Making our MASTER BATTERY and SLAVE CLOCKS *Further Details*

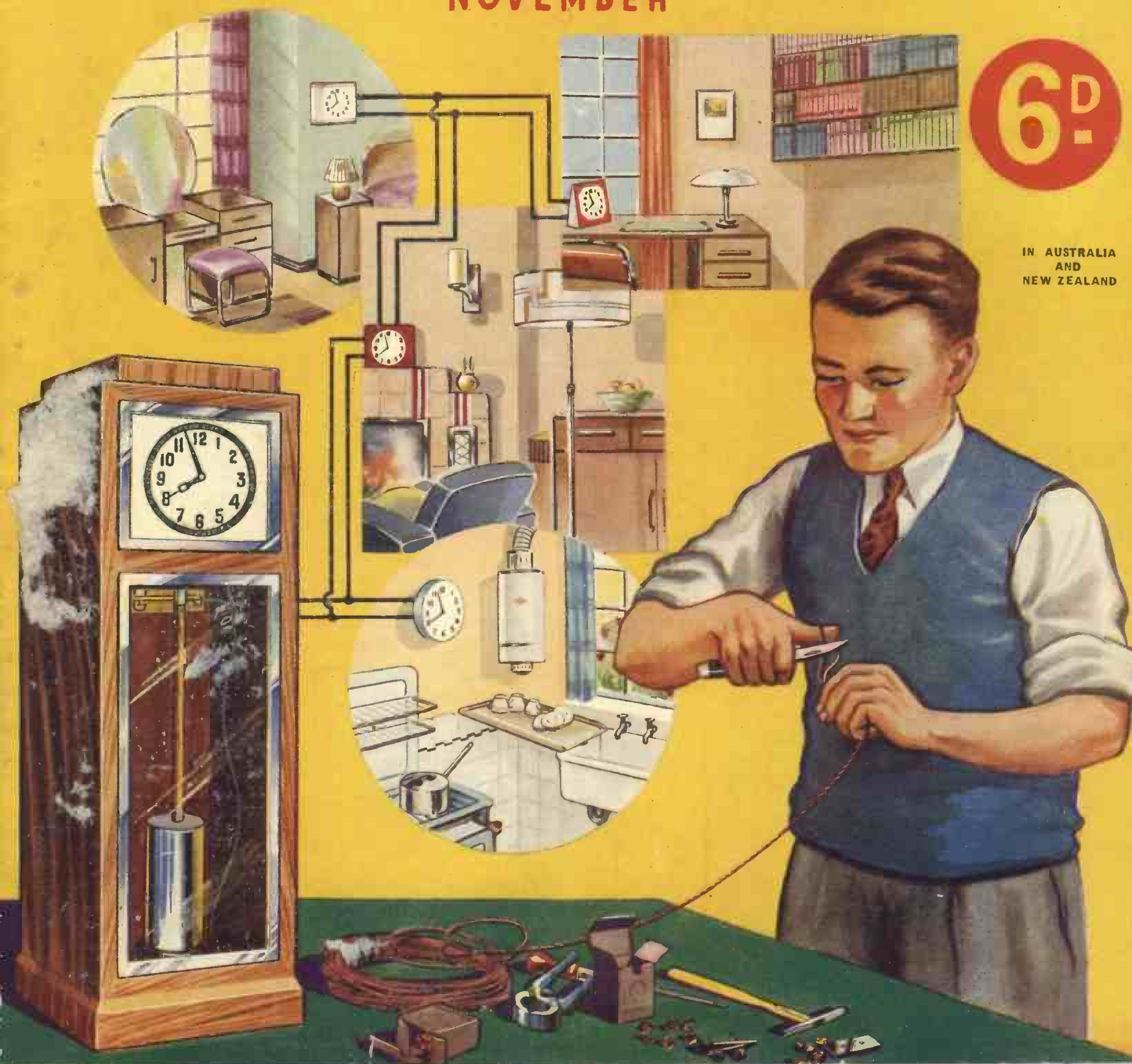
NEWNES

PRACTICAL MECHANICS

NOVEMBER

6D.

IN AUSTRALIA AND NEW ZEALAND



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PRACTICAL MECHANICS

Editor : F. J. CAMM

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Fair Comment
By The Editor

Engineering Opportunities

THE recent crisis, now happily over, has served the useful purpose of drawing the attention of the whole country to the great need for skilled people in all the creative branches of industry, and by this term I am referring not only to engineering, but to the woodworking, building, and other practical crafts. We must not blind ourselves to the fact that this country is short of skilled people, whilst it is somewhat over-weighted with executive people who have nothing to execute. I have before remarked that the failure of the apprenticeship system immediately after the last war has been responsible. No doubt in the wave of enthusiasm which broke out when the last war finished, people imagined that we had put war behind us for all time. Recent events have shown how misplaced was that notion and we are now warned that we must re-arm on a war-time basis to make our international diplomacy effective. All shades of political opinion, I think, are agreed upon that, and I hope I shall not be accused of raising political issues if I say that the first thing we must do is to encourage people to take up those trades and professions upon which rearmament depends. If it is our intention to encourage engineering, certain things must be done at once, and not the least important is that the terms of apprenticeship must be made attractive. I do not regret my own apprenticeship period for one moment, although, compared with modern conditions, the hours seem most fantastic. We started work at 6 o'clock in the morning, and we finished at 7 o'clock at night. We could legally claim only two days' holiday a year—Christmas Day and Good Friday. We were not allowed to have holidays with pay, and a fairly heavy sum had to be paid to the employer. The full term of apprenticeship was usually seven years, and the salary was 4s. a week for the first year, with 2s. annual rise, reaching 16s. a week in the last year.

I do not comment one way or the other on the fact that to-day we have not only shortened the working day, but we have shortened the number of working days. There are now holidays with pay, and conditions in all trades have improved out of all recognition. No doubt the workshop conditions prior to this state of affairs needed drastic remedies, but there is always the risk that the pendulum may swing too much the other way. It is, unfortunately, very true that the average youth wishes to start his business career at a high salary and that he wishes to short-cut the uninteresting jobs from which he would gain considerable experience. There seems to be a tendency to encourage the modern youth to believe that he can start at the top of the ladder.

We must therefore encourage people to become efficient by introducing some system which has the advantages of the apprenticeship system and none of the disadvantages, and we must also demonstrate that the well-paid positions are available to those who have made themselves qualified. If such a system is introduced, the present tendency to employ a man because influence is exerted on his behalf, and irrespective of his ability, must stop. The soldier is taught that a field marshal's baton reposes in his knapsack. We must demonstrate that this is a fact and not a piece of sententious flummery—just a form of words without sincerity behind them. We must also see that from a pecuniary point of view the skilled individual is worthy of his hire.

Conditions have improved but there has been the risk of improving them to the point where the public believes that they must do less work, and that the less they do the more they must be paid.

In the position in which the country now finds itself, excellent opportunities will exist for many years for those who assiduously apply themselves to the task of making themselves capable, and this task is rendered the more easy now that technical institutes and classes all over the country bring the boon of education within the means of all. The old cry that education was the prerogative of the rich does not apply to-day. The country needs ability and is prepared to pay those who can supply it. It is no use expressing the *will* to do anything, you must be *able* to do something really well. The man who says he can do anything, can usually do nothing.

Workshop Calculations, Tables and Formulæ

IN a preliminary announcement of my new book last month, the price was wrongly stated as 2s. 6d. This should be 3s. 6d. The book is, of course, bound in cloth, printed on excellent paper, and is specially designed for fitters, turners, draughtsmen, millwrights, foundrymen, tool makers, technical students, and all those engaged in the mechanical crafts.

"Practical Mechanics" Handbook

NOW that the presentation offer of the above volume has closed, a special bookstall edition has been produced at 6s. Copies are available from or through any newsagent, or direct from The Publisher, George Newnes, Ltd., "Tower House," Southampton Street, Strand, W.C.2.

Index & Binding Case for Vol. V

INDEXES for Vol. V are now ready, price by post 7½d., and the binding case, including title page and index, costs 3s. 6d. by post from The Publisher, George Newnes, Ltd., "Tower House," Southampton Street, Strand, London, W.C.2. I advise all reader to have their issues bound; loose copies are easily lost, borrowed, or mislaid. The information published in PRACTICAL MECHANICS is well worth reserving for future reference

The P.M. Battery Clock:

In Last Month's Issue We Gave A Blueprint And This Month We Explain How To Install Slave

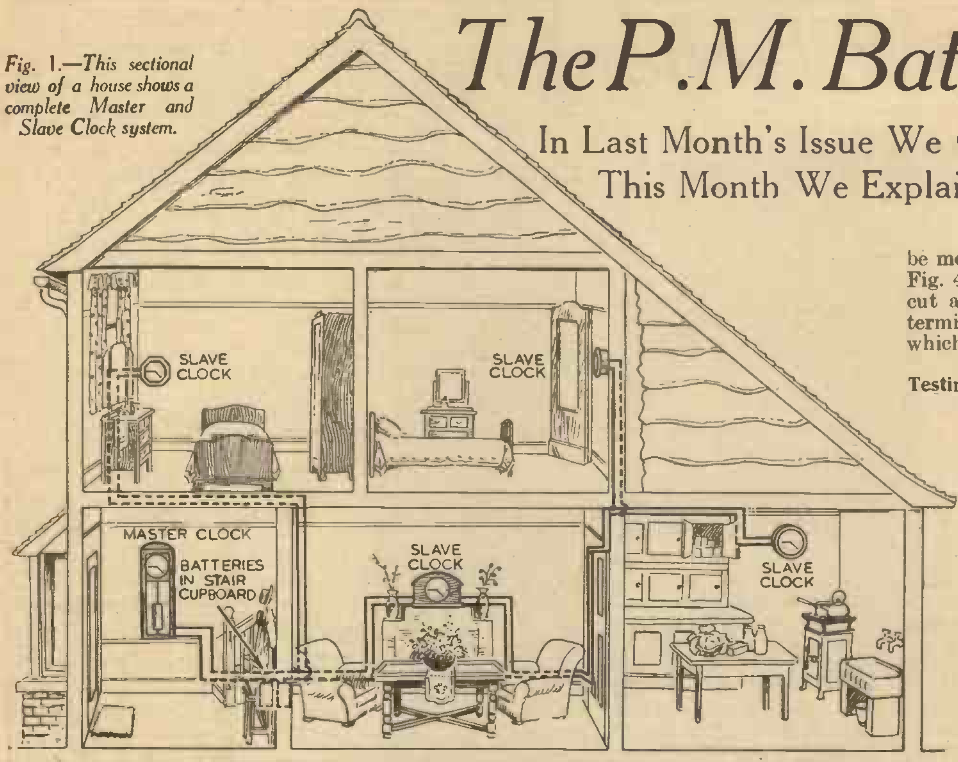


Fig. 1.—This sectional view of a house shows a complete Master and Slave Clock system.

THE Blue Print which we gave last month explained how to make a simple, but most reliable master battery clock. Many hundreds of these clocks are already under construction and our preliminary supply of dials was soon exhausted. If you are building the clock you should obtain one of these dials by sending 1s. to the publisher, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

The recent crisis brought a large demand for battery clocks, for it was realised by those who were using mains operated clocks that in the event of a cut-off of the electric mains supply they would have been without a timepiece. In homes where the electric supply is not available a battery clock provides a solution to the problem of clock winding, for our clock will run for at least two years, from one pair of cells.

Unlike the synchronous mains clock which cannot easily be adapted for such purpose, our battery electric clock will control a number of slave clocks throughout the house, and this month we show how, by adapting some cheap alarm timepieces, you may instal in your home a complete electric clock system controlled by the one master clock, which, once adjusted to correct time, will give you accurate time in every room in the house.

