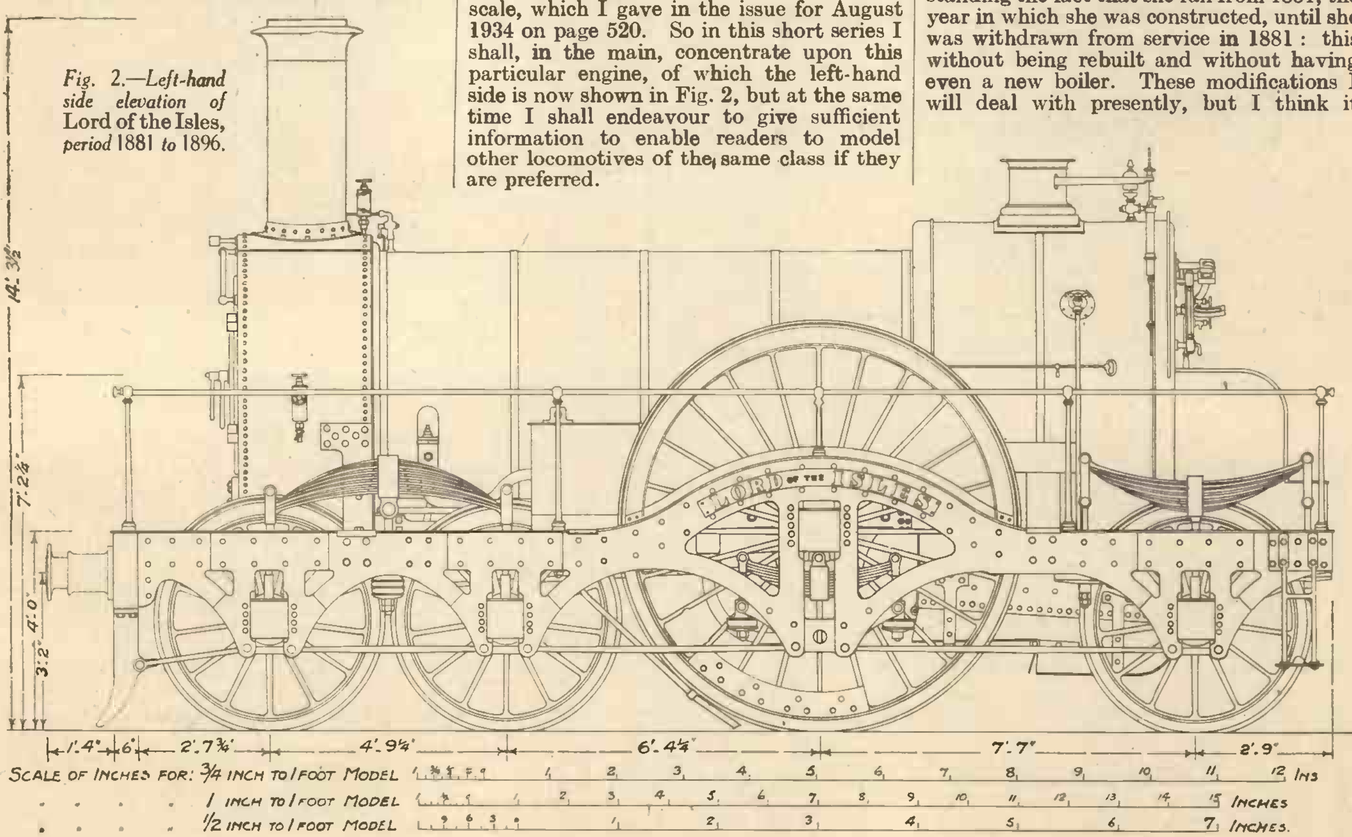


Fig. 1.—The original old engine Lord of the Isles, *broken up in* 1906.

SINCE the articles which I contributed to PRACTICAL MECHANICS on "Locomotive History and Development" were published in 1934, I have been asked from time to time by correspondents and others for further information respecting some of the engines which I illustrated. Most of the inquiries, however, concern the Great Western 8-ft. broad gauge singles, and of them the famous *Lord of the Isles* is the most popular, although in one case it was a later-built engine with a cab which was asked for. In a general way the main object of most of my correspondents was the making of a model and, of course, for this purpose much more complete drawings would be necessary than the shaded side elevation of the right-hand side drawn to scale, which I gave in the issue for August 1934 on page 520. So in this short series I shall, in the main, concentrate upon this particular engine, of which the left-hand side is now shown in Fig. 2, but at the same time I shall endeavour to give sufficient information to enable readers to model other locomotives of the same class if they are preferred.

Fig. 2.—Left-hand side elevation of Lord of the Isles, *period* 1881 *to* 1896.



Differences between Engines

There were differences not only between engines built, rebuilt, or renewed at different dates, but all of them were modified in respect to themselves from time to time. Thus the appearance even of the *Lord of the Isles* was changed, often at only few years' intervals, by alterations, notwithstanding the fact that she ran from 1851, the year in which she was constructed, until she was withdrawn from service in 1881: this without being rebuilt and without having even a new boiler. These modifications I will deal with presently, but I think it advisable to first give a list of the whole of the Broad Gauge Singles; their names, dates of construction and of rebuilding, and then to proceed to indicate by drawings where the chief differences occurred. In some cases these drawings will possibly have, of necessity, to be mixed up with drawings of *Lord of the Isles* where details are the same for all the engines.

It will perhaps be noticed that from the foregoing I have omitted the first *Great Western* of 1846. Although this engine had 8-ft. driving wheels I do not consider that she fitted in so exactly with all her later sisters as to entitle her to belong to the same class. Her fire-box, leading wheel diameters, wheel base and heating surface were all so radically different. I gave a drawing of her as a six-wheeled engine in the August issue 1934 (see Fig. 11).

List of 8-ft. Single Engines. Name.	Originally Built.	Renewal or Rebuild, new boilers.	Second rebuild, new boilers.	Scrapped.	New Engines Built.	Scrapped.
Iron Duke	April 1847	Aug. 1873	—	—	—	1892
Lightning	April 1847	—	—	April 1878	May 1878	1892
Great Britain	July 1847	1870	—	Oct. 1880	Sept. 1880	1892
Emperor	Sept. 1847	1873	—	Oct. 1880	Sept. 1880	1892
Pasha	Nov. 1847	—	—	1876	—	—
Sultan	Nov. 1847	Sept. 1876	—	—	—	1892
Courier	June 1848	—	—	1878	Nov. 1878 (new boiler 1888)	1892
Tartar	July 1848	Aug. 1876	—	—	—	1892
Dragon	Aug. 1848	1872	—	1880	Aug. 1880	1892
Warlock	Aug. 1848	Nov. 1876	Sept. 1888	—	—	1892
Wizard	Sept. 1848	—	—	Nov. 1876	—	—
Rougemont	Oct. 1848	—	—	Aug. 1879	—	—
Hirondelle	Dec. 1848	June 1873	—	1888	—	—
Tornado	Mar. 1849	—	—	Mar. 1881	July 1888	1892
Swallow	June 1849	Oct. 1871	—	—	—	1892
Timour	Aug. 1849	July 1873	—	—	—	1892
Prometheus	Mar. 1850	May 1870	—	1887	May 1888	1892
Perseus	June 1850	1863	—	Dec. 1880	—	—
Estafette	Sept. 1850	June 1870	—	1885	—	—
Rover	Sept. 1850	Oct. 1871	Nov. 1888	—	—	1892
Amazon	Mar. 1851	—	—	July 1878	Sept. 1878	1892
Lord of the Isles	Mar. 1851	—	—	—	—	1906
Alma	Nov. 1854	June 1872	—	1880	Nov. 1880	1892
Balaclava	Dec. 1854	Oct. 1871	—	—	—	1892
Inkermann	Mar. 1855	—	—	Oct. 1878	Oct. 1878	1892
Kertch	April 1855	—	—	Dec. 1872	—	—
Crimea	May 1855	—	—	Sept. 1878	Sept. 1878	1892
Eupatoria	May 1855	—	—	Oct. 1878	Oct. 1878	1892
Sebastopol	July 1855	—	—	1880	Oct. 1880	1892
Bulkeley	—	—	—	—	July 1880	1892
Great Western	—	—	—	—	May 1888	1892

Original and New Engines

A careful scrutiny of the above list will show that in many cases old engines were broken up and entirely new ones took their places, the only thing retained being the name—quite possibly the old nameplates were transferred. The point is that the new engines, although generally of the same design and appearance, were constructed to new drawings and altered measurements.

From the model-maker's point of view differences in the curves and proportions of framing and axle and wheel spacing are important, and in Fig. 4 three outlines are given. The first, A, shows the framing of the first six engines, *Iron Duke* to *Sultan*, of 1847. B gives the modifications in respect of wheel spacing of the succeeding twenty-three engines 1848-1855; *Courier* to *Sebastopol*, which includes *Lord of the Isles* and C all the rebuilds and new engines of 1878-1888. These last were all constructed during Mr. Wm. Dean's term of office, and it will be seen that the shape of the slotted frame plates outside of the driving wheels was greatly altered—all the radii of the curves being made shorter. These radii have been carefully dimensioned and shown in all three diagrams so as to facilitate the model-maker's work of setting out geometrically on the steel plate from which the frames would be cut. In order that the diagrams may be equally useful for any size of model I have figured the drawings in feet and inches of full-size frames and the model maker will, therefore, use a draughtsman's scale in setting out, the scale used being that of the model which he is building.

Scale of Model

If I were asked what is the best scale to adopt for a working steam model of one of these engines I should say: "The largest it is possible to afford having regard to cost and space available for a railway on which to run it." My own preference would be for 1 in. to 1 ft. or even larger, but on all drawings of *Lord of the Isles* I shall place three scales, viz. ½ in., ¾ in. and 1 in., as I have done in Fig. 2. The model builder can then work to any one of them, but in figured dimensions of the drawings in inches the reader must understand that a model of ¾ in. to 1 ft. is being concentrated upon; this being thought, both by our worthy Editor and myself, to result in a model sufficiently large for most people.

The Question of Period

Before setting out to build it will be necessary to decide what period in the life of *Lord of the Isles* the model shall depict. As I have indicated, it did not always present exactly the same appearance. The most notable change which was made was in the chimney. Now it is a strange thing that a big alteration in the shape or size of the chimney of a locomotive seems to alter the character of the whole machine; at least it did when engines had chimneys which *were* chimneys and not mere rings on top of the smoke-box.