The Works of the "Slave"

The first thing to obtain is an old clock. Remove the spring and take out all the cogs except the two behind the face. Fix the frame of the clock together again and replace the fingers if these have been removed. It will be seen that when the knob, which was for adjusting the fingers, is turned, the fingers move round rapidly and easily. This constitutes the mechanical part of the clock.

A cog wheel must be made with sixty teeth. This requires some care, but it may be easily made, provided that the diameter is large enough. Mark out on a sheet of brass or mild steel about 1/16th thick, a circle 3 in. in diameter. With the same centre draw another circle 2¾ in. in diameter and move this radius 1⅜ in. round, marking on the circumference of the smaller circle. This is divided up in six equal parts, each of which must be divided up into ten equal parts. The teeth are cut to the shape shown in Fig. 3, and are trimmed off by using a three-cornered file.

When the wheel is complete, it must be soldered on to the shaft passing through the clock.

The Electric Part of the Clock

The electric part of the clock consists of a powerful electro-magnet. Obtain two carriage bolts, 1½ in., × ¼ in., and file the heads flat. Cut a bracket of soft iron and drill it to take the carriage bolts. The holes should be 1¼ in. apart. Fix the bolts in the bracket and wrap them with insulating tape. Wind the bolts with No. 24 D.C.C. wire, packing it on as neatly and tightly as possible. Cut a strip of spring steel for an armature and leave a small lug projecting so that it may be screwed on to the back of the clock. Cut the back for the clock from ½ in. wood and by means of the brackets mount the clock in the centre. (See Figs. 2 and 5.) The end of the armature is bent at right angles and the end is then bent again at right angles to form a small hook. A piece of soft iron is riveted to the armature strip to aid the attraction of the magnets. Mount the armature so that the small hook engages with the wheel, and mount the magnets so that they will easily attract the armature. The construction of the stops A (Fig. 2) is clearly shown in Fig. 4. They consist of 1 in. nuts and bolts, with the nuts soldered to the metal brackets, and should be mounted in the position indicated. (See Fig. 4.) The arm B is a strip of mild steel cut and mounted as the armature. Two terminals should be fixed on the back to which the magnet coils are connected.

Testing the Clock

Test the clock as follows : Connect it in series with two dry cells and a morse tapper. Press the key and adjust the stops so that the wheel advances one tooth each time the circuit is completed. The spring B acts as a ratchet and, when the current is switched off, the armature springs back and the wheel remains in its position. It will be seen that for each tooth the wheel advances, the finger moves on one minute. This should be tested for all sixty teeth.

On the spindle of the second finger of the master clock, fix a contact about 1 in. long. This may be a piece of wire twisted round the shaft and secured with a blob of solder. On the back of the clock an insulated contact is fixed so that once each minute the two contacts meet. Solder a wire to the frame of the clock and another to the insulated contact and connect them in series with the clock and two dry cells. (See Fig. 7.) Once each minute the circuit is completed, and the wheel advances one tooth and the minute finger travels on one minute. Once the clock is installed it needs no attention, except for the occasional renewing of the batteries.

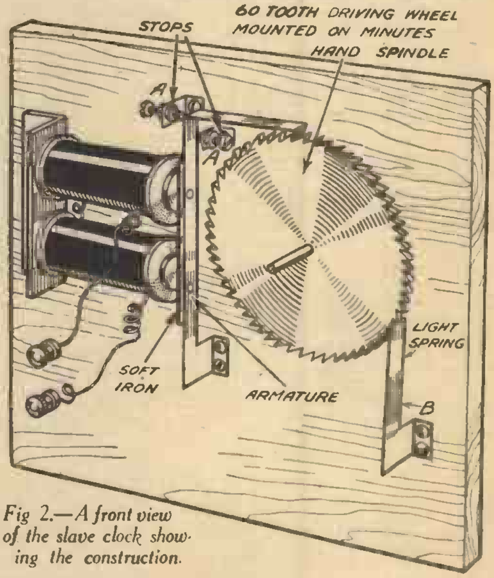


Fig 2.—A front view of the slave clock showing the construction.

To finish the clock off, build a case round the "works" and design and cut a suitable face, then stain the whole a dark brown.

Any number of these clocks may, of course,

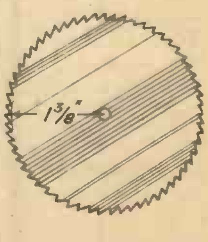


Fig. 3.—The cog wheel is cut with 60 teeth.

A stout art board dial can be obtained for 1s., post free, from the publishers, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

The "Slave" Mechanism

Instructions For Making A Master Battery Clock. Clocks, Each Controlled By The Master Clock

be operated from the "Master" clock which was described last month, and the only question is the carrying of the necessary wires from master to the slaves. The best arrangement will be found to include all the slaves in parallel, that is, two wires are run from the master to the furthest slave, and branches taken from the two wires to each clock as desired.

Chimes

If chiming or striking mechanism is required, this will most conveniently be arranged on the master clock, or in its vicinity, although there is no reason why the master should not be built (without the small indicating clock at the top) and installed in a cellar or attic, out of the way, and each room fitted with a slave. In this case the striking or chiming mechanism could be fitted in the required room or in the hall. It is not proposed to give any actual constructional details at this point for installing a suitable chiming mechanism. There are numerous different methods of fitting such apparatus, which may be electrically driven or clockwork operated, the actual mechanism being set into operation by electrical means at the required time.

Westminster chimes, consisting of ordinary brass rods clamped to tune to the required notes, may be easily constructed, and the four hammers operated by a rotating drum fitted with small projecting fingers or cams. A small electric motor could be set into operation for this purpose, very little power being required. The small dry cell would operate this. Alternatively, large diameter brass tubing could be used to provide heavy churchlike tones, and hammers for these could be power operated, each by a small magnet or motor, the individual motors or magnets being set into operation through the medium of a rotating contact maker, itself driven by a small motor.

It should not be difficult to arrange a small operated wheel on the lines shown in Fig. 2, with contacts at the four quarters. The hour-striking mechanism will, of course, have to be separately controlled, owing to the time taken when chiming the longer hours, unless some scheme can be incorporated for giving continuous action on the striking mechanism whilst the minute wheel continues to move.

Radio Interference

It will probably be found that every time the contacts close in the Master or slave clocks a 'click' will be heard in the loudspeaker if a radio set is in use. This may be prevented by wiring a large capacity condenser across the actual contacts. A value of 2 or 4 mfd. will be found quite suitable. This will also prevent the points of the contacts from becoming pitted due to the arc which takes place. A lamp may, of course, be used in place of the condenser, but the latter component is to be preferred. If it is desired to economise on the drain on the dry batteries, these may be dispensed with and the clock operated from an ordinary battery trickle-charger. In this case a really reliable charger should be used, capable of giving an output of about .8 amps at 6 volts. To avoid damage to the charger due to the back E.M.F. which will take place when the contacts are made and broken, it is desirable that an artificial load shall be applied to the charger. A very useful load may be adopted by connecting an old accumulator across the terminals of the charger (the cell being filled with acid, of course), or alternatively, a large capacity mansbridge condenser having a capacity of 2,000 mfds.

Reliability

One of these clocks has been in use for several years with a trickle charger as the source of supply with a 2,000 mfd. condenser (12 volt) across it and no trouble of any kind has been experienced. The contacts have not been touched or cleaned and the trickle charger still functions perfectly. The charger was actually screwed to the back board of the Master clock behind the dial and a twin-flex lead is taken from the back of the clock to a mains socket on the wall near it. Ordinary standard twin-laid bell wire is used for connection between the various slaves and this is carried in the picture rail in some rooms and along the top of the skirting board in other cases and is thus more or less invisible.

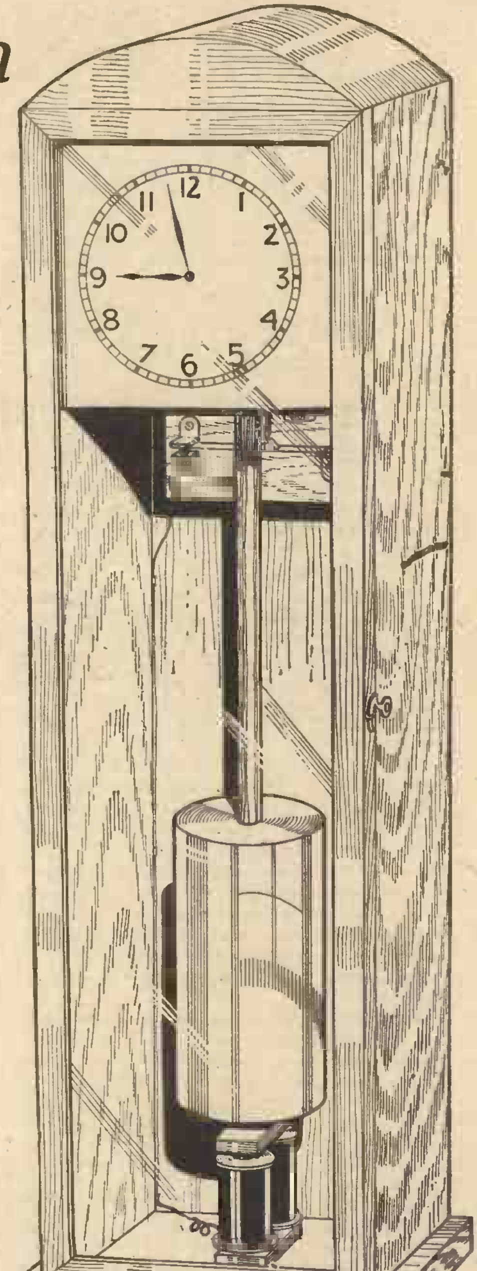


Fig. 6.—The master clock which was described last month.

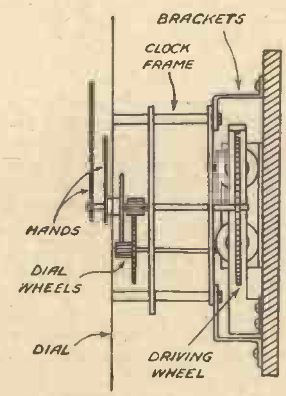


Fig. 5.—A side view of the slave clock.

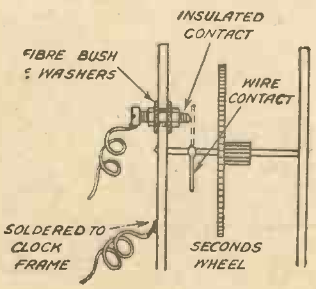


Fig. 4.—How the stops are mounted.

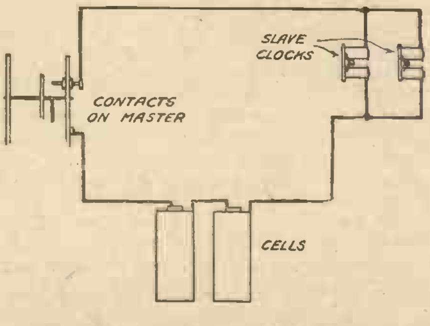


Fig. 7.—Wiring of the master contacts and slave clock magnets.

Watch Repairing and Adjusting—3

Adjusting the balance and other vital parts of the watch

THE balance, before being removed, should be thoroughly examined, as it is one, if not *the* most important part of the watch. If the balance is not vibrating lead it around sufficiently with the point of the tweezers to cause it to vibrate, and watch the action. The balance wheel should have no "up and down" movement as it revolves, and when viewed from above the wheel should be perfectly circular. Any irregularity in this direction will have an adverse effect on the timekeeping. The type of balance likely to give most trouble in this way is the bi-metallic compensation type—a balance consisting of two metals fused together, usually brass and steel, and having the rim cut right through in two places to allow for expansion and contraction to counteract changes of temperature. Extreme care should be taken with this type of balance as it is possible to cause distortion even by handling. Few balances are so badly damaged that they will not respond to treatment with a pair of tweezers or brass nosed pliers, but there is really no cure for a balance which is very much "out of round". A new balance is the only remedy. Fig. 1 shows a plain balance and a compensation balance.

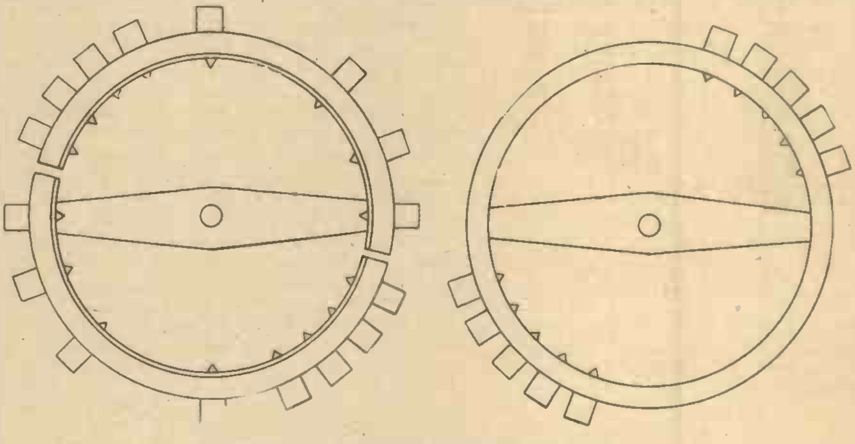


Fig. 1.—A compensation balance and a plain balance

Curb Pins

Examine also the clearance between the arms of the balance wheel and the bottom of the hairspring stud—the small detachable block to which the end of the hairspring is pinned—and the curb pins—the two pins in the regulator. Little trouble is likely with curb pins consisting of the two pin type, but the type which consists of one pin and a movable block often called the boot-piece from its shape needs more careful attention. Fig. 2 shows the two types of curb pins. The sole of the boot-piece is often left too thick, thereby leaving only very little clearance between it and the arms of the balance. As the object of the boot-piece is to prevent other coils of the hairspring from being caught in the curb pins there is no necessity for the sole to be left thick. It is quite a simple matter to reduce the thickness with a fine file when the regulator has been removed from the balance bridge. Lay the regulator upside down on a boxwood block and turn the bootpiece to the closed position. Hold the regulator down with the forefinger, and with the second finger as a guide to the safety edge of the file make one or two forward cuts until the thickness has been reduced to a minimum. Re-cut the screw driver slot with a slitting file if it appears to be shallow. Before replacing the regulator it is advisable to file off the outside corner of the boot-piece. This will prevent the points of extra long balance screws from fouling it when the watch is lying in a dial up position.

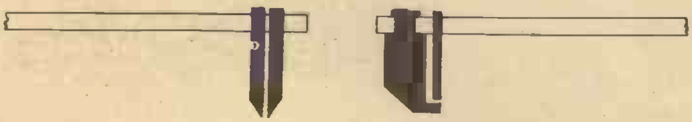


Fig. 2.—Two types of curb pins.

Endshake

The small amount of free space between the ends of the pivot and the flat surface of the endstones is known as endshake—in the case of ordinary train wheels between the shoulder of the pivot and the jewel hole—and correct endshake is an important condition in any watch.

Too much endshake is as great an evil as no endshake. Very little of the jewel hole is actual bearing surface. Should, therefore, there be too much endshake, there will be a tendency for one or other of the pivots to come out of the bearing hole when the watch is in either a "dial up" or "dial down" position. Apart from the damage likely to occur to the pivots, the balance would have every opportunity of fouling the curb pins, the hairspring stud, centre wheel and pallet bridge. Contact with any of these would spell disaster. Fig. 3 shows a pivot in a jewel hole with the correct amount of endshake. When one pivot is resting on an endshake the other pivot should be just clear of the other endstone. In some cases it is possible to tell whether a balance has endshake by turning the movement first one way and then the other way and listening to the drop of the balance, the sound will be decidedly metallic. With brass set jewels excessive endshake can be corrected by reducing the shoulder of the brass jewel setting. Whichever setting is altered will depend to a certain extent upon the position of the roller with the pallet fork.

Adjusting the Jewels

If the upper disc of the roller is so near the fork as to be likely to cause friction in certain positions, the bottom jewel must be raised. If the roller adjustments are correct the top jewel should be lowered. It is quite possible the jewel screws will not keep the endpiece tight after such an alteration. The quickest and neatest way to overcome this trouble is to select a new brass-set endstone, place it in a suitable lathe chuck, and turn it to fit, leaving it flush with the plate. Insufficient importance is given to jewel settings, for I am frequently finding watches with loose balance and other jewels. It is quite easy to appreciate the amount of friction created when a pivot is rotating in a jewel hole and the jewel hole itself is moving in its setting.

There should be a reasonable amount of clearance between the underside of the balance wheel and the upper surface of the pallet bridge. As long as daylight can be seen between these two surfaces, it will signify that they do not touch, but with such a small margin, the smallest speck of dirt or the tiniest hair is quite likely to impede the vibration of the balance.

The Pallet Bridge

To be on the safe side it is advisable to reduce the thickness of the pallet bridge. Remove the bridge and place it upon a piece of cork, and with a sharp file carefully reduce the surface. Exercise great care, for it is easy to bend a delicate bridge of this type. Brush away any file dust and

(*Continued on page* 104)

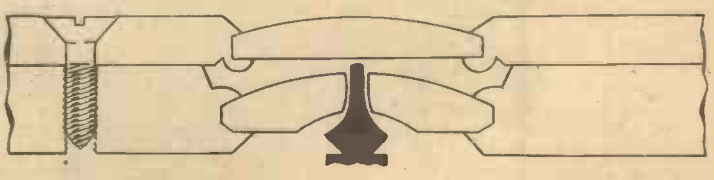


Fig. 3.—A pivot in a jewel hole with the correct amount of endhsake.

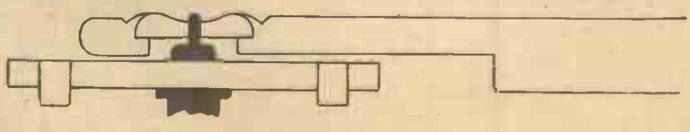
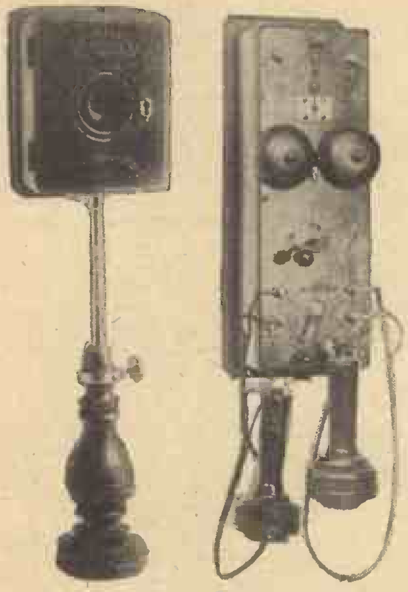


Fig. 4.—A section of the pallets and pallet bridge.

THE STORY OF THE TELEPHONE

Alexander Graham Bell—the Name is Now World Famous—Was the First Inventor of the Telephone.



(Left) One of the first desk telephone instruments. The Blake transmitter, 1879. (Right) An early telephone wall set of 1878, dubbed "Williams' Coffin!"

THE telephone has behind it a story which, in every detail, is peculiar to itself. No well-equipped research laboratory staffed with professional scientists and having at its command all the available resources of electrical science brought the telephone into the world. The origin of the instrument did not take place at the hands, even, of any acknowledged electrician. Rather, in fact, the opposite was the case, for the inventor of the telephone comprised an individual who had acquired just sufficient mastery over electrical theory to guide him through his necessary experimental work, but of chemical and related scientific knowledge he possessed but little.

Alexander Graham Bell—the name is now world famous—was the first inventor of the telephone, and a rough garret above a shop in the American city of Boston constituted the birthplace of the instrument. Bell, whose native city was Edinburgh, having been born there in 1847, had emigrated to Canada with his parents in 1870. Quickly he found his way over into the States and two years later, in 1872, we find him taking up permanent residence in the city of Boston.

Speech Training

Bell's father, Alexander Melville Bell, had developed a system of speech training which his son, Alexander Graham Bell, subsequently adapted for use in teaching the deaf. The latter obtained a lectureship in Boston University, becoming "Professor of Vocal Physiology," as well as a private teacher of speech for the deaf.

Graham Bell had for some time been interested in electrical matters. His ingenious mind had pondered long over the nature and principles of human speech and there is no doubting the fact that even at this early period the idea of transmitting speech from one place to another by some unknown electrical means had occurred to him upon more than one occasion.

All sorts of curious notions passed through the brain of Bell and many of these were connected with his hobby of electricity. In 1874, we find him busily engaged during his spare time in the construction of what he termed an "Harmonic Telegraph" which was to be an instrument by means of which he expected to be able to transmit half a dozen or so Morse telegraph messages over a single wire.

It was about this time that Bell got into touch with a skilled instrument-maker, one Thomas A. Watson, by name, who was then employed in a Boston electrical shop. Watson, under Bell's direction, put all his skill and practical experience into the construction of Bell's "Harmonic Telegraph" and, in addition, he gave up a considerable proportion of his time to assisting Bell in his experiments and trials with his telegraph instruments. Watson, in fact, quickly became Bell's right-hand man. His innate practical ability was most useful to Bell and the latter, ultimately, regarded him not as a mere assistant but as a close friend.

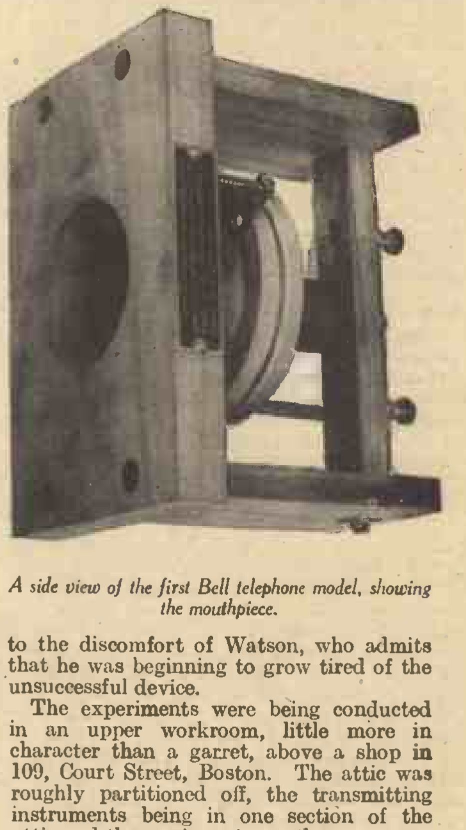
The "Harmonic" Telegraph

It was during the course of some experiments with the unsuccessful "Harmonic Telegraph" that Bell first confided some of his dreams of a working telephone to Watson.

"I have never forgotten his exact words," Watson wrote years after the death of Bell, "they have run in my mind ever since, just like a mathematical formula. 'If,' Bell said, 'I could make a current of electricity vary in intensity precisely as the air varies in density during the production of a sound, I should be able to transmit speech electrically.'"

Bell then sketched out for Watson some rough ideas of his on the subject of projecting speech electrically, but they were much too complicated and theoretical in nature to impress the more practical Watson.