With regard to *Lord of the Isles*, there was a time when the engine was exactly like my own 1-in. scale model of *Hirondelle* (photographs of which will be reproduced later). This, I think, was the most handsome period, but in Fig. 2 I have drawn her, as she was when she was broken up, with Dean's copper chimney cap. She is shown so, too, in the photograph Fig. 1, which heads this article, but I have many other photographs showing her at all periods.

Fig. 3 shows all the chimneys which were ever fitted to the 8-ft. singles, four of which are applicable to *Lord of the Isles*.

History of Alterations to Lord of the Isles

Although much has been written about this engine no one has ever dealt with the changes which were made in details which affected her appearance and I, therefore, give the history of these here, placing the information in tabular form and making reference, where appropriate, to the sketches in Fig. 3. I ask the reader to give par-

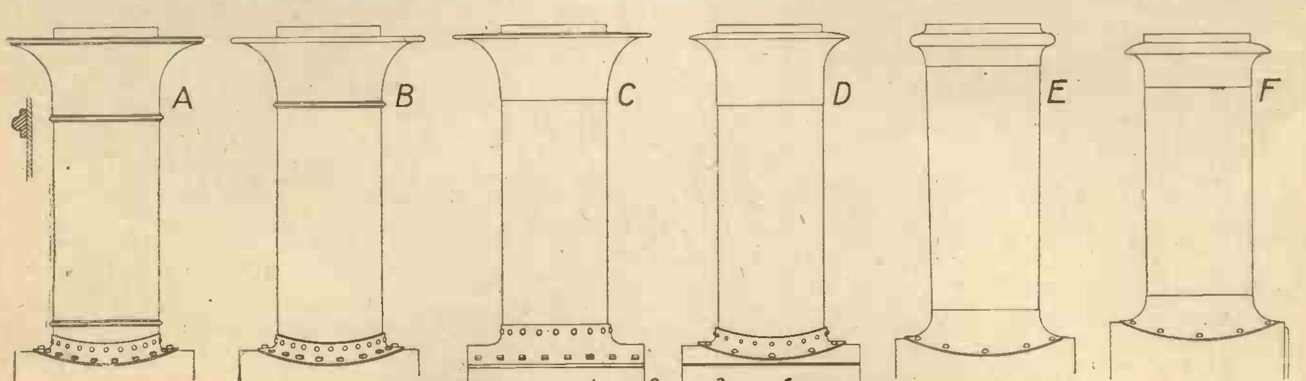


Fig. 3.—Chimneys of different periods used on the 8-ft. single B.G. Engines.

ticular attention to this history, for the items of different periods should not be mixed up in the same model.

1851 (*when built*)

Chimney.—Ornamental bead below bell-top. Pattern B Fig. 3. (This bell-top was probably of black iron and not copper. It has every appearance in my photographs of being of iron, as were the chimney tops of all Gooch's other engines up to this time.) Base formed by an angle-iron ring.

Smoke-box.—There was a riveted seam half-way between chimney base and boiler centre-line in the smoke-box plate.

Sand-boxes.—None.

Balance Weights in driving wheels.—Very small, covering three spokes only.

Weather Board.—None.

Leading Equaliser Springs.—Two straps employed as hangers attached to trunnions on buckle and to pin passing through the sandwich frame.

Trailing Axle Spring.—Short span of only 4 ft. between the hangers.

Ashpan Dampers.—Coupled together and worked by one handle.

Smoke-box Dampers.—Louvre pattern over ends of flue tubes worked by lever on outside of smoke-box with rod back to footplate.

Leading Wheel Splashers.—Both equal in height above frame.

After 1851 (Great Exhibition of that year when the engine was shown)

Sand-boxes.—Two small square ones were fixed in front of the front leading wheel splashers. Pipes carried down behind guard irons. (Sand was poured down pipes by fireman going to front of engine.)

After 1851 *and Prior to* 1856

Chimney.—Bead removed and a large polished copper top added (3 ft. in diameter) as at C, Fig. 3. The base was now a square plate saddled on smoke-box and secured with square-headed bolts.

Sand-boxes.—Existing small front ones retained and two large ones placed in front of driving wheel splashers with gear operated from footplate.

Balance Weights.—Enlarged to embrace five spokes, flush riveted.

Weather Board.—Added over brass corner on back of fire-box. This had semicircular spectacle glasses.

Leading Springs.—New buckles with single eye-bolt form of hanger passing through the oak of sandwich frame and fitted below with rubber pads and nuts. This is shown in Fig. 2.

Ashpan Dampers.—Two handles, one for each damper.

Smoke-box Dampers.—Removed.

Leading Splashers.—Front now higher than the second pair to allow for heavier leading wheel tyres and greater range of movement of horns on the axle-boxes.

Rear Sand-box.—A small box was now fitted on the left-hand side of the footplate only: the pipe passed down behind the trailing wheel. Although the pipe followed the curvature of the wheel in *Lord of the Isles* it did not do so in all other engines, but was straight in some, and the object of this box was doubtless to deposit sand on the rail to render the tender brakes more effective. The brake blocks on all tenders of this period were wholly on the left-hand side.

Smoke-box.—No seam now appears where it formerly did, and the box must have been renewed at the same time as the chimney.

1870 *or Shortly After*

Chimney.—Probably again renewed for a new copper top is fitted: deeper vertically and of smaller diameter over the bell (see D, Fig. 3). A square plate is seen to be still on the top of the smoke-box, but is now riveted and the chimney base is once more an angle iron ring.

Balance Weights.—These, still the same size, are now secured with round or snap-head rivets.

Trailing Axle Springs.—Increased from 4 ft. to 4 ft. 6 in. span.

Leading Sand-boxes.—These small boxes have by now been removed.

Smoke-box Door.—The original form of door, hinged at the bottom, which will be illustrated later, now gives place to a new and more modern circular door, hinged at the side and with central bolt and clamping handles. A curved hand-rail above the door was also added.

Cylinder Lubricators.—Lubrication was first provided for by a large oil cup and box, with cocks, over the regulator handle, but now three Roscoe displacement lubricators are added, one on each side of the smoke-box and one on the top behind the chimney.

Buffers.—Up to this time were of leather stuffed with horsehair (see Fig. 12, August issue, 1934), but now iron buffers are fitted on both engine and tender.

Driving Wheels.—Whereas these had previously no flanges, new flanged tyres are now seen to be fitted.

(*Continued on page* 245)

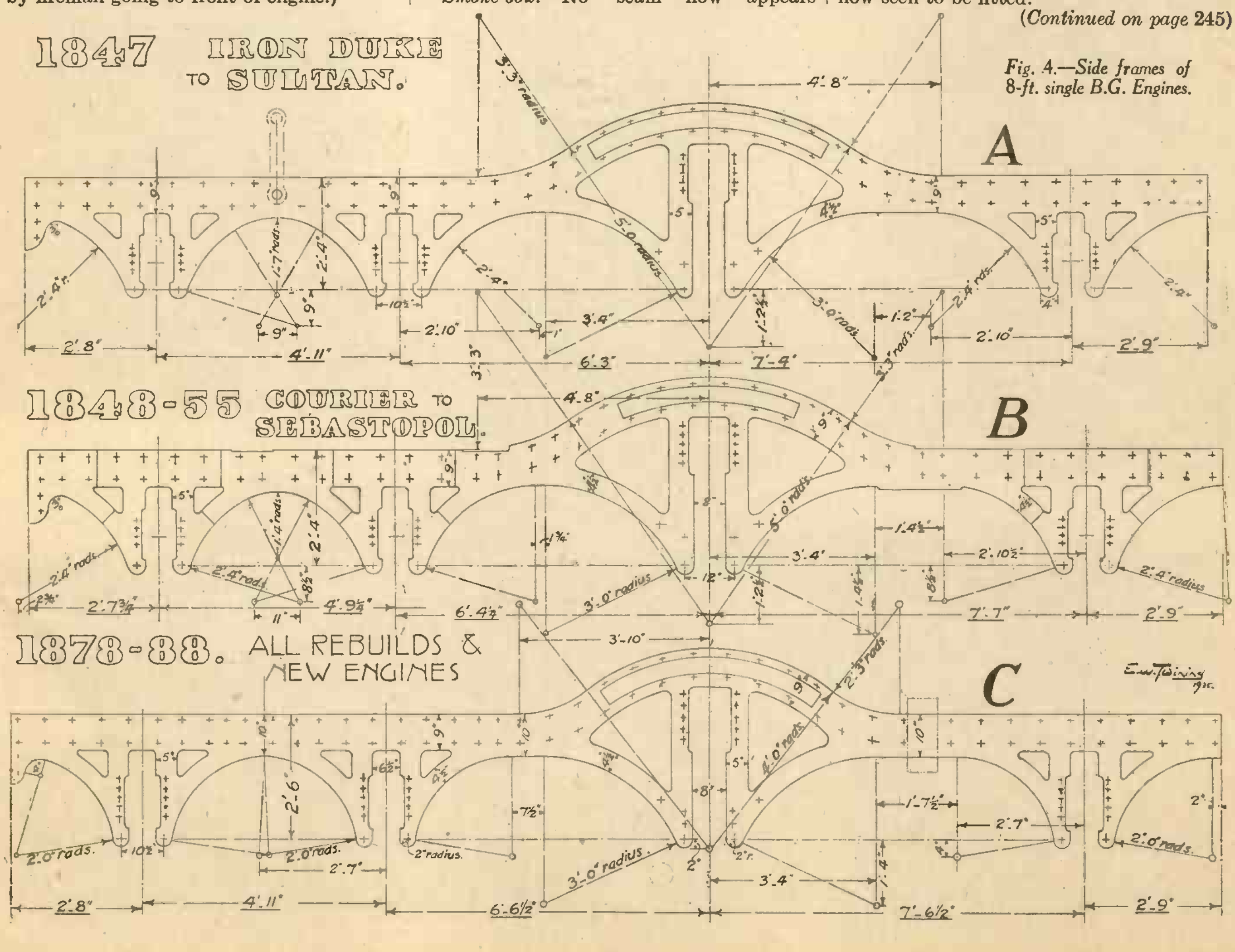


Fig. 4.—Side frames of 8-ft. single B.G. Engines.

The Canal-Ways of England

A water staircase on the Kennett and Avon Canal, near Devizes.

The Canal was the First of all Man-made Systems of Transport, and it is Probable that Goods were Conveyed by Water Centuries before Primitive Man had Constructed the First Wheeled Vehicle

CANALS were constructed in very early times in Egypt, Chaldaea, and China. Probably the first of such were dug for irrigation purposes, but their value for transport was soon discovered. Pliny tells us that Sesostris built a canal from the Nile to the Red Sea about 2000 B.C., thus anticipating our modern Suez Canal by nearly four thousand years.