Meanwhile, the experiments with the "Harmonic Telegraph" continued, much to the discomfort of Watson, who admits that he was beginning to grow tired of the unsuccessful device.

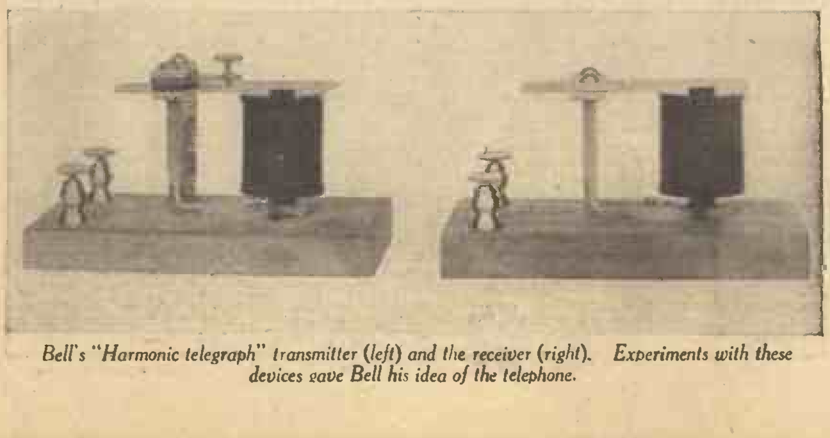


A side view of the first Bell telephone model, showing the mouthpiece.

The experiments were being conducted in an upper workroom, little more in character than a garret, above a shop in 109, Court Street, Boston. The attic was roughly partitioned off, the transmitting instruments being in one section of the attic and the receivers in another.

One afternoon—on June 2, 1875, to be precise—Bell and Watson were in the attic at 109 Court Street, Boston, tuning the receivers of Bell's "Harmonic Telegraph" apparatus. Watson was vibrating the transmitter and Bell was listening at the receivers in addition to tuning the latter. Suddenly Watson heard a shout from Bell and immediately afterwards Bell rushed in to Watson. "What did you do then?" he cried. "Don't change anything! Let me see!"

What had actually happened was that Bell's "harmonic" receiver had picked up the transmitted hum of a vibrating reed in the transmitter and Bell had immediately



Bell's "Harmonic telegraph" transmitter (left) and the receiver (right). Experiments with these devices gave Bell his idea of the telephone.

been struck with the fidelity of the transmitted note.

A Simple Principle

The principle of Bell's unsuccessful "Harmonic Telegraph" was a simple one. A flat metal strip or "reed" was free to vibrate over the iron core of a bobbin electro-magnet. The vibrational frequency of the spring or "reed" could be tuned by means of adjusting-screws and Bell had hoped that the transmitted currents from a series of these vibrating reeds would, at the receiving end, all sort themselves out and each set of currents cause similarly-tuned reeds at the receiving end to vibrate in sympathy. It was a clever idea, but Bell never obtained any success from it.

On the memorable occasion above mentioned, the contact point of the "Harmonic Telegraph" transmitter was screwed down upon the flat reed, making, when the reed was vibrated, not, as in the case of the other pairs of transmitters and receivers, the make-and-break current of telegraphy, but the uninterrupted undulatory current of telephony. Thus the whole "voice" of the reed, including its vibrational overtones, was transmitted. Bell heard, understood and realised the tremendous importance of the received sound.

Within an hour or two, Bell had thought out a scheme for building up an electrical telephone and before he left the building that evening he had given to Watson directions for the construction of such an instrument—the first telephone. Watson was to mount a small drum of gold-beater's skin over one of the "Harmonic Telegraph" receivers and to attach the free end of the receiver-spring or reed to the centre of the skin diaphragm. Finally, a mouthpiece was to be fixed over the diaphragm.

World's First Telephone

This crude arrangement constituted the world's first telephone. It was tried out between the attic of the Court Street building in Boston and a room two storeys below. The first results from the telephone instrument were very meagre, but, all the same, they sufficed to convince Bell of the fact that he was on the right track in his conception and design of the instrument.

It was not until February 14, 1876, that Bell filed his application for his first telephone patent and, indeed, not until a month after this date—March 10, 1876—that the first complete sentence was intelligibly transmitted by telephony. Watson afterwards recounted the fact that this memorable sentence took the form of: *Mr. Watson, come here; I want you!*—which was uttered by Bell.

After Bell's fundamental experiments had been completed, the telephone developed rapidly. The instrument was exhibited at the Centennial Exposition at Philadelphia in the June of 1876, its inventor being awarded one of the Exhibition's medals. Incidentally, it is of interest for us to note that the renowned Sir William Thomson, afterwards Lord Kelvin, a great English electrical pioneer, was Chairman of the Committee of Judges on this occasion.

In the following August occurred the first one-way telephonic transmission of speech over any considerable distance. It took place between Brantford and Paris, Ontario, a distance of eight miles.

Development of the Invention

Bell, at this juncture, had put so much time into his experiments that his private practice as a teacher of speech and of the deaf had begun to suffer badly. He appears, however, to have given scant consideration to this fact, for now almost the whole of his energies were given over to the technical and scientific development of his new invention.

In the February of 1877, Bell began a series of public lectures on and demonstrations of the telephone. The first of these was given to a scientific society known as the *Essex Institute* at Salem, Mass., in which town Bell then resided. Watson, as usual, was his main assistant at these lectures, being located at the other end of the telephone line and shouting into the instrument such phrases as "Good evening!", "How do you do?", "What do you think of the telephone?" and so on. Then the faithful Watson would sing into the instrument, the song being reproduced in the receiving instrument displayed in the centre of the lecture platform.

These lectures became very popular and Bell achieved much fame by them. Lecturing on a scientific novelty, however, was one thing, but exploiting the telephone commercially Bell found to be quite another matter. Indeed, he took but little interest in the commercial side of his instrument. He was, however, helped in his commercial affairs by two noted men, Thomas Sanders and Gardiner Green Hubbard, who were interested in Bell's work for the deaf as well as his inventions in electrical communication.

Bell Telephone Company

The first Bell Telephone Company was floated on 5,000 shares, the interest in the Company being divided up between seven shareholders, Alexander Graham Bell, Mrs. Bell, Gardiner G. Hubbard, Mrs. Hubbard, C. E. Hubbard, Thomas Sanders and the ever-available Thomas A. Watson.

On January 28, 1878, the first commercial telephone Exchange was opened at New Haven, Connecticut. This served 21 telephones by means of eight lines.

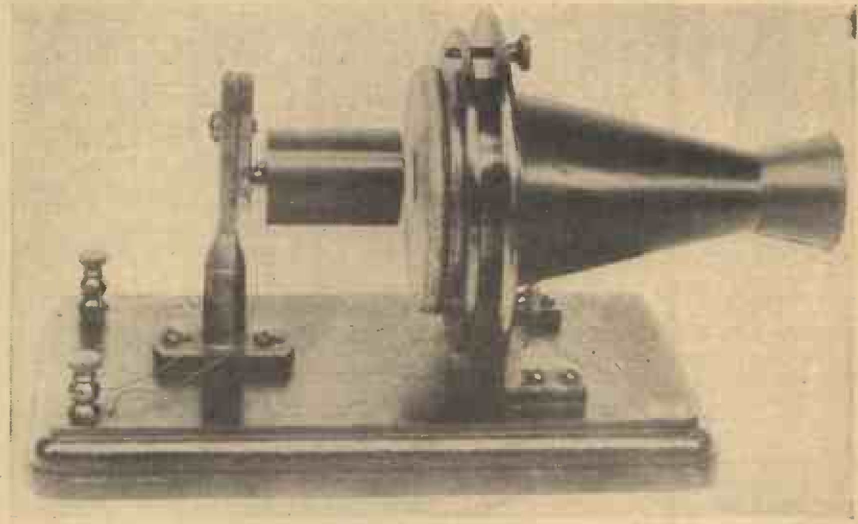
Rapid Progress

Bell's instruments were crude at the beginning, but leaving all further developments to the Company bearing his name, he lived to witness a rapid and remarkable process of evolution in the sphere of telephone apparatus and appliances.

At first the commercial telephone had no calling-up device. You just tapped the diaphram of the transmitter with a pencil and awaited results. Next came a buzzer calling device and, after this, the magneto wall-set telephone, an instrument comprising a long narrow box to which were hooked the telephone mouthpiece and earpiece. These instruments were the invention of a man named Williams and, owing to their elongated shape, they soon came to be known as "Williams' Coffins." They were used in conjunction with a hand switch which in one position put the magneto calling-up device into operation and, moved the other way, placed the telephone circuit proper into action.

"Williams' Coffins" were made by the hundreds. After them, came the Blake transmitter, the invention of Francis Blake, which gave louder reception and therefore greatly popularised the early telephone system.

It was not until some years afterwards that Bell's telephones gained popularity in England.

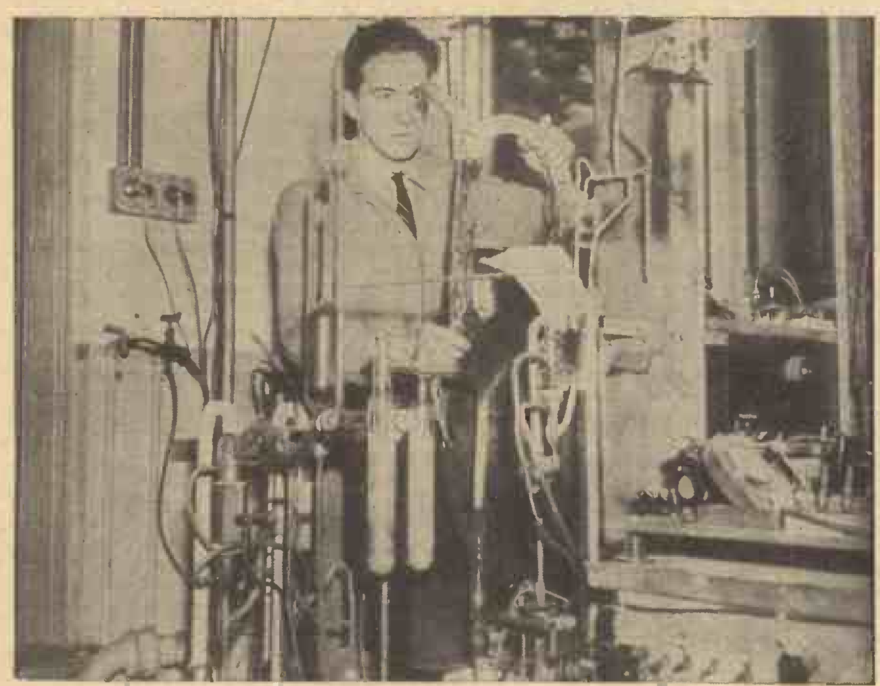


Telephone transmitter exhibited by Bell at the Philadelphia Centennial Exposition of June 1876.

ATOMIC MECHANICS—2

Exploring the Structure and Internal Mechanics of the Atom

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



Dr. A. O. Nier of Harvard University, with the most delicate atom "sifter" known to science. The apparatus which he recently perfected is technically known as a mass spectrometer, and is designed to detect the presence of rare isotopic forms and to give the most accurate measurements ever made of the relative abundance of different isotopes present in an element. By using this atom "sifter" in the study of the lead atom scientists may be able to extend their knowledge of the earth's history back farther than ever before.

RUTHERFORD was led to the Nuclear Theory of the Atom by the experimental study of the deviations suffered by high energy alpha-particles when they were projected into atoms, a theory which was clearly pointed to by the accumulated results of the research in this branch of physics carried out during the first ten years of this century.

The high speed alpha-particles were provided by various radioactive elements which ejected them during the spontaneous breaking up of their atoms, and their deviations in transit through thin metallic foils were measured by observing the pin-point flashes of light made by the impact of the alpha-particles on a screen of zinc sulphide. The two outstanding facts revealed by these observations were that only a small percentage of the alpha-particles fired into the foils underwent any deviation at all, but that amongst this minority there were some which were scattered through surprisingly large angles. This suggested that the atom is a highly porous structure with the majority of its mass concentrated in some very small region, enabling most of the alpha-particles to pass straight through, while a select few made glancing or direct hits on the concentrated mass, being widely deflected as a consequence.

Central Nucleus

It was conjectured, therefore, that the great majority of the mass of the atom is collected together in a very small central nucleus which also contains all the positive charge of the atom, and that this nucleus is surrounded by a distribution of electrons moving in relatively immense orbits, their number being just sufficient to make the complete atom electrically neutral. One grave difficulty involved in this theory became immediately apparent. In order to maintain the distance of separation between the negatively charged electron and the positively charged nucleus against their mutual force of electrostatic attraction, and to prevent the atom from collapsing into practically no size at all, the electron must be considered to be in a state of continuous movement in an orbit round the nucleus to give it the outward centrifugal force necessary to counter-balance the inward electrostatic force. Such a motion in a curved path implied, from classical theory considerations, that the electron must be in a state of continuous radiation so that it must eventually radiate away all its energy and disappear completely. On this hypothesis, therefore, the atom seemed doomed to instability.

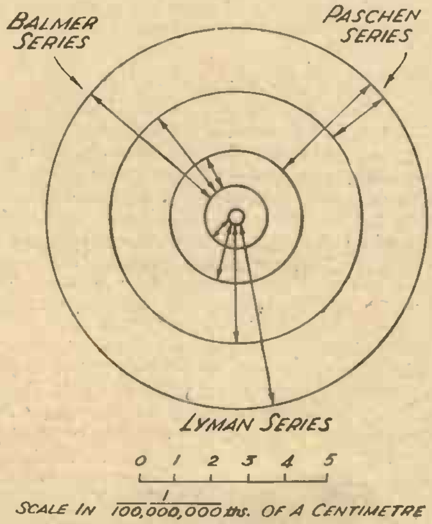


Fig. 1.—Diagram to scale of the original Bohr model of the atom showing the possible electron transitions between orbits giving rise to the Paschen, Balmer and Lyman series of spectra. Only the first five orbits are drawn.

A solution to the problem was offered by Niels Bohr in 1913. Its brilliancy can be judged from these facts: in a single stroke it preserved both the nuclear theory and the notion of atomic stability, by boldly applying the quantum theory to atomic mechanics (a hypothesis which was relatively new at the time and distinctly revolutionary in its concepts); it gave a simple and convincing elucidation of the quantity of apparently unrelated spectroscopic data which had gradually accumulated during the preceding fifty years, and it provided a working model of the atom which was highly successful in accounting for new facts which were discovered in the subsequent ten years.

Hydrogen Line Spectrum

In formulating his theory Bohr was guided by the prime consideration that in some way the number and order of the lines in a spectrum are related to the arrangement and behaviour of the particles in the atom. The internal mechanism of the atom is clearly responsible for the emanation of the light since an analysis of this light by the spectrometer shows that the same lines are always produced by the same atoms, and that every element has its own characteristic emission spectrum. A single spectrum line is discussed in terms of its three properties, intensity, polarisation, and position (wavelength of frequency), and a complete spectrum in terms of the regularities in the distribution of the lines. A successful atomic theory, therefore, has to explain both the law of arrangement and the individual characteristics of the lines. Bohr's first task was to explain the law of arrangement in the simplest of all spectra, the hydrogen line spectrum.

The relative simplicity of the hydrogen spectrum had already attracted the attention of several investigators, and as early as 1884 Balmer had established an empirical formula which expressed as a mathematical series the wavelengths of certain outstanding lines in the visible part of the spectrum. A little later, Paschen evolved a similar formula for a series in the infra-red, and Lyman produced one for the ultra-violet. All of these formulæ are contained in the single expression $f = R.(\frac{1}{n^2} - \frac{1}{m^2})$ where f represents the frequency of a particular line in a spectrum, n and m are suitably chosen integers (1, 2, 3, etc.), and R is some constant quantity. As this formula was purely empirical, an equation deliberately manufactured with the sole purpose of fitting the experimental facts, nothing much was known of its ultimate nature other than the fact that it always remained constant.

Bohr's Theory

Bohr based his theory on two fundamental assumptions whose only justification was that by means of them the above formula could be deduced from theoretical considerations, enabling an almost complete explanation of spectroscopic data to be made in terms of the nuclear atom model reinforced by these two assumptions. He asserted that first of all the electrons in the atom could only exist in those orbits in which the angular momentum is an integral multiple of the quantity $h/2\pi$, where h is the universal Planck constant of action, and that they rotated in these orbits without emitting or receiving any radiation. Secondly the emission or reception of radiation by the atom occurred only when an electron made a transition from one orbit to another; when the electron passed from one orbit to one more remote from the nucleus the atom absorbed a quantum of radiation, when it passed from an orbit to one nearer the nucleus the atom emitted a quantum.

It became immediately possible, by the application of these quantum assumptions and the well established principles of particle mechanics to the whirling electrons and the central nucleus, to calculate with precision the diameters of the various possible orbits which this theory permitted and so to draw on a large scale a picture of what the actual atom was envisaged to be like. (See Fig. 1) In the simplest of all atoms, that of hydrogen, a single electron rotates about a single proton which serves as nucleus. Its possible orbits form a system of circles concentric about the nucleus whose diameters are proportional to the squares of the integers, so that passing from the nucleus outwards successive orbits have diameters which are respectively proportional to the numbers 1, 4, 9, 16, etc. The figures which give the actual orbit sizes and electron velocities are somewhat staggering and are practically impossible to appreciate fully in the imagination. For example, the calculated value of the diameter of the innermost orbit of the hydrogen atom is 0.0000000333 centimetres, and the electron in it performs just over two thousand million million revolutions per second, moving with a speed of just under 70 million centimetres per second, (approximately 432 miles per second). The calculated values of the energy changes in the atom which accompany the transitions of an electron between these various orbits agree exactly with the observed frequencies of the emitted light expressed in the formulae of Lyman, Balmer and Paschen, and this close correspondence between theory and experimental fact amply justifies the arbitrary assumptions upon which the theory is founded.

Newly Discovered Facts

Not only was the Bohr atom found to account for spectroscopic phenomena which had been observed before the advent of this theory, but it also lent itself, after further modification, to the explanation of newly discovered facts. A spectrometer of high resolving power shows that each apparently individual line in certain spectra has a multiple structure, consisting of a series of exceedingly fine lines grouped very closely together, so closely that an instrument of low resolving power would interpret the whole group as one single line. In order to account for this multiple structure it became necessary to introduce extra orbits into the atom model other than the circles, so that the transition of an electron between one of these new orbits and a circular one involved an energy change sufficiently small to explain the small difference in frequency between the lines of fine structure in one group.

The resemblance in design between the Bohr atom and the orbits of the planets about the sun in our solar system, suggested that elliptical orbits were possible in the atom, and after more exact considerations Sommerfeld in 1916 modified the Bohr model by introducing the elliptical orbits calculated to account for the fine structure of the hydrogen spectral lines. Thus began the era of precise atomic pictures, a period of approximately ten years during which the atom of every known element was represented by a drawing made to scale of a system of circular and elliptical electron orbits arranged about a central nucleus. The eventual downfall of the Bohr-Sommerfeld theory by the advent of Heisenberg's Quantum mechanics and Schrödinger's Wave mechanics in the years 1925, 1926, carried away with it the notion of precise atomic pictures, for it has been found that the effect of an electron rotating about the nucleus of an individual atom cannot be represented by a definite circular or elliptical path drawn about a definite point as nucleus.

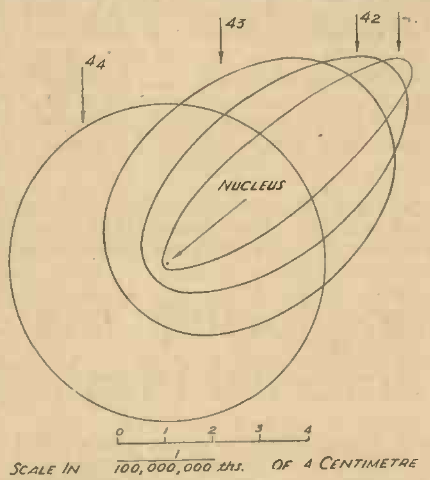


Fig. 2. Diagram to scale of Bohr-Sommerfeld atom model showing the fourth circular orbit and its three associated elliptical orbits.

Sommerfeld's Method

Sommerfeld's method of computing the necessary elliptical orbits is based on the idea that each circular orbit has associated with it a series of ellipses whose major axes are equal in length to the diameter of the circle, and whose minor axes are certain fractions of this diameter. Thus the second circular orbit is associated with only one ellipse, whose major axis is the same as the circle's diameter and whose minor axis is half this diameter. The circle is denoted by the symbol 2_2 and the ellipse by 2_1, the suffixed number referring to the length of the minor axis. The fourth circular orbit for example has three ellipses associated with it, denoted by 4_3, 4_2, 4_1, respectively to indicate that all the ellipses have a major axis of 4 units (equal to the circle's diameter), and successive minor axes of one third, one half and one quarter of this diameter. The nucleus of the atom serves as the common centre for all the circles and a common focus for all the ellipses. (See Fig. 2).

A further refinement was introduced into atomic mechanics by Sommerfeld by the application of Einstein's Relativity law of variation of mass with speed to the electrons moving in circular and elliptical paths. The variation of the mass of a moving body with its velocity is perceptible only at very high speeds, and the enormous speeds of orbital electrons in an atom are sufficiently high for this purpose. The calculated difference in the mass of an electron moving in a circular and in an elliptical path is just sufficient to account for the minute frequency differences which characterise multiple structure of spectral lines.

The Quantum Theory

Although the quantum theory of atomic mechanics was ushered in with such striking successes, there gradually appeared amongst its many achievements certain weaknesses which when probed and examined with the meticulous care which always attends the unfolding of scientific theory, led to its ultimate downfall and abandonment.

In 1925 the problem was taken up by Heisenberg, Schrödinger and their collaborators. They based their New Quantum Mechanics on the fact that matter and energy exhibit a dual nature inasmuch as any particle of matter can be represented as a wave of energy, and any wave of energy as a particle. This theory has flourished during the last decade and at the present time almost all chemical and atomic phenomena can be explained in terms of the behaviour of extranuclear electrons. Nuclear theory is still incomplete, but it is believed that when an understanding of inter-particle forces is arrived at, the application of the quantum theory might solve the problem of the nucleus.

SLEEVE VALVES FOR AERO ENGINES

A New British Engine Achievement

THE sleeve-valve engine, familiar to motorists, has now taken to the air. When the new long-range flying boats of Imperial Airways go out on the Empire air routes and on to their special duties on the Atlantic, Tasman, and Pacific routes, the quiet hum of their engines will be the announcement of a new achievement in British transport engineering.

Every country in the world has attempted to translate the advantages of sleeve valves to standard aero engines.

Britain—through the Bristol Aeroplane Company—has succeeded.

Commercial Air Transport

The new Imperial flying boats—identical in appearance with their 30 sisters on the routes to Durban and Sydney, but strengthened to lift an extra six tons—will be fitted with four Bristol Perseus XIIc motors.

They have been specially developed for use in commercial air transport.

Together they muster 3,560 h.p. for the take-off of the new flying boats, and each is internationally rated at 680/710 h.p. at 2,500 revolutions per minute at 4,000 ft.