So far as our own country is concerned, the first canals were made by the Romans nearly two thousand years ago. One of these, the "Foss-dyke" extended from the Trent to Lincoln, a distance of eleven miles, and a much bigger one—the "Caerdike"—connected the River Nene with the River Witham from a point near Peterborough to three miles below Lincoln, a distance of forty miles.

Early Waterways

Although the Egyptians, the Greeks and the Romans were accomplished canal builders, they were only able to construct their waterways through comparatively level country, because they failed to invent the lock, which was not discovered until the fourteenth century.

As every one knows, the lock is a device by which the canal can ascend or descend hills by a series of steps, and can also connect seas or rivers which are at different levels. Although this is one of the most important discoveries in human history, the very name of the inventor is unknown—though both Italy and Holland claim that the first lock was made in their own country. The lock also made it easy to adapt shallow rivers for navigation, by damming them to raise the level of water, and using a lock to connect the two levels. Long before canals were built on the grand scale, there was much useful work done in improving navigation on our rivers. The Thames was improved in 1423, the Lea in 1425, the Ouse in 1462, the Severn in 1503, the Humber in 1531 and the Welland in 1571.

The first ship canal to be built in this country was the "Exeter" in the sixteenth century.

(Above)—King John's Castle, Odiham, from the canal.

(Right)—Goring Lock on the Thames.

The City of Exeter had been an important port for centuries, the river affording safe approach for the sea-going ships of the time until the year 1284 when the citizens somehow offended Isabella de Fortibus, Countess of Devon. She at once ruined the trade of the city, and destroyed the navigation of the Exe by flinging in a mass of rocks about two miles below the city. This obstruction still remains and is known as "Countess Weir," but under the progressive rule of King Henry VIII a ship canal was dug, which again connected the city with the sea.

Improving River Navigation

During the seventeenth century the work of improving river navigation continued, and next came the period of the "Canal Boom," from 1730 to 1830 during which time more than ninety canals were projected, bringing the total mileage to 4,700 and the cost to more than fourteen millions.

At the top of the "boom" canal shares rose to fantastic figures, a single share in the Birmingham Canal was valued at £1,170, and one in the Grand Trunk and Coventry was worth £350.

The pioneers of British Canals were

A modern diesel barge on the Grand Union Canal, Uxbridge.

Francis, Duke of Bridgewater, with Brindley and Telford the engineers. Brindley alone laid out 350 miles of large canals. These men were the pioneers of civil engineering in this country. By them apparently insurmountable difficulties were overcome. The waterways were carried through mountains by long tunnels, over ravines upon aquaducts, and across valleys on embankments.

Trade and Industry

The value to trade and industry of this enterprise was enormous. Thus in 1750 the cost of carriage of goods by road from Manchester to Liverpool was 40*s*. per ton, but by the Mersey and Irwell the water rate was only 12*s*., and after the opening of the Bridgwater Canal it was reduced to 6*s*.

Similarly the rates from Manchester to Nottingham were reduced by the Trent and Mersey Canal from £6 to £2, and from Leicester from over £8 to £2 6*s*. 8*d*.

The Canal Boom of the eighteenth century was followed in the next, by a no less sensational collapse, caused by the construction of railways.

The first result of railway enterprise was the entire cessation of canal building, and the next was the almost complete ruin of the canal carrying trade. During the three years from 1845 to 1848 the Railways were allowed to buy up more than a thousand miles of canals, a total which has been since increased. They were purchased to be stifled, and many miles of derelect, weed-covered waterways still can be seen, mute proof of the effectiveness of their rival's plans.

Improved Construction

During recent years, a new period of canal construction and improvement has begun. It commenced with the building of the splendid Manchester Ship Canal, which was completed in 1893, and has been a tremendous success. It is 35-miles and a half long, with a bottom depth of 120 ft., as compared with the *then* bottom width of the Suez Canal of only 72 ft. It is sufficient to state that before the Ship Canal was built, Manchester was an *inland* city, and it is now the *fourth largest ocean port* in the country.

We have mentioned that in the eighteenth century there were nearly five thousand miles of canals in this country, which figure has diminished to-day to 2,475, that is about one-half. But this figure represents canal-ways which can be used, while the lost mileage is represented by those which have fallen to ruin. Some are actually dry, while many others have shrunk to shallow weed-covered ditches with broken locks and crumbling banks, and a few have been converted to road or railway tracks. The owners of some of these ruined canals cannot be discovered, because—if found—they would be liable for the repair of road bridges over their bankrupt canals.

I am glad to say, however, that an effort is now being made to revive and modernise our canals. Several Royal Commissions on transport (the last in 1928) have advised that canals have real value, and should be modernised and used.

Horse haulage on the Grand Union Canal, Hemel Hempstead.

Motor-driven Barges

The new plan is to amalgamate groups of canals, widen them, supply improved locks, and make them fit to accommodate motor-driven barges of large size.

One of the most successful examples of this idea is seen in the Grand Union Canal, which is an amalgamation of eleven waterways built between 1776 and 1840. A million pounds has been devoted recently to the work of modernisation, half of which has now been expended. The mileage of canal is about 300, giving direct communication between London and Birmingham, with connections to many important midland towns. A fleet of modern canal boats is now working, they travel in pairs, one being fitted with a diesel engine, and the second is towed. The dimensions of these modern barges are impressive—length 71½ ft., breadth 7 ft. ½ in., draught 3 ft. 9 in., and the speed is such that the journey from London to Birmingham can be effected in fifty hours. Although canals cannot compete with road or rail transport when *speed* is of prime importance, they offer important advantages. Breakage, pilferage, and actual loss are almost unknown, and freights are the lowest possible by any form of transport. Bulky or brittle goods are specially suited for canal transport, especially in large consignments.

The Grand Union Canal has a tunnel at Blisworth which is 1¾ miles long, and another at Braunston 1¼ miles long.

A lock on the Grand Union Canal, Marsworth.

Modern Locks

There are some fine modern locks, of which those at Knowle (Warwickshire) are perhaps the most impressive. Dredging is effected by large diesel-engined cranes, fitted on self-propelled barges. A large "grabber" is lowered to the bottom of the canal, and comes up full of mud.

Although Canals are not always beautiful, several afford splendid scenery. Of these the Caledonian Canal, 60½ miles long, is the most famous. It was designed by Telford in 1803, but not completed until 1847, at the cost of a million and a quarter. It is however little used to-day because of the small size of its twenty-nine locks, eleven of which form an impressive group called "Neptunes Stairway."

Among lesser canals the "London and Hampshire" or "Basingstoke" deserves mention, as it passes through fine woodland country, and affords some charming vistas.

CHOSEN

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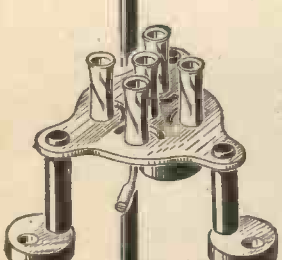
Says Mr. F. J. Camm.

"I have now had an opportunity of submitting your baseboard type Short Wave Valveholder to extensive tests.

"I first of all tried it with a short-wave receiver which suffered from microphony. It gave markedly improved results. I next tried it in a short-wave receiver using another well-known make of valveholder, and the results were equally good. Finally, I tried it in an ultra short-wave receiver, where, as you know, components need to be meticulously correct in order to avoid noises and variations in inductances caused by the movement of the wires.

"I therefore pass the design as O.K. in every way."



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Yours faithfully

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OVER 50 TYPES

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BRITISH MADE

THE SIGN OF A GOOD VALVE

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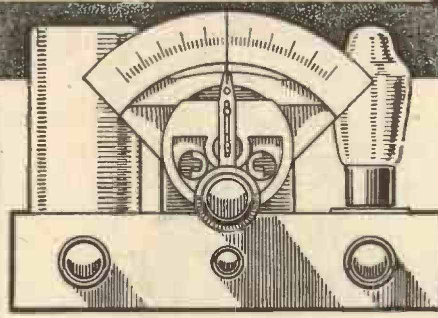


THE TELEVISION TWO

NOT for many years has the amateur radio enthusiast had such a splendid opportunity to explore "undeveloped territory" as he has to-day. Many of us remember the thrills we got in those now distant days when after many hours patiently spent constructing a new receiver, we succeeded in getting signals through from some distant station which had hitherto proved unattainable. Many of us also can, no doubt, remember listening to amateurs testing on the old 440 metre amateur wave-band.

Do you realise that the ultra-short waves are at the moment in probably a rather less developed state than were our present broadcast bands in 1923? The possibilities of these ultra-short waves can scarcely be exaggerated. Preconceived notions regarding "purely optical range" have already been proved ridiculous. All scientific theory with regard to these frequencies has "gone up in smoke," and it is only with the aid of the ordinary amateur enthusiast that a new and accurate conception of the behaviour of the ultra-short waves can be obtained.

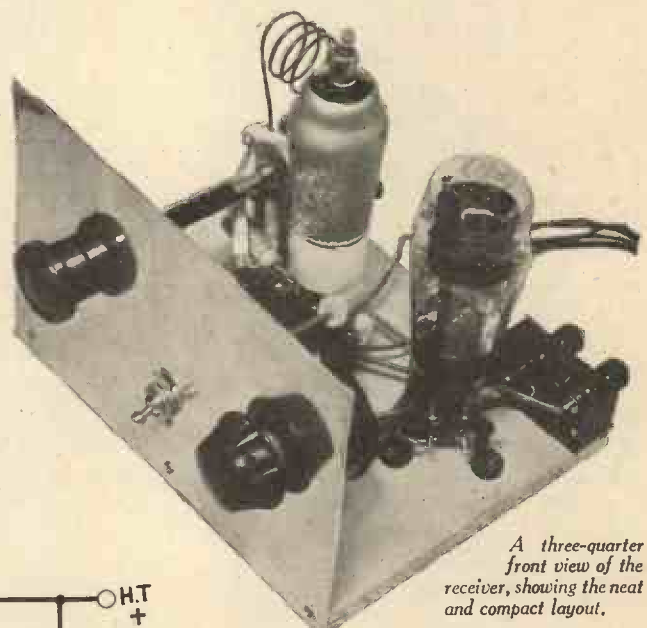
Whereas in 1923, really practical components were few and expensive, even simple apparatus costing many pounds, to-day it is quite unnecessary to spend more than almost the same number of shillings to obtain components of incomparably greater efficiency.