Advantages

Their advantages are many. They eliminate valve maintenance; the number of parts is amazingly small compared with a poppet engine; they effect a substantial reduction in fuel consumption; they lessen mechanical and exhaust noise; and they are extraordinarily simple.

SECRETS OF POLISH MAKING

The Art Of Preparing Different Kinds Of Polishes Explained For The Benefit Of The Handyman And The Small Manufacturer

THE traditional beeswax polish so extensively used in former days on furniture of all kinds has many virtues, so much so that it is still employed regularly as a nourisher and preserver of old furniture in many of the old homes of England.

On modern furniture, however, the pure beeswax polish, which is made simply by dissolving beeswax in warm turpentine until a pasty mass is obtained, is not so successful. The polish is a soft one, and, particularly on the smoothly shellacked and synthetically-finished furniture of modern days, it is apt to fingermark badly. Beeswax polish is a relatively expensive preparation. Moreover, it is not an antiseptic one. Furniture treated with it and allowed to stand in damp situations or in damp climates is liable to attacks of the furniture mite, that pin-head-sized little white creature which, although harmless in itself, is certainly obnoxious, since it feeds upon the wax on the furniture under conditions of damp, and often appears in large numbers.

Polishing cloths. Here is shown the making of one of the well-known "polishing cloths," as described in this article.

An All-round Polish

And all-round polish for all types of furniture, except, of course, the French-polished varieties, can be made by dissolving equal quantities of beeswax, paraffin wax and grey carnauba wax in a mixture of equal quantities of turpentine and white spirit.

The two latter liquids should be placed in a glass jam jar, or similar vessel, which is heated by being immersed in a pan of water. Care must, of course, be taken to see that the turpentine does not catch fire during the heating process, but, using a small gas-ring for the purpose, there will be very little danger of this occurring, whilst the employment of a domestic electric stove or immersion-heater will entirely eliminate this slight risk of fire.

After the turpentine-white spirit mixture has been made hot, about one-third of its weight of a mixture of the three above-mentioned waxes, finely shredded, are added to the liquid, portion by portion, with constant stirring.

Colouring the Wax

If it is desired to colour the wax, this can be done now by adding a small quantity of any suitable wood stain dissolved in methylated spirit. The spirit solution of the dye should be a concentrated one so that very little of the solution need be used.

Finally, in order to render the wax polish antiseptic, mould and insect-proof, it is a good plan to add to it at this stage a teaspoonful or two of zinc oleate. This will dissolve at once in the warm liquid and will render the preparation highly antiseptic. Similarly, barium oleate, zinc or barium naphthenates, or the synthetic chlornaphthalene wax manufactured by Imperial Chemical Industries, Ltd., and known as "Seekay wax," will, when added to the liquid in small amount, confer high antiseptic properties on the wax preparation.

If cheapness is an asset in manufacturing this wax preparation, the turpentine-white spirit mixture may be "let down" with half its bulk of paraffin oil and a few drops of eucalyptus oil and/or methyl salicylate added to disguise the smell of the paraffin.

On cooling, the wax will set to a plastic mass. It is economical in use, for a little of it can be made to cover a relatively large area of furniture, the paraffin wax ingredient of the mixture having good "spreading" properties and the carnauba wax component conferring hardness upon the surface film of wax which is thus laid upon the woodwork.

The above composite wax preparation will not fingermark, unless, of course, it is laid upon the woodwork surface excessively thick. It will not grow mould or encourage mites or other insects.

By increasing the quantity of wax ingredients dissolved in the mixed liquids, a wax almost as stiff as bootpolish can be obtained. This is preferred by some, since it can be brushed on to the woodwork.

A novel polishing liquid. Emulsified wax, prepared according to the directions given in this article.

Polish for Woodwork

Quite a new polishing preparation for woodwork of all kinds is emulsified wax. This has the advantage of being cheap and adaptable.

To make it, obtain an ounce of Turkey Red oil and add it to a pint of hot water, stirring the liquid well. Now, add a few drops of ammonia until the liquid smells strongly of the alkali. Finally shred into the liquid about half an ounce of the wax which it is desired to emulsify—paraffin beeswax, or carnauba, or a mixture of these waxes, and then boil the liquid for about one minute.

Making the well-known beeswax turpentine polish.

The liquid must now be allowed to cool and it is essential that it be rapidly stirred all the time it is cooling. When cold, filter the liquid through cloth in order to remove from it any hard lumps of excess wax. A milky liquid will result, the milkiness being due to the presence of innumerable globules of wax suspended in the water.

Emulsified wax of this nature is simply brushed on to the furniture and woodwork surface and the water allowed to evaporate. A very fine film of wax will be left behind on the woodwork surface and, on being rubbed over with a soft cloth, it will give rise to a high polish.

This type of emulsified wax polish is very suitable for covering carved pieces of woodwork, since the wax, being in emulsion form, can obtain access to the smallest crevice of the woodwork. It is also of value for using as a grain or wood filler before shellac-polishing woodwork.

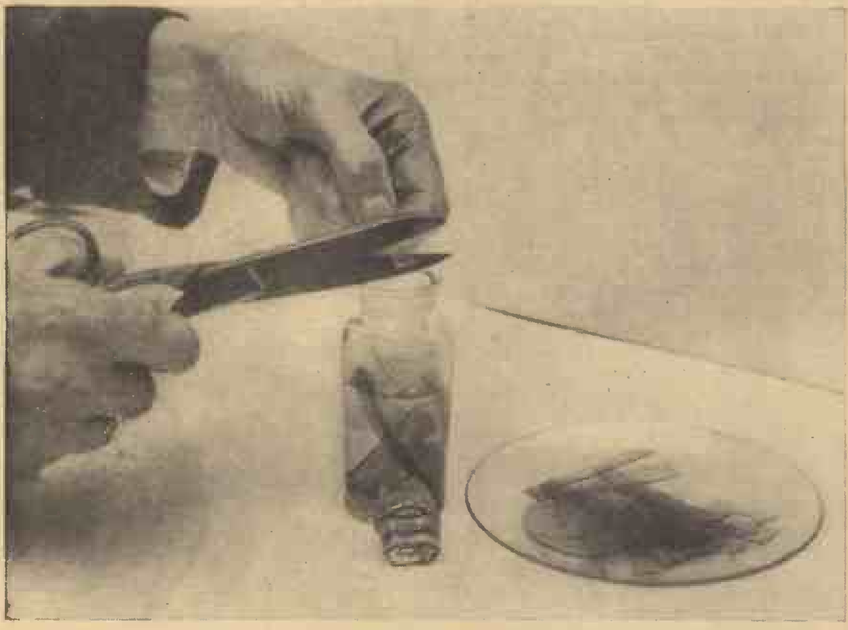
Shellac Polishes

Shellac polishes for wood are easily made. Orange shellac is dissolved in warm methylated spirit until a thick solution results. This forms the common "button" polish which is applied thinly to the woodwork surface with a soft rag or a brush. Shellac polishes may, of course, readily be coloured by adding to them small amounts of spirit soluble woodwork stains dissolved in methylated spirits.

Much use is made of shellac polish for furniture in modern times, for it is hard, inexpensive and easily applied. At the same time, however, if the polish is laid on too thickly, an "over-gloss" effect is obtained, the woodwork being rendered sticky or treacley-looking.

Cellulose polishes are nowadays being introduced for woodwork of all kinds. They are, actually, perfectly colourless and transparent lacquers which, drying with a hard film, preserve the natural appearance of the wood. For this reason, therefore, they are being used a good deal in the surface finishing and polishing of "limed," light-coloured and unstained woods.

A good cellulose polish may be made by dissolving clean scrap celluloid in amyl or butyl acetate. The liquid may, if desired, contain a third of its volume of acetone, which will cheapen production somewhat, but this proportion of acetone must not be exceeded, otherwise the polish film will dry too quickly and produce an objectionable "bloom" on the woodwork surface.



Cellulose polish. Shredding scrap celluloid preparatory to dissolving it in amyl-acetate for the preparation of a glossy cellulose polish.

After the solution of the celluloid in the amyl-acetate or mixed solvents is complete, add to the solution castor oil at the rate of half a teaspoonful of the latter to every pint of the celluloid solution. This addition is essential, since the castor oil preserves the flexibility of the cellulose film.

The celluloid or cellulose solution, when suitable for woodwork polishing, should have the consistency of varnish. It is rubbed on to the wood surface with a soft rag or by means of a brush. Two hours will be necessary for its complete drying and hardening. If desired, a second coat of the polish may be applied.

Dyeing the Polish

Novel effects may be obtained on woodwork by dyeing the polish with brilliant colours. This is simply effected by adding to the celluloid solution a small quantity of methylated or surgical spirit in which some spirit-soluble aniline dye has been dissolved. In this way, white woodwork can be given a bright green, a scarlet or any other highly coloured glossy finish. The cellulose polish is also applicable to metalwork of all kinds, provided that the surface of the latter is reasonably clean and grease-free.

For polishing, or, as the term is, "reviving" French-polish surfaces, such as the cases of pianos, the following preparation is an excellent one and is, in fact, identical in composition to many of the present-day "polish-reviver" preparations :

Vinegar (or dilute acetic acid) ...	6 parts
White spirit	$1\frac{1}{2}$ „

To every pint of this liquid add one saltspoonful of best castile soap powder and an equal amount of French chalk. Also add two or three drops of shellac varnish.

The above "reviver" is used by being rubbed over the polished woodwork surface with a soft rag, the rubbing treatment being finished with a dry cloth. The reviver preparation must be well shaken in its bottle before application to the furniture, for its ingredients do not mix together.

"Polishing cloths" are favoured in many households for polishing woodwork, metal and other objects. They are readily made by soaking ordinary woollen cloths in a solution of 4 parts of soap in 20 parts of water, about 2 parts of jewellers' rouge being added to the solution. The cloths, after immersion in the liquid, are lightly wrung out and allowed to dry without heat. For many uses, these give excellent results.

Metal Polishes

Metal polishes are, of course, legion in the modern world. Intrinsically, they consist of a suitable abrasive material mixed with an oily liquid. For instance, an excellent liquid metal polish can be prepared by adding 10 parts of talcum powder or kieselguhr (infusorial earth) to 100 parts of white spirit containing a little ammonia. A few drops of a "perfume" such as methyl salicylate (oil of wintergreen) can be added, if desired, in order to disguise the odour of the white spirit.

Metal polishing pastes may be made by saturating 8 parts of kieselguhr with 2 parts of white spirit and by adding to the resultant paste a small quantity of thin lubricating oil and a trace of soap powder. A drop or two of nitrobenzene added to this preparation will impart to it the odour of many commercial metal polish pastes. Needless to say, the ingredients of the preparation must all be well mixed together.

Powders

Polishing powders for metal objects frequently consist of pure magnesium carbonate mixed with one quarter of its bulk of jeweller's rouge. Alternatively, a mixture of common whiting and Venetian red (equal parts) can be used.

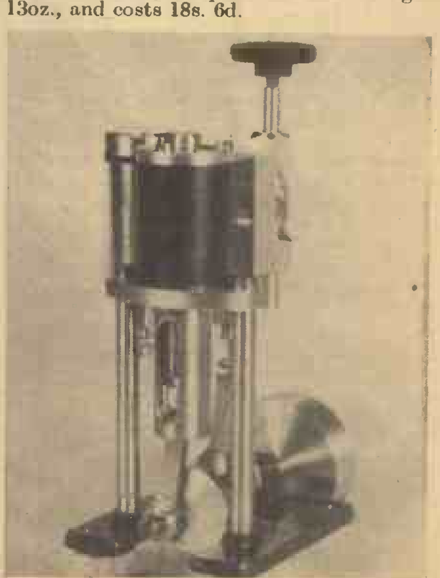
"French polish" is, of course, not merely the name of a special type of shellac polish. Rather, it is the description given to a method of applying shellac polish to woodwork, a method which calls for much skill and experience, and one which cannot be successfully attempted by the uninitiated amateur.