The receiver described is inexpensive to build and highly efficient in operation, and forms an excellent introduction to ultra-short wave working. Points of interest are (1) Extreme constructional simplicity, (2) Use of the special new "Harries" valve developed by the High Vacuum Co., (3) No coil changing.

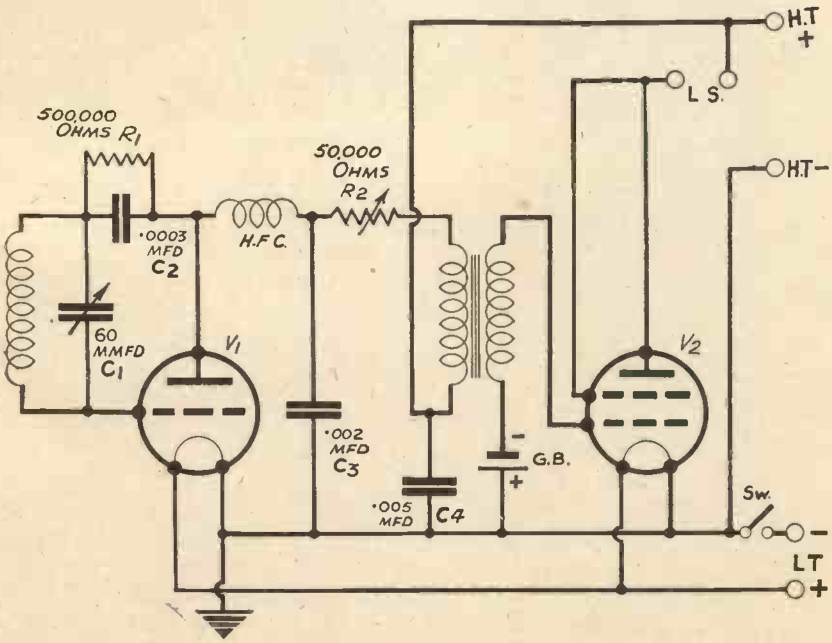
The Hivac special detector valve, apart from its internal construction being developed for short-wave work, has the grid brought to a connection at the top of the valve, the normal grid pin being unconnected. The Harries output valve is interchangeable with the pentode type, the Harries valve differing in that it has no suppressor grid, its special construction giving improved characteristics. On account of there being one electrode less, the valve cannot be termed a pentode, but this makes no difference so far as the connections are concerned.

The Circuit

The circuit chosen is of the super-regenerative type, and as the detector is self-quenching, there is no separate oscillator valve required. The output from the detector is fed through a 3 : 1 L.F. transformer to the output valve. The resultant signals are of sufficient strength to work a small permanent magnet speaker, and this method of reception is to be recommended,



A three-quarter front view of the receiver, showing the neat and compact layout.



The circuit diagram.

since the output on headphones is absolutely deafening.

For those readers who are unfamiliar with the principles of super-regeneration, the following brief description will be of interest. It is well-known that a valve is in its most sensitive condition when it is oscillating. For the reception of speech and music, however, it is obviously impossible to use it in this way, consequently for telephony reception a valve has to be used in the "just not oscillating" state. In super-regenerative reception, a separate series of oscillations are generated at a low frequency, usually of the order of 20 Kc. per second. This frequency is known as the "quench frequency," and the oscillations are allowed to mix with the normal oscillations. This process leads to a condition in which a loud rushing sound is heard all the time no signal is being received. Immediately a telephony signal is tuned in, the rushing sound dies down very much in strength, and the signal comes through free of distortion. The amount by which the rushing sound (quench noise) diminishes when a signal is tuned in, depends upon the

THE "TELEVISION TWO" COMPONENT LIST

One U.S.W. Tuning Condenser (S.W. 106) (Bulgin).
One L.F. Transformer (3/1) (B.T.S.).
One Extension Rod (4 in.) (Bulgin).
One 4-pin S.W. Baseboard-mounting Valveholder (Clix).
One 5-pin S.W. Baseboard-mounting Valveholder (Clix).
One On-off Switch (type S. 80) (Bulgin).
One U.S.W. Choke (type H.F. 21) (Bulgin).
One 50,000 ohms Potentiometer (VC 36) (Bulgin).
One 500,000 ohms Resistance (1 watt) (Dubilier).
One ·005 mfd. Fixed Condenser (tubular) (Dubilier).
One ·002 mfd. Fixed Condenser (tubular) (Dubilier).
One ·0003 mfd. Fixed Condenser (tubular) (Dubilier).

Wooden baseboard, size 8 in. × 6 in. (Peto Scott).
Aluminium panel, size 8 in. × 7 in. (Peto Scott).
Two valves (types D210/SW, Y/220) (Hivac).
Quantity No. 16 S.W.G. bare copper for coil (Bulgin).
Quantity No. 18 tinned copper for wiring (Bulgin).
Flex leads for battery connection (Peto Scott).
Two lengths of sleeving (Peto Scott).
Two terminal blocks with A, E and L.S. terminals (Belling Lee).
Four plugs, GB +, GB −, HT −, HT + (Belling Lee).
Two spades, LT −, LT + (Belling Lee).
One component bracket (Peto Scott).
Telephones (Ericsson).
Loud speaker—37 J (W.B.).
Accumulator—2-volt (Exide).
Batteries, H.T. 120 volts, G.B. 9 volts (Drydex).

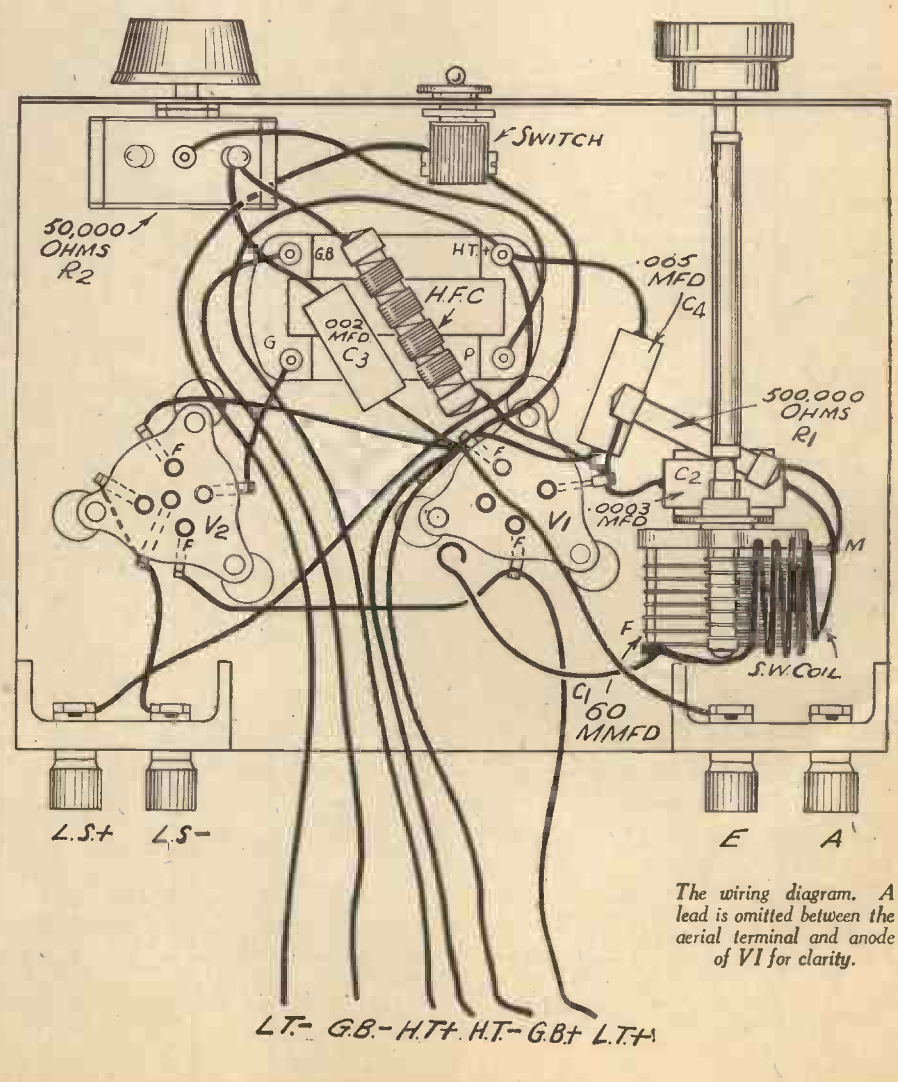
strength of the signal itself. For a strong signal, the background is dead silent, and in an efficient receiver such as that described, even very weak signals can be easily understood. The amount of quench noise is controlled by the potentiometer on the right of the panel.

There are very few points in the construction which will not be clear from reference to the diagrams. The coil should be wound with No. 16 s.w.g. copper wire, and consists of four turns wound on a 1-in. diameter former. The former can be of practically any material so long as the diameter is correct. The wire should first be straightened by stretching slightly, and the four turns wound touching each other. After winding, the former should be removed and the turns spaced out until there are approximately 2–3 diameters of the wire between the adjacent turns. When winding the coil, don't forget to leave sufficient wire at each end for connecting to the terminals of the tuning condenser. Approximately 1½ inches each end are required.

Operation

When you have completed and checked over the wiring and are ready for the first tests, the following notes will be found helpful. Set the tuning condenser at minimum capacity, and using a full 100 volts H.T., or 120 if available, slowly rotate the potentiometer control until a loud rushing sound is heard. Increase the capacity of the tuning condenser and a point will probably be found where the quench noise ceases. When this happens, the potentiometer should be readjusted. If the set has been carefully constructed and wired it will be found that a setting can be made of the potentiometer that enables quench noise to be heard throughout the entire tuning range. Having ascertained that the receiver is functioning, an aerial can be connected, AND HERE IS ONE OF THE MOST IMPORTANT POINTS OF THE ENTIRE SET. The aerial should consist of not more than 10 ft. of wire, erected if possible vertically. On no account should this be directly connected to the set, but must be loose-coupled in the following manner. A short length (about 3 inches) of thin rubber-covered flexible wire should be wound as tightly as possible round the end of the aerial. *Note.*—Under no circumstances must the insulation of this wire be removed. This flex and the aerial itself form a small condenser. One end of the short length of flex having been bared, it is then connected to the aerial terminal of the set. This method of aerial coupling may be a little crude, but it will be found very suitable for use with receivers of this type. To adjust the degree of coupling, it is only necessary to unwind a little of the flex from round the last 3 in. of the aerial. An earth terminal is provided, but the use of an earth is not essential, and its utility appears to vary in different localities, probably owing to slightly different aerial erections.