Boot polishes are, for the most part, mixtures of equal quantities of carnauba and Japanese waxes, the mixed waxes being dissolved in about five times their bulk of turpentine or turpentine-white spirit mixture, lampblack being stirred into the liquid as it cools down. In place of lampblack, various dyes and stains may be added for the preparation of non-black shoes polishes.

HIGH-SPEED MARINE ENGINE

THERE is always a demand among model boat builders for a reliable, efficient and well-constructed steam engine, and the "Eclipse" engine shown herewith fills all these conditions. It has been designed by men of practical experience and fully tested out before the final design was decided upon. The engine is suitable for boats of good lines up to 3ft. long where a good turn of speed is required. Suitable boilers for this engine are the Twin Drum Minor and the Streamlinia type.

The engine is made throughout of hard brass castings and non-rusting material, has long and properly fitting bearings and large capacity displacement lubricator. The height to the top of the cylinder is $3\frac{1}{2}$ in., and the base measures 2in. x $1\frac{3}{4}$in. The direction of rotation of the engine can be reversed by adjusting the eccentric by the grub screw. Each engine is thoroughly tested under steam at working pressures from 20lb. to 75lb. per square inch. It weighs 13oz., and costs 18s. 6d.



The "Eclipse" model marine engine.

Tricks With Bottles

Simple and Amusing Tricks can be Performed with Bottles which have been Specially Constructed. This Article tells you how they are made and Adapted for Various Tricks

By Norman Hunter
(The Well-known Conjurer of "Maskelyne's Mysteries")
Further Articles on the Secrets of Conjuring will appear Regularly and Exclusively in this Journal

THE simplest form of conjuring trick with a bottle for which nothing in the way of mechanical apparatus is necessary consists of making one or two silk handkerchiefs disappear and re-appear inside a glass bottle which has previously been shown empty and corked.

The trick is done by exchanging the empty corked bottle for a duplicate bottle containing handkerchiefs identical with those to be vanished. The bottle being of transparent glass must, of course, be covered in some way while the trick is done and the obvious way is to wrap it in paper. Under cover of this wrapping process the empty bottle is exchanged for the full one as shown in Fig. 1. The bottle containing the handkerchiefs is laid on the table and a sheet of paper placed over it, the back part of the paper being curled slightly the better to hide the bottle. There is a bag on a light metal frame attached to the back of the table and hidden by the cloth.

A Duplicate Bottle

The visible bottle having been shown empty and corked, it is held in the right hand as the table is approached. The performer then makes a sweeping movement with the hand holding the bottle, at the same time lifting the back edge of the paper as though to wrap up the bottle. Actually he lifts the hidden bottle under the paper and, as his right hand comes behind the paper he drops the empty bottle into the bag and continues the movement, wrapping up the hidden bottle. (Fig. 2.) The whole thing is quite simple and needs practising only to give confidence so that there shall be no hesitation. Small bottles should be used, such as those used for olive oil, and the wrapping up movement should be deliberate and quite leisurely.

The vanish of the handkerchiefs can be managed by any of the methods given in previous articles of this series.

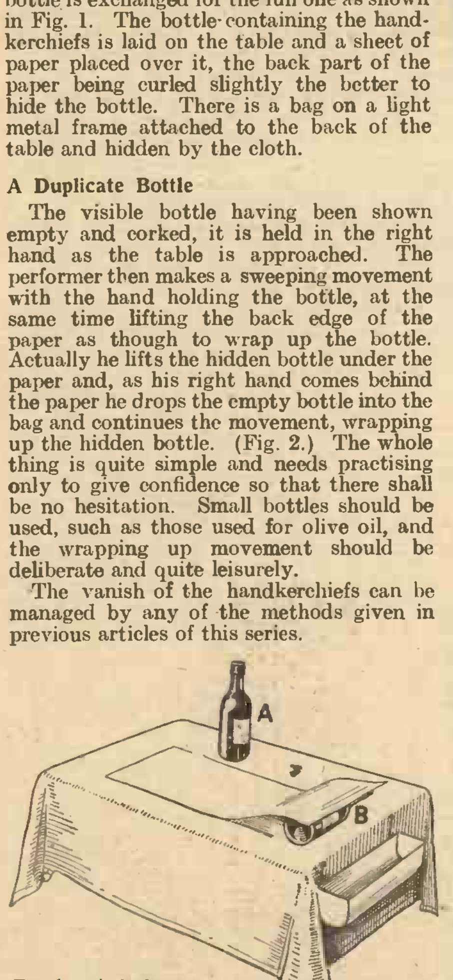


Fig. 1.—A duplicate bottle concealed behind paper

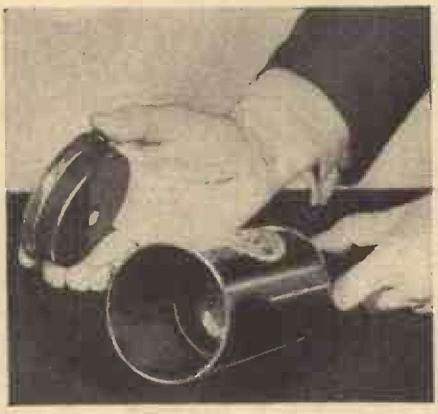


Fig. 3.—A hollow bottle of metal having a compartment at the top for holding liquid, and a loose bottom.

The same method of exchanging one bottle for another can be used to produce different effects. For instance an empty bottle could become filled with any kind of drink chosen by the audience. To do this, have the hidden bottle filled with, say, Stout. Show a duplicate empty bottle and do the wrapping up exchange, giving the full bottle to someone to hold. Now ask the audience to call out the names of things

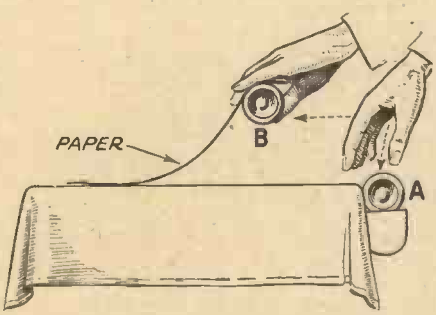


Fig. 2.—Empty bottle dropped into bag behind table and full one wrapped up in its place.

they like to find in bottles. Whatever is called out you write the word "stout" down every time, using a different slip of paper for each word. After about a dozen drinks have been called out, among which someone is certain to name stout, spread out the papers, writing side down of course, and ask the person holding the bottle to take one. The result when he finds the bottle he has been holding full of the drink he has chosen will be both surprising and effective.

Fig. 4.—A pair of trick bottles made of metal. Both are hollow and the inner one has a partition just below the shoulder so that liquid may be poured from the upper part.

A Card Trick

Another type of trick in which the bottle is not prepared is that in which a chosen card appears standing on the neck of the bottle. The card is forced as described in my article on card tricks and a duplicate of this card is attached by a clip to a wire arm operating on a spring at the back of the table as shown in Fig. 6. The wire arm is bent to the shape of the bottle and when released swings out and up from the back of the table, bringing the card into position on the top of the bottle. The bottle is placed in a previously marked position at the back of the table and, the card having been vanished, or burned, the catch is released by pulling a thread and the card duly appears on the bottle.

Another method of producing the same effect is explained in Fig. 6. Here the card is concealed under the label of the bottle. The label is steamed off and stuck on again by its edges, forming a pocket into which the card will slip. A small screw eye is driven into the cork and a length of fine black cotton is led through the eye, attached to one of the short sides of the card which is then tucked into the label pocket. The other end of the thread can be in the hands of an assistant who gives it a sharp pull on the given signal, or it may be tied to a small lead weight supported at the back edge of the table just behind the bottle. The performer then causes the card to appear by picking up the bottle, tipping the weight off the table which causes the card to fly up to the neck of the bottle. In this case the movement of the bottle helps to disguise the flight of the card.

Prepared Bottles

Now we come to specially prepared bottles. Fig. 3 shows one type. It is made of metal and has a loosely fitting bottom. The bottle is filled with rice or bran and the bottom placed in position. By slipping a finger under the bottle as it is picked up the bottom is held in position and the bottle may be freely shown. It is then placed on a tray and covered with a paper tube. When the tube is lifted the bottle is picked up with it and the rice or bran gushes out in a heap, covering the loose bottom. The hollow bottle is disposed of into a bag behind the table while attention is drawn to the transformation and the tube can then be tossed for inspection.

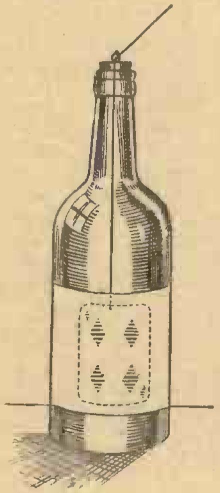


Fig. 5.—A card concealed in pocket formed by label.

An improvement on this type of bottle consists in having the upper portion of the bottle made into a watertight compartment to contain a glassful of liquid which can be poured out before the change and so add to the conviction that the bottle is real. All that is needed is a disc of metal soldered into the hollow bottle just below the shoulder. This is just visible in Fig. 3.

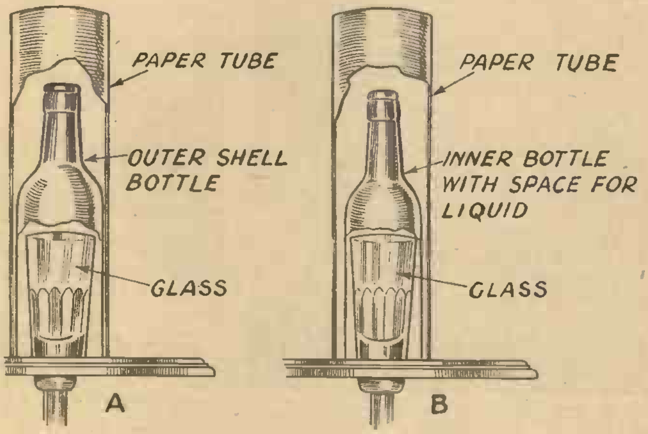
A simpler method of making a bottle of this kind is to turn the neck and shoulder from solid wood and make the lower part from sheet metal. The neck can then be drilled out and a metal tube inserted to carry a small quantity of liquid.

Different Effects

This trick bottle also is amenable to various kinds of treatment to produce different effects. For instance instead of filling the hollow space with bran a miniature bottle may be placed inside and the large bottle shrunk by placing the cover on. Or again the large bottle may be converted into three or four little ones or it may be transformed into some totally different object such as an apple. In this case a cider label on the large bottle will provide an element of logic for the trick.

Fig. 4 shows a further development of the hollow or shell bottle principle. Here the bottle with compartment for liquid as already described is fitted with an outer shell bottle. This outer bottle slides easily over the inner one and it is of course hollow throughout. The two bottles are usually employed for a trick known as the Passe Passe Bottle and Glass. The effect in this case is that of causing a bottle and a glass to change places.