This receiver, when used with the value of coil and condenser specified, will tune wavelengths between approximately 4·75 and 8·5 metres. This range enables the 5-metre amateur band to be tuned and also both the vision and sound transmissions from the Alexandra Palace Television Station. Tested in the S.W. London district, 25 miles from Alexandra Palace, both vision and sound transmissions were received with NO AERIAL WHATSOEVER. The addition of an 8-ft. length of wire merely hung across the room fetched in both transmissions at really good volume on a permanent magnet moving-coil speaker. The 5-metre amateur band was next tried, and here results exceeded all expectations, two-way duplex telephony communication being carried on with another local amateur transmitting station without the slightest trace of interference from my own transmitter working only a matter of 3 ft. away, with the receiving aerial actually running within 6 in. of the transmitting aerial!



The wiring diagram. A lead is omitted between the aerial terminal and anode of V1 for clarity.

Interesting Radiogram Units

Details of Some Useful Accessories for the Reproduction of Gramophone Records

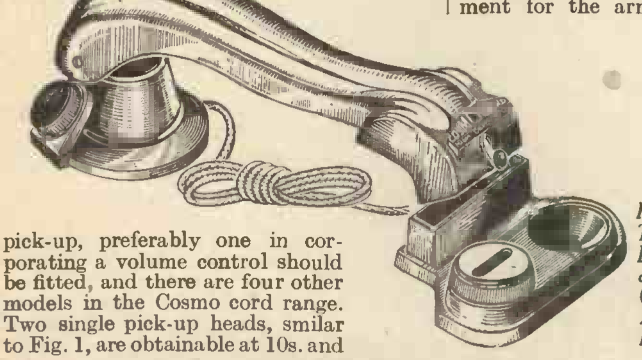
MANY listeners already own a standard broadcast receiver in which no provision is made for the reproduction of gramophone records. It should be remembered that there is not the slightest difficulty in incorporating the pick-up in the standard wireless receiver, and it is not even necessary to alter the wiring of the receiver in order to do so.

An Adapter Included

A simple adapter may be included merely by removing a valve from the valveholder, plugging the adapter into the valveholder and then replacing the valve in the adapter. Terminals on the latter device enable the pick-up to be connected, and to prevent the radio signals from being heard the set may simply be detuned. This is, of course, the cheapest and simplest modification, and to keep down the cost a simple, cheap portable gramophone of the acoustic type may be employed, with the ordinary sound-box replaced by a simple pick-up. A unit of this nature may be obtained for 5*s.* and is illustrated in Fig. 1. This Cosmocord pick-up is fitted with a tone-arm adapter with clamping screw, which enables it to be fitted to practically any standard tone arm, and a 24 in. length of silk connecting-cord is fitted. The response curve of this little unit is remarkably good.

Dearer Models

Where an attempt is being made to erect a more substantial type of radiogram, a good electric motor should be obtained, and the receiver converted into the combined apparatus. Then a better type of



pick-up, preferably one in corporating a volume control should be fitted, and there are four other models in the Cosmo cord range. Two single pick-up heads, smilar to Fig. 1, are obtainable at 10s. and

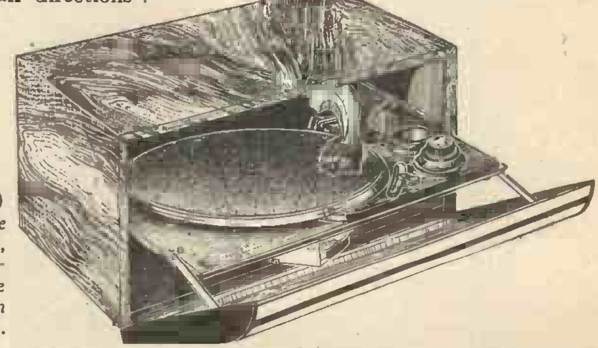


Fig. 2.—(left) The 25s. De Luxe Pick-up, and Fig. 3.—(right) The Ad-a-gram Playing Desk.

15*s.* 6*d.* and another model, No. 176, costing 17*s.* 6*d.*, is available as a ready-built bakelite unit with volume control. This has a 2,000 ohm winding and the needle movement is very free, thus preventing undue wear on the record. Three feet of silk braided connecting-lead are provided, and the rear part of the pick-up carrier-arm is provided with a substantial base for attachment to the motor-board. In the De Luxe class there is the model shown in Fig. 2 which is sold at 25*s.*, complete with a support upon which are mounted two needle

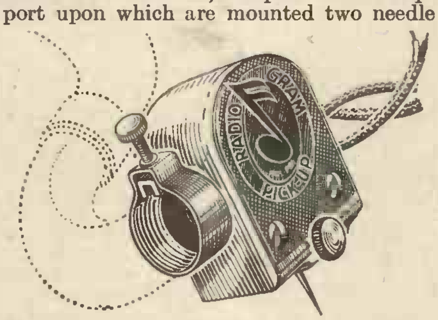


Fig. 1.—An inexpensive Pick-up from the Cosmocord range.

cups. This particular model has a 6,000-ohm winding, and a unique method of reed suspension is employed. This dispenses with the usual type of rubber suspension system and provides a perfectly free movement for the armature in all directions other than up and down. This results in a more faithful reproduction and freedom from "chatter."

Playing Desk

Where it is not desired to build a new cabinet or a standard table receiver is to be used for radio and gramophone reproduction, one of the neat Cosmocord playing desks may be used to solve the difficulty of accommodating the motor and pick-up. Model 84 is illustrated in Fig. 3, from which it will be seen that this consists of a neat shallow cabinet with drop front. When this is lowered the table carrying the motor is drawn forward to enable the record to be placed into position and the needle to be placed in the pick-up. The front may then be closed to exclude surface noise. The receiver may be stood upon this cabinet and will form a neat and compact radiogram, entirely self-contained. To accommodate the record-storage problem a further model is manufactured by the Cosmocord company, in which the lower part of the cabinet (which resembled the standard radiogram cabinet) is used as a storage cupboard, and the playing desk forms the upper portion, upon which the usual table model radio receiver may be placed.

BOOKS worth READING

The Editor is always pleased to advise readers on the selection of books.

"Power Wiring Diagrams," by A. T. Dover, M.I.E.E., Assoc.A.I.E.E. 216 pages, 272 line and half-tone illustrations. Published by Sir Isaac Pitman & Sons, Ltd., London.

AS the title suggests, this book is chock full of clear and well-prepared diagrams for almost every conceivable type of electrical device and switching system. Additionally, there are ten useful tables for items such as "Full-load Currents of D.C. and A.C. Motors," "Current ratings of Cables," "Volt-amperes required by A.C. Switchboard Instruments when used with Current and Voltage Transformers." There are also five pages devoted to conventional signs as used in the diagrams, and the following section of the book is divided into eleven sections, which include: Direct-Current Generators and Balancers, Arc-welding Generators, Power Transformers, and finally Automatic Voltage Regulators.

There is also a five-page index, which is well cross-referenced. The book is eminently suitable and in convenient form for use by students as well as practising electricians.

"Simple Home Electricity with Care and Repair of Appliances," by Mary Gilbert, M.C.A., M.I.H. Price 2/6, 108 pages, 27 illustrations. Published by Sir Isaac Pitman & Sons, Ltd., London.

AS increasingly greater use is made of electricity and electrical appliances in the home, the housewife should have at least a vague idea of the principles and use of the apparatus. In this book the author sets out to give, in non-technical language, the information required by the woman of the house.

After explaining the meaning of electrical units the book goes on to show how the greatest value can be obtained from the use of electricity. Other chapters deal with lighting—choice of lamps, switching, etc.; repairing a blown fuse; fitting flexible cords; remedying failures; simple repairs of electric irons, vacuum cleaners, and so forth. The book is comprehensive without being tedious, and deals only with those points which can be successfully and safely tackled by a woman of average intelligence. It is well and pleasingly written and contains a satisfactory number of good illustrations.

BATIK DYEING

An Effective Method of Decorating Fabric, which is Used Extensively in Java

A design for a cushion cover.

BATIK dyeing is a process of fabric decoration which is very popular in Java. It is distinguished from other forms of surface decoration, such as cotton-printing and stencilling, by its marbled appearance, or network of fine lines known as crackle. Batik can be used for curtains, cushion-covers, screens, chair-backs, and anything else ornamental. In Czechoslovakia it is used to make patterns on Easter eggs. Beautiful colour effects are obtainable. Silk is the easiest of all materials on which to work, but Japanese or any pure silks of a lighter variety are suitable for the purpose. Crêpe de chine, ninon, and georgette all produce good results, if they do not contain dressing, and very attractive silk scarves and handkerchiefs can be made.

Tools and Materials

Camel-hair brushes Nos. 2, 9, and 12, also a flat brush for borders, and a fitch-hair brush for applying wax to broad surfaces, will be needed. Ordinary paraffin wax may be used though there is a specially prepared wax made. A spirit lamp, dyes, a small aluminium saucepan, and a glass stirring rod for the dye bath will also be necessary.

The Tjanting tool, or Javanese batiking spoon, has a small receptacle for wax and a spout at the end through which the hot wax flows. The successful student may like to experiment on wood with a batik pencil. This is rather like a stylo pen, but it is made to hold sticks of wax. When held over a flame the wax melts and flows through the point.

To save expense, household dyes can be used, though the specially manufactured dyes are easier to handle.

Designing

Bold, simple patterns are the best. Remember, those parts of the design which are waxed will remain the original colour of the material after it is dipped in the dye bath. Where the wax splits the dye will penetrate and produce the crackle referred to above. A more decided crackle can be obtained by crushing the waxed parts in the hands before the final dipping.

Preparing a batik is not unlike making a design for appliqué. Draw your design on transparent paper to the size required, and pounce it by pricking round the outline with a darning needle or a tracing wheel. Now fix the tracing into position on the material, dip the pouncing pad (a tight roll of felt) in powder colour or crushed charcoal, and rub well over the entire surface. A wad of soft rag or cotton wool can be substituted for a pounce. The design is now ready to be pinned to the stretcher.

Repeating pattern for a silk handkerchief, showing the crackle.

MATERIALS REQUIRED

- Brushes, Nos. 2, 4, and 9, for colours or wax.
- Specially prepared wax.
- Spirit lamp for melting wax.
- Glass stirring rod.
- Specially prepared dyes.
- Tjanting tool.
- Transparent paper, 30 in. wide.

A suggestion for batik.

Waxing

Melt a small amount of wax (this will not dry and set hard when it is on the brush) over a spirit lamp, but do not let the wax boil. Dip your brush into the hot wax and fill in the design. The wax should penetrate the material if it is at the correct heat, so that no dye can reach the waxed parts. If there is any clogging, put the brush in the wax again to be reheated. If preferred, apply the wax with a Tjanting tool which is very useful for outlining. Do not let the spout touch the material, or this will close the hole and stop the supply of wax. When the Tjanting tool cools put it back in the saucepan so that the hot wax will melt it. Work as quickly as possible.

Another method is to outline the design with a fine brush and fill in with a larger one. It is important that the edges should be clear. Before dipping in the dye bath, see that the wax has penetrated the material, and, if not, apply a second layer of wax on the wrong side. When this is done, soak the fabric in cold water.

Dyeing

Mix the concentrated dye with cold or tepid water, and test it on a spare piece of wet material until the desired colour is arrived at. The dye always dries lighter. It is advisable to protect the hands from stain by wearing india-rubber gloves. Plunge the fabric into the dye bath, keeping it well below the surface and move it about with a glass stirring rod. When the colour is deep enough, take it out and rinse well in cold water. Lay the fabric on a table or smooth board and dab it with a cloth to remove excess of moisture. Pin out to dry to avoid streaky effects, and keep flat while drying. Any heat will cause the wax to run.

After the first dyeing, the fabric must be allowed to dry thoroughly and if more than one colour is used, repeat the process described above. All parts remaining the colour of the first dye are re-waxed, the material is again soaked in cold water and is then dipped in a bath of the second colour. Rinse and pin out to dry after each drying and always use the lightest

A Czechoslovakian border design.

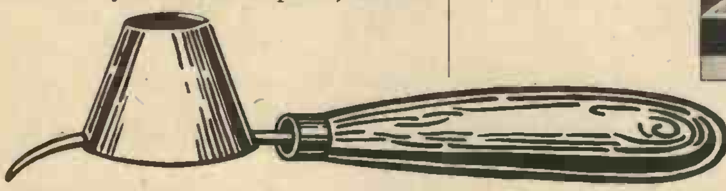
A Javanese border design.

colours first. Small spots of colour can be added with a brush so that the greater part of the surface need not finally be re-waxed.

Removing the Wax

When it is dry, lay the material between sheets of brown paper and remove the wax by ironing with a hot iron. If traces of pouncing and wax remain, they can be removed by immersion in petrol, which is also the best way of cleaning batiks when they are soiled. The beginner is well advised to start with small articles such as scarves and handkerchiefs, which look well when finished with a rolled hem. Dyes which cannot successfully be used together are red and green, also orange and purple. Brushes should be washed after use.

Wooden stretchers for small designs and rug frames for larger ones, are comfortable to work on.



(Right) Repeating a pattern in three colours or dipping for a scarf border. (Below) A Tjanting tool or Javanese batiking spoon.

THE SPRAY METHOD OF COATING SURFACES WITH METAL

By FRANK W. BRITTON, D.Sc.

IN a past issue of PRACTICAL MECHANICS (September 1935) an article appeared on electro-plating which included some excellent hints on simple plating lay-outs for the home experimenter. The present subject is unfortunately not quite so simple as to enable the amateur to carry out for himself the spraying of metals or other surfaces, with metal—it is, as yet, a rather skilled operation and, as far as the author is aware, no really convenient appliance for home use is yet on the market. Aluminium, gold, lead, nickel, silver, tin and zinc have been successfully sprayed on to surfaces, while, on account of the rapidity of the process, there is hardly any oxidation. It is probable that electro-plating on iron, of brass, bronze, copper, silver and gold, will hold the field for some years to come, as these metals, when sprayed, do not seem to produce a sufficiently homogeneous coating to prevent the iron or steel corroding and rusting when brought into an acid atmosphere, or in contact with electrolytes.

Preparation of the Surface

Prior to metal-spraying it is necessary to roughen all surfaces ; this is done either by sand-blasting or by blasting with steel grit so that a rough mesh-like effect is produced on the metal. Such a fine structure in a way matches the size of the particles of the finely divided metal in the molten spray.

Cleanliness is essential, of course, metals in the finest state of division simply will NOT adhere to any surface unless it is absolutely free from dirt, the same precautions which have to be taken in electroplating are likewise important in hot metal spraying. A deposit appears to be made up of countless granulations formed as each particle rapidly cools. These particles before solidifying become coated with a minute film of oxide but this does not prevent the entire deposit from holding firmly together by the partial fusion of each semi-fluid particle, the whole coating adhering to the actual metal surface through the minute net-like surface effect of sand-blasting.

Method of Melting

The metal in its transit from the blowpipe feed consists of many millions of isolated globules of molten metal which partially flatten themselves against the surface to be coated, as the result of an intense collision or, if we like, through a heavy bombardment, somewhere in the neighbourhood of a speed of 12 miles-per-minute. Each particle has a diameter approximating a hundredth of a millimetre.

The fact that a fine wire when placed in the hottest zone of a blow-pipe flame becomes white-hot and then molten—forming globules, is the basis of the metal-spray process. If the globules of fluid metal fall into the path of a high-velocity current of gas, they are immediately broken up into a continuous stream or spray of molten metal. A blow-pipe, incorporating a suitable high-pressure gas supply nozzle forms the spray-metal tool.

According to the metal used for spraying so is the structure of the surface produced. The essential difference between the structure of a casting lies in the fact that in the latter, there is an almost continuous layer (upon layer) of fine metal particles separated by the inclusion of imprisoned gases. Whereas, in a sprayed metal surface, instead of such gas spaces there are minute films of oxide separating each particle. A considerable difference attaches to the close structure produced by the metals of lower melting point. In this case, the particles are much smaller and form a far finer spray than metals like nickel, gold, etc. This fact renders it necessary to give a thicker coating of the higher melting-point metals.

Slight Oxidation

We mentioned that there was a slight oxidation of the molten particles themselves on reaching the metal surface, but this does not apply to the metal wire itself in its passage from the blow-pipe flame to the surface. Proof of this is witnessed in the complete freedom from burning of magnesium, of all metals. As in the case of metal-hardening by rapidly bombarding it with blows (or the impingement of steel balls as in the later methods) so in metal-spraying, the film of deposited metal is slightly harder than the same metal when cast, while its density is a little less. These slight variations make for certain alterations in the working of sprayed-metal articles, such as higher speed and lighter cut when machining, chiefly perhaps to prevent peeling of the particles by cutting directly through them, instead of "cut-shearing" them. Polishing offers no difficulty whatever, the usual methods being used.

Of all metals, aluminium probably offers greatest scope in industry, both on account of its durability on exposure and fairly good conductivity. It is notoriously difficult to electro-deposit aluminium—results are so uncertain. I remember, some years ago, when experimenting with chromium-plating, I made use of an aluminium anode and, with an outrageously high voltage around 200, current density of 5 amperes per square foot of article to be plated (cathode), and a concentrated chromic acid bath, obtained a most satisfactory deposit of aluminium. A spoon, so treated, is still in existence and has been fairly well used for five years or so, and I still have some specimens of iron screws and nails, also a small sheet of aluminium-plated brass, which, by the way were not quite so successful as the spoon, but nevertheless somewhat of a curiosity in the way of accidental plating. The strange thing too, was the fact that I obtained almost as good results with a voltage of 6, although the film was more or less oxidised and matt. Aluminium, as far as its electro-deposition is concerned, is a most evasive sort of metal, far and away better results apparently having been obtained by the spraying method.

A Strong Film

The aluminium film or oxide is remarkably strong and the metal adapts itself admirably for spraying even for large areas and bulky structures. Temperature of working is rather critical, above a certain limit rapid absorption takes place and, as a protective coat the deposit becomes useless, this temperature limit is 970° C.—this being about 310° C. above the melting point of aluminium. Iron articles which are spray-treated with aluminium form an exceedingly hard alloy with the latter which then oxidises to form a scale-free coating. Alternate spraying of aluminium and zinc is most advantageous in many instances, successive layers of the two metals producing a most adherent protection.

Tin and Lead Spraying

The two metals, tin and lead adapt themselves to the spraying process for the former, on account of its feeble reactivity, is ideally suited to the preservation of foodstuff and is one of the most useful of the common metals. Unfortunately, it seems that sprayed tin requires to be of a fairly good thickness considering the rather porous nature of the metal. Most pots, pans and other culinary utensils need only a light deposit of tin which is ordinarily too porous, so to overcome this, the film is coated with a layer of varnish.

(To be continued.)

AROUND THE TRADE

New Lines Introduced by the Manufacturers

A Free Jig-saw Puzzle

FITTING together the pieces of a jig-saw puzzle is extremely fascinating and interesting. Those readers interested in this type of puzzle should drop a line to The Rawlplug Co., Ltd., Rawlplug House, Cromwell House, Cromwell Road, London, S.W.7, mentioning this journal, and they will be only too pleased to send a puzzle, free of charge, by return.

Villiers Engines

THE Villiers Engineering Co. was established in the year 1898, and since its foundation has manufactured high-grade cycle and motor-cycle components.

The first Villiers two-stroke engine was made in 1913, and since that date the company has specialised in the production of two-stroke engines, with highly successful results. Year by year the annual output has increased, with the result that this firm are to-day the largest manufacturers of small internal-combustion engines in Europe.

Upwards of 300,000 Villiers engines have been made, and the factory not only produces its own flywheel magnetos and carburetters, but makes all its own steel forgings, castings, and all other parts down to the smallest nuts and bolts.

Make a Success of Life

"KNOW thyself" is wise advice. Once a person knows himself he will find that he has a certain sphere of usefulness to himself and to others. He has also a certain amount of energy to spend in attaining and maintaining that place in the world which is his place, and his alone. In the vast majority of cases that store of energy is far greater than he thinks it is. Pelmanism will show you how to discover that latent energy and, having discovered it, how to use it. It also shows you how to get your feet on the ground, and set on the path that leads to your success. Write now to the Pelman Institute, Pelman House, Bloomsbury Street, London, W.C.1, for their free booklet, which gives complete details of the course.

00 Gauge Railways

HAMBLINGS, 10 Cecil Court, W.C.2, have recently produced their latest catalogue in which is listed a large range of 00 gauge accessories. Also are listed a number of locomotives and rolling stock. Interested readers should write to the above address for this catalogue which costs 4*d*.

Nursery Rhyme Lamp Shades

THE General Electric Co., Ltd., has introduced a pleasing range of novelty shades for use with Osram decoration lamps.