At the outset the two bottles, nested together, stand on the table with a glass inside. Two paper tubes are shown and one is placed over the nested bottles. This tube is instantly removed and the other cover placed on the bottle, to show that either cover will fit. Actually when the first tube is removed the outer shell bottle is brought away with it. The inner bottle with the glass inside is now left covered by the second tube and the presumed empty tube is placed over another glass on the other side of the stage. The state of affairs is now as shown in Fig 6. A is the outer shell covering a glass, B is the inner bottle also hiding a glass, both being covered by paper tubes. The performer is now in a position to show either a bottle or a glass under either tube and the trick of making bottle and glass change places could be repeated as often as desired. Actually it is better not to make the change more than

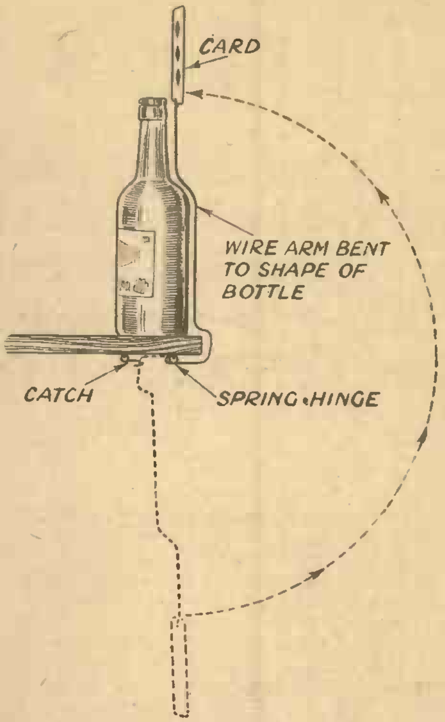


twice and finally leave the inner bottle visible, having the outer bottle inside one of the tubes. This outer bottle can then be disposed of by permitting it to slide over the inner bottle as the latter is picked up.

A Watertight Compartment

The watertight compartment in the neck of the inner bottle permits of liquid being poured from this bottle during the trick and each bottle has a hole about the size of a shilling at the back an inch or so from the bottom through which the second finger may be placed to press the concealed glass against the inside of the bottle when picking up the shell.

With the same pair of bottles and an appliance for changing one article for another, an entirely different trick can be performed. In my own performances I use an opera hat fitted with a hinged partition previously described in this series but illustrated again here for the sake of completeness. The trick is a sort of General Post effect. A bottle is placed on one table and covered with a paper tube. Another paper tube has a couple of silk scarves tucked into it while a few handfulls



Figs. 6 and 7.—(Above) A hinged spring arm carries card to top of bottle. (Left) In this effect a bottle and glass are made to change places.

of little coloured balls are poured into the hat. On the word of command the hat is turned over and the two scarves drop out, the balls having vanished. The tube into which the scarves were tucked is lifted and there is the bottle. The other tube which was originally placed over the bottle is then picked up and out fall the missing balls.

At the start of the trick the two bottles are nested and the inner one is filled with those soft, coloured balls sold for throwing about at carnivals. The loose bottom shown in Fig. 3 is placed in position. Two scarves are laid over a chair and two duplicate scarves are tucked into the hat on one side of the partition which is then swung over to hide them. The disposition of the articles is shown in Fig. 8.

Nested Bottles

The nested bottles are first picked up, the loose bottom being held in place by a finger crooked underneath, and placed on a table to the performer's right where there is a small tray to receive them. The two

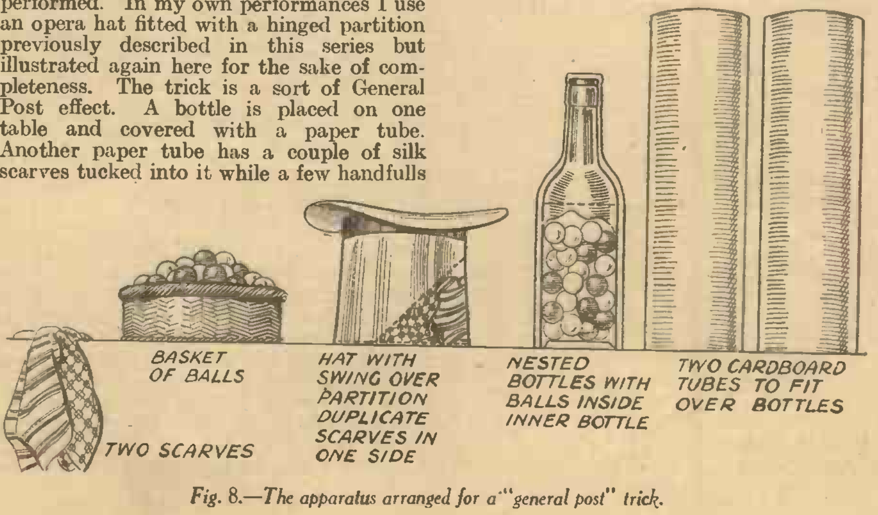


Fig. 8.—The apparatus arranged for a "general post" trick.

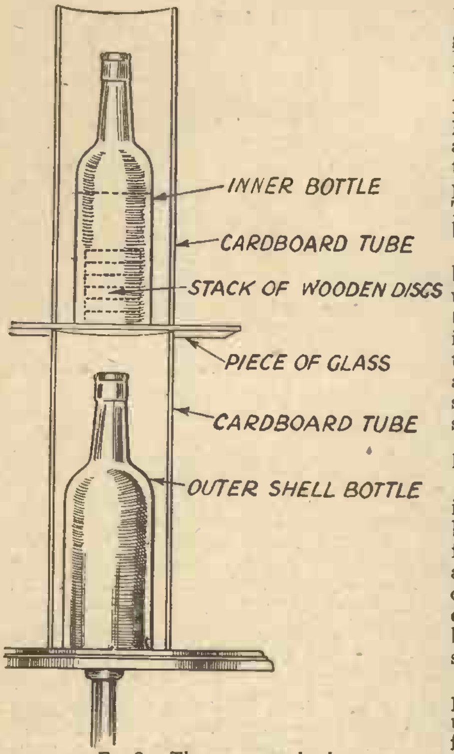


Fig. 9.—The penetrating bottle.

covers are placed on as in the Passe Passe bottle and glass trick already described, the outer bottle being removed in one cover while the second one is left over the inner bottle.

Going to the left side of the stage, the performer picks up the two scarves and tucks them into the tube he holds in his hand, where of course they go inside the outer shell bottle. The tube is then stood on a table. The hat is then picked up, shown empty with a sweeping movement and the balls poured from the basket into the hat.

To produce the effect the partition in the hat is swung over and the scarves allowed to flutter out. The cover is lifted from the bottle on the left, revealing the bottle in place of the scarves. Finally the right-hand tube is picked up and the missing balls roll out. The whole trick should be worked fairly rapidly and the covers carried off as the performer makes his exit at the end of the trick.

Another Trick

Another totally different effect, also using the two nested bottles is as follows :

A bottle is placed on a disc of glass on top of a cardboard tube previously shown empty. Another tube is placed over the bottle. The upper tube is lifted and the bottle has vanished, to be found in the lower tube, having apparently passed clean through the glass.

Here again the trick starts with the two bottles nested. The cardboard tubes are shown empty and placed one after the other over the bottles as before. The first tube is removed with the outer bottle inside and on this is placed the glass. The inner bottle is stood on the glass and covered with the second tube. Fig. 9. The trick is now virtually done as all that remains is to lift the top tube and with it the bottle, remove the glass and lift the lower tube, revealing the outer bottle.

The trick gains in effect if the space inside the inner bottle is occupied by a stack of coloured discs of wood or a handful of sweets, which appear in place of the bottle in its supposed journey through the glass. I frequently performed this effect at Maskelyne's with a story about a party being given in a first floor flat. During the party a rich but teetotal auntie called. The people instantly sent the drinks downstairs, as illustrated by the passage of the bottle to the lower tube, and pretended to be playing draughts as shown by the discs. Thus everything was perfectly all right, but " the people downstairs got the beer. "

A totally different type of trick with a bottle is that in which the bottle is held upside down and dropped into a paper tube. The tube is lifted for a moment showing the bottle resting neck downwards on the palm of the hand. The tube is lowered and at once lifted again when the bottle is seen to have turned completely over and be standing right way up.

Double-necked Bottle

The special bottle for this trick is shown in Fig. 10. It consists of a double-necked bottle, turned from wood and fitted with a fairly loose outer covering which slides up and down. Fig. 11 will make the details of the construction clear. The outer casing is best made from a length of seamless brass tubing as its weight will facilitate smooth working of the trick.

To perform the effect the dummy bottle is picked up and the little finger slipped underneath to prevent the bottle proper from dropping out of the casing. The paper tube is then held in the other hand and the bottle is dropped into it neck downwards. The sliding outer casing of the bottle will naturally settle down inside the paper tube. When the paper tube is lifted to show the bottle still upside down the outer casing is gripped through the paper and lifted as well, revealing the lower neck of the bottle. Finally the tube is lowered and then entirely removed, leaving the bottle standing right way up.

If desired the bottle can be constructed

Fig. 10.—An upside-down bottle, The bottle proper is turned from wood and has a neck at each end. The outer casing is a piece of seamless brass tubing. According to which end the casing is slid the bottle will appear right way up or upside down.

so that liquid may be poured from it, by drilling out either or both of the necks and fitting them with tubes and corks.

Pouring Out Drinks

Pouring out any drink called for by the audience from an apparently ordinary bottle is a trick that was very popular some years ago. The secret lies in the bottle, which is of metal and is divided into three or four compartments. Each compartment runs the entire length of the bottle, right to the mouth and each compartment is filled with a different drink. In order to control the pouring out of the drinks a fine tube was connected to each compartment and led to a tiny hole in the outer casing of the bottle. The tubes were necessary in order that the air holes might be arranged in a row on the outside of the bottle. To work the trick the bottle was held in the right hand with all the air holes closed by a finger pressing on each. To pour out any of the three or four liquids the corresponding finger was raised to admit air to the compartment, rather like playing a sort of flute. Sometimes the bottle had an additional compartment, down the centre which had no air hole and a wider mouth so that it might be filled with water via a funnel in front of the audience and the water either poured out again to prove the bottle without preparation or else left in and be presumably converted into the various drinks.

Concealed Glasses

Of course, three or four different drinks would not be sufficient to satisfy the demands of an audience so a further expedient is brought into play. One of the compartments is filled with pure spirits of wine and some of the glasses to be used have a small quantity of different flavouring essences in the bottom. The idea is that in the excitement of watching the trick individual members of the audience would not notice the difference between say genuine port and spirits of wine mixed with flavouring essence. Actually I think it very unlikely that this old conjuring device would be very convincing. It would be better to have a few small wineglasses already three parts full of some different wines hidden behind the stack of glasses on the table ready for the trick. When a drink was asked for that was not in the bottle but was " in stock " the corresponding glass would be picked up with the fingers concealing the liquid. Keeping all fingers firmly pressed on the air holes a generous glassful of nothing would be poured out, the fingers round the glass shifted to reveal the wine and the glass of quite genuine wine handed to the correct member of the audience.

Ale and Stout

By the use of this expedient the trick might very well be done with an unprepared bottle filled with ale or stout. When ale or stout as the case might be was asked for it would be poured openly and lavishly into an obviously empty tumbler. When any other drink was required the required glass already charged would be picked up from behind the others as already described and the bottle given a slight tilt, not sufficient to pour out any of the beer, but simply to carry out the illusion of pouring out the selected drink.

In this form the trick could terminate by handing the bottle for inspection. Needless to say in any trick of this description, demands for drinks which cannot be produced are simply not heard by the performer, who will usually find he is inundated with requests for the few he can supply. It is just a matter of acknowledging the demands for what can be produced and ignoring the rest, often a useful dodge in conjuring.

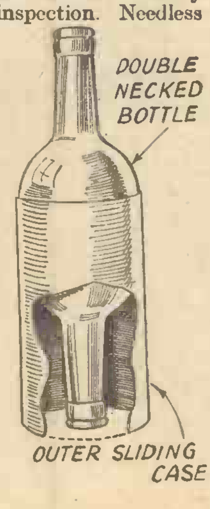