The shades, which are bell-shaped, are moulded from coloured bakelite, and are 2½ in. diameter at the bell end, and 2 in. high. The colours are red, white, green, blue, yellow, and flame, and each shade carries a coloured pictorial representation of a popular nursery rhyme. The shades are neatly packed 12 in a box, which is attractively adorned with nursery rhyme figures and lends itself admirably to window- or counter-display settings. A set of one dozen shades costs 5*s*.

Ample stocks to meet demands are available, as well as a range of attractive descriptive literature to help in popularising these new novelty shades.

OUR BUSY INVENTORS

Signposts for Reserve Seats

THOSE privileged folks who can afford a reserved seat in a theatre will be interested in a new device for enabling them easily to find the seats allotted to them. It is usual for the rows of theatre seats to be lettered or numbered, but these signs are not always readily seen, especially in cinemas in which the light is subdued. The aim of the inventor has been to illuminate these letters or numbers in such a manner that the light in the theatre is not appreciably increased. According to his device, the end seat of a row is provided with a panel of translucent or transparent material with an indicating mark thereon. A source of illumination is placed so that a beam of light is directed upon the edge of the panel. This arrangement will help the unattended searcher to find a seat not reserved for some other patron of the theatre.

How to Pull the Strings

IN the days of good Queen Victoria, when the young were initiated into the mysteries of the A B C, they were introduced to an anonymous archer whose name began with A and who shot at a frog. I presume there are still in this country a number of archery clubs. The member of such clubs may be intrigued by a newly devised appliance enabling them to grip an arrow and bowstring without injury to the hand. When this is done by the hand only, even after very slight use of the bow, it is asserted that the tips of the fingers are apt to become sore. No doubt the fingers of an expert like the late Robin Hood would become hardened. But, in the case of the fair sex, some of whom are interested in archery, their tender skin is liable to abrasion. The above-mentioned invention comprises a pair of pivoted arms, each having at one end a clamp and at the other end a handle. The clamps grip the arrow and the strings of the bow. And this makes for a happy release.

American Devices

A GLANCE at recent inventions which hail from the United States reveals some striking devices. Though I am not yet able to give full details of these contrivances, their titles tempt me to lay the reins upon the neck of my imagination. I write on the eve of an election on the other side of the Atlantic. A voting machine which has been patented there may help the free and enlightened electors to record their votes mechanically. One wonders whether a fishhook extricator is designed to remove the hook from the gills of the fish or the garments of anglers. A contraption known as a "sleep inhibitor," might be convenient for keeping awake the audience during a prosy speech. And a device for automatically closing a valve, in the event of an earthquake, will be useful in a country like Japan.

DYNAMO.

NEW INVENTIONS

The following information is specially supplied to "Practical Mechanics," by Messrs. Hughes & Young (Est. 1829), Patent Agents, of 9 Warwick Court, High Holborn, London, W.C.1., who will be pleased to send readers, mentioning this paper, a copy of their handbook, "How to Patent an Invention," free of charge.

Ladies' Hat Stretcher

THE principle of the trouser-stretcher is now to be used in connection with ladies' hats. A new device has for its purpose the assurance that the hat, when not being worn, shall keep its shape. At present, to achieve this object, the crown is sometimes stuffed with paper. But this rudimentary method has been surpassed by the invention in question which consists of an arrangement of circular wires. The device is light, can be cheaply made, and is adapted to fit hats of various size. Thus, when the headgear of the fair sex is not on active service, both crown and rim may be made to retain the design of the hat when it left the hands of the milliners. This stretcher will be especially useful in schools, banks, and factories, in which the hats of the members of the staff are usually hung upon hooks.

Anti-rheumatic Penholder

A PENHOLDER, for which curative properties are claimed, has made its début. It is contended that it will prove an antidote to rheumatism. The object of the inventor has been to provide a penholder or a pencil case which will contain a source of electricity which will pass into the hand of the writer. The conductor to complete the circuit is provided by the fingers of the writer, which normally possess the necessary amount of moisture to supply the conditions for producing a small electrical discharge. Let us hope that this anti-rheumatic penholder will also prevent writer's cramp.

Crib with a Ladder

THE average infant is often loath to retire to rest, or, to put it in baby language, he does not want to go to "bye-bye." However, a recent invention contains a feature which will tempt the young to go to bed somewhat earlier than Samuel Pepys. A crib with a little step-ladder leading up to it will undoubtedly intrigue the juvenile mind. This crib is of the usual pattern with side railings, but one of these is cut away to furnish a passage opening, at which point a step-ladder descends. When raised, this ladder fits into the opening.

Harmless Deception

IT was an American poet who declared that "things are not what they seem," and an innocent deception has been patented in the United States in the form of what is termed a "pocket-handkerchief simulator." The device comprises a breast pocket, from which there protrudes a pair of tabs resembling two corners of a handkerchief. There is no complete square of material, but the public are led to believe that the wearer is the proud possessor of an elegant silk handkerchief.

Perfumed Ear-ring

AN ear pendant which is a fount of fragrance has just been patented. This novelty, in addition to playing the customary rôle of an ear-ring, has a tiny pocket which holds a charge of concentrated perfume.

DYNAMO.

PRACTICAL MECHANICS Replies to Queries and Enquiries

If a postal reply is desired, a stamped addressed envelope must be enclosed. Every query and drawing which is sent must bear the name and address of the sender and be accompanied by the coupon appearing on page 247. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., 8-11 Southampton Street, Strand, London, W.C.2.

ETCHING ZINC PLATES

"I INTEND using a coating of Canada balsam as a resistance in the etching of zinc plates. I want to dissolve the Canada balsam in some liquid which is *entirely* free from water. This liquid must be volatile.

"Could you give me more details concerning the process of anodising aluminium as described in 'Practical Mechanics'? I would like to know the plant necessary for this process. Also, has the oxide coating a matt surface after anodising? Can I obtain a treatise on this process?

"Can you tell me the properties of 'Xylene'?" (E. Gilliam, Leeds.)

THE best solvents for Canada balsam are chloroform, benzene or xylene. All of these are volatile.

The anodic oxidation of aluminium is carried out in several ways. In the first place a 3 per cent. chromic acid solution may be used as the electrolyte. Into this is placed the anode (comprising the aluminium article) and a lead or iron cathode. The current is turned on and is gradually raised to 40 volts during fifteen minutes. It is kept at that voltage for another thirty-five minutes and then raised to 50 volts for a final five minutes. The temperature of the bath is maintained at 45° C. In a second method of anodising, a sulphuric acid electrolyte is used, and the bath is operated with a constant voltage of from 10 to 20 volts for a period of thirty minutes.

The film of aluminium oxide deposited by the process of "anodising" is exceedingly thin (approximately one-thousandth of an inch) and it is very hard and resistant to adverse influences. Freshly anoded aluminium may be dyed with certain colouring matters, the aluminium being immersed in a dye-bath in a similar manner to cloth. The dye is attracted by and deposited upon the oxide film on the surface of the metal.

The anodic film may be obtained in a matt condition. Usually, it possesses a silvery sheen.

We are not aware of any special treatise on the anodic oxidation of aluminium.

Xylene is an inflammable liquid obtained from coal-tar naphtha. It is really a mixture of three components, vix. ortho, meta and para xylenes, which can be separated from the commercial "xylene" by chemical means. Commercial "xylene" has a boiling-point between 136° and 141° C. The liquid is a good solvent for many substances. It possesses properties similar to benzene and toluene, but is not as volatile.

ULTRA-VIOLET RAY

"1. WHAT substance is used as an ultra-violet ray filter?

"2. Will an ordinary electric light bulb emit ultra-violet rays—if not, what kind of lamp will?

"3. What chemicals are used for making flash paper?" (M. W., Bucks.).

1. BY the term "ultra-violet ray filter" do you mean a filter capable of passing ultra-violet rays or one which filters out such rays? A coating of finely-divided silver upon glass or quartz passes ultra-violet rays to the exclusion of others. A solution of æsculin and of most yellow dye-stuffs or a piece of gelatine dyed with such solutions filters out ultra-violet rays. A solution of β-naphthol-disulphonic acid has a similar effect.

2. An ordinary electric light bulb is useless as a source of ultra-violet rays. Such rays are best obtained artificially from an arc lamp or a mercury vapour lamp.

3. There are several types of flash paper. We believe that the paper to which you refer is an exceedingly thin paper impregnated with a solution of potassium chlorate and/or saltpetre.

SORBO RUBBER

"I HAVE a sorbo rubber mat, grey in colour, which has got very dirty.

"Water does not seem to clean or bring back the colour.

"Could you please suggest any preparation which you think would do this?" (P. H., Chesterfield.)

YOU will probably get a satisfactory result by cleaning your rubber mat with a paste composed of water and fuller's earth, chalk, or powdered pumice stone.

Alternatively, rubbing over the surface of the rubber with a rag charged with xylene or solvent naphtha should produce the desired result.

Again, a similar rubbing with a rag moistened with a weak (5 per cent.) solution of caustic soda should give good results. Be sure, however, to rinse every trace of the caustic soda away afterwards.

ORGANIC BODIES

"HOW are the following substances prepared?

"1. Acriflavine.
"2. Phenolphthalein.
"3. Resorcin.
"4. Amidopyrin."

(F. H., Co. Meath.)

THE substances which you mention in your letter are mostly complex organic bodies which are prepared bv lengthy and intricate processes. Bearing this fact in mind, we feel sure that you will appreciate the fact that it is quite impossible for us to describe, with the detail you require, the preparation of these materials, since such description would occupy very many pages.

You can, however, obtain the information you require from any modern textbook of Organic Chemistry and Dyestuff Chemistry, as for example Holleman's *Textbook of Organic Chemistry*.

Dealing, however, very briefly with your queries, we give the following information:

Acriflavine (or trypaflavine) is a flavine dyestuff of high antiseptic powers. Amidopyrin, a drug, is a derivative of a complex compound called pyrazolone, made from ethyl acetoacetate and phenylhydrazine. Phenolphthalein, the well-known chemical indicator, is made by heating pure phenol (carbolic acid) with phthalic anhydride and zinc chloride for 8-10 hours. Resorcin, or dihydroxybenzene, is usually made by heating guiacol or methylcatechol (which is contained in beechwood tar) with concentrated hydriodic acid. Synthetically, resorcin is prepared by fusing phenol-orthosulphonic acid with caustic potash.

For laboratory details of the preparation of these substances, we must, however, as previously mentioned, refer you to the standard textbooks.

"ALUMINIUM AND ITS ALLOY"

"1. WHERE can I obtain in small quantities, flimsol powder or solder? or is this different from the special fluxes mentioned in the above article?—if so, names of vendors, please.

"2. What solution or solutions shall I require to deposit aluminium on carbon and copper, if copper is not suitable give me a common metal that would do, for electroplating?

"3. What is the material used in gas-lighters which ignites the gas when held in the gas stream and is it still obtainable?"
(A. C., Tunbridge Wells.)

1. YOU can obtain small amounts of flimsol powder and other aluminium fluxes from Sir W. Burnett & Co. (Chemicals) Ltd., Great West Road, Isleworth, Middlesex. Flimsol powder is not a flux, but a compound containing aluminium in alloy form.

2. You cannot deposit aluminium successfully on carbon or on other articles. Aluminium is so cheap to-day that there is no call for electro-plating with this metal.

3. The material to which you refer is platinum black, a very finely-divided form of metallic platinum. We do not think these automatic gas-lighters are still manufactured, but you can obtain platinum black (it is very expensive) from Messrs. Johnson, Matthey & Co. Ltd., Hatton Garden, London, E.C.1.

AN ANODISING BATH

"WILL you please give me details for the manufacture of a small anodising bath, also detail for working same?"
(R. S., Lancs.)

ONE of the best baths for the anodic oxidation of aluminium consists of a 3 per cent. solution of chromic acid. The anode of the bath is the article to be oxidised, the cathode consisting of a strip of lead or iron. A current gradually rising to 40 volts should be applied for the first 15 minutes and maintained at this voltage for another 35 minutes. During the next 5 minutes the current should be raised to 50 volts and maintained at 50 volts for a further 5 minutes, after which time the anodic oxidation of the metal will have been completed. During the entire process, the temperature of the bath should be maintained at 45 degrees Centigrade.

Another anodising bath comprises a medium-dilute solution of sulphuric acid, the electrodes for this bath being as above. This bath can be operated on a steady voltage varying from 10 to 20 volts. The passage of current through it for 30 minutes is sufficient to produce the desired results. The bath, also, may be worked at ordinary temperatures. It does not, however, give so fine-grained an anodic film as the former bath.

A MODEL G.W.R. BROAD GAUGE LOCOMOTIVE

(*Continued from page* 231)

After 1877

Some little time after Mr. Dean took office he introduced a new and very neat bright copper top to his chimneys, F in Fig. 2. One of these was fitted to *Lord of the Isles*, which was carried until the end. The base remained the same—an angle-iron ring.

No other alterations were made.

No brakes were ever on the engine, nor were injectors ever fitted. The boiler feed was by pumps worked from the crossheads.

The *Lord of the Isles* was withdrawn from service in 1881 and ran, in its thirty years of activity, 789,300 miles. This with its original boiler.

Other Chimneys on B.G. Singles

In Fig. 3 I have shown two chimneys other than those referred to in the foregoing, viz. A and E. Now that illustrated at A, was the first one designed by Gooch for the 8-ft. singles. The six-wheeled *Great Western* had it, so did *Iron Duke*; but how many other engines after that and up to 1851 I do not know definitely: probably only those built before the end of 1847. I do know this, however, that all the chimneys of that pattern were wholly of iron.

The other pattern, E, was of Mr. Joseph Armstrong's design. Mr. Armstrong succeeded Daniel Gooch at Swindon and placed this tapered chimney with its beaded copper top on some, if not all, of the 8 ft. singles. After Mr. Dean took charge in 1877 he continued to use Mr. Armstrong's chimney for two of three years. The evidence of this is seen in the 7ft. narrow gauge 157 to 166 class of 1879 (see PRACTICAL MECHANICS, September 1934, page 571). He must, however, have designed the form shown at F before 1881, since it was given to *Lord of the Isles*.

I have pleasure in acknowledging the courtesy of Mr. C. B. Collett, the present Chief Mechanical Engineer at Swindon, who has kindly supplied me with the photograph of *Lord of the Isles* in its final state, and given me permission to reproduce it.

(*To be continued*)

STARGAZING

(*Continued from page* 222)

by its brilliant chief star Vega. It also contains those remarkable objects, the Ring Nebula and the quadruple star ϵ Lyræ. The former is the only annular nebula within reach of telescopes of moderate aperture; the latter, though apparently single to unaided vision can, with some optical assistance, be easily separated into two smaller stars. Through a large instrument each of them will also be found to be double, constituting a quadruple system. Almost level with Vega, so to speak, is β Cygni, the bottom star of the large cross formed by the brighter components of Cygnus (the Swan). It is a beautiful yellow-and-blue double. Cygnus, being one of the constellations traversed by the Milky Way, affords a particularly rich field for telescopic sweeping.

It may again be mentioned that a cardboard revolving planisphere and a small star atlas will enable all the objects in these articles to be readily located.

THE CHEMISTRY OF "COLD LIGHT"

(*Continued from page* 221)

from chemicals and most of them are little-known ways.

Rochelle Salt

If, for instance, we boil a strong solution of Rochelle salt (sodium potassium tartrate) in the dark, the solution will, as soon as a certain concentration has been reached, proceed to give off quite a miniature shower of "cold" sparks. Again, if we throw a quantity of powdered fluorspar on to a heated shovel or iron plate, the fluorspar will shine with a brilliant light. Sometimes, also, when an ordinary lump of sugar is broken up in a dark room it will emit flashes of light. The causes of these luminous displays are quite unknown, but they are definitely chemical and not electrical in nature.

For the benefit of advanced experimenters who are closely interested in the subject of chemical luminescence, the following account of a most remarkable synthetic luminescing compound which has recently been produced in commercial quantities[1] will not be unwelcome.

The chemical substance in question is known (for want of a shorter name) as *ortho-aminophthalic cyclic hydrazide*. Now, if half a gramme of this be dissolved in 50 c.c. of a 5 per cent. solution of caustic soda and five drops of hydrogen peroxide are added to it, a solution will result which, when dropped into a concentrated solution of potassium ferricyanide (made alkaline with caustic soda), will produce a vivid flash of cold light at every drop of the solution into the ferricyanide solution. The light produced is so vivid that objects in a dark room can be illuminated with it. Even when the two solutions are mixed at very high dilutions, the chemical luminescence is still perceptible in the form of a pearly violet-white haze or glow.

This material (*i.e.* ortho-aminophthalic cyclic hydrazide) is quite the most remarkable cold-light producing substance which has yet been made artificially. Whilst its properties, of course, do not place it in the same class as those luminous compounds of the world of living creatures, luciferin and luciferase, they are, nevertheless most striking ones, and experiments with this newly produced material are, in particular, eminently suitable for chemical demonstrations, etc.

[1] By the British Drug Houses, Ltd., London, N.1. Price about 3*s*. 9*d*. per gramme.

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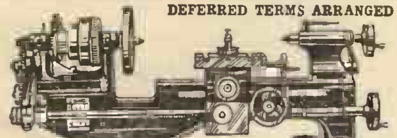

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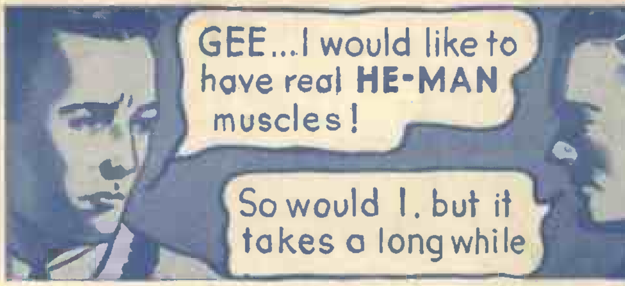

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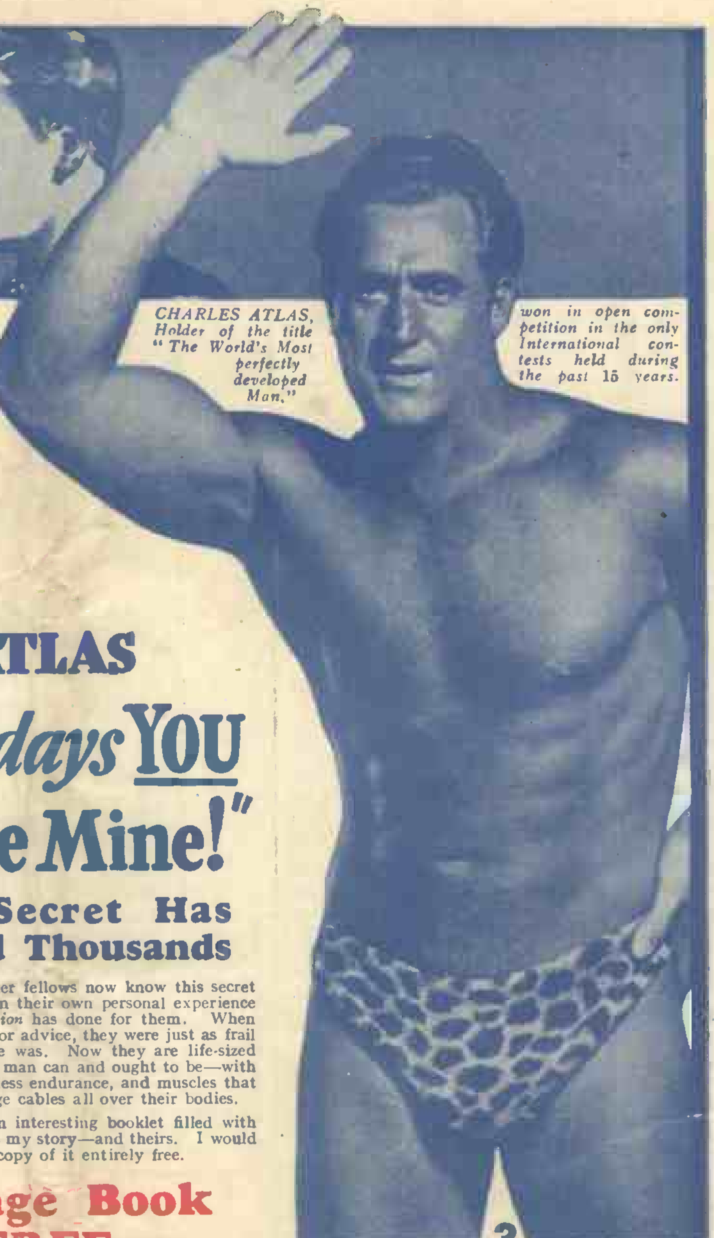

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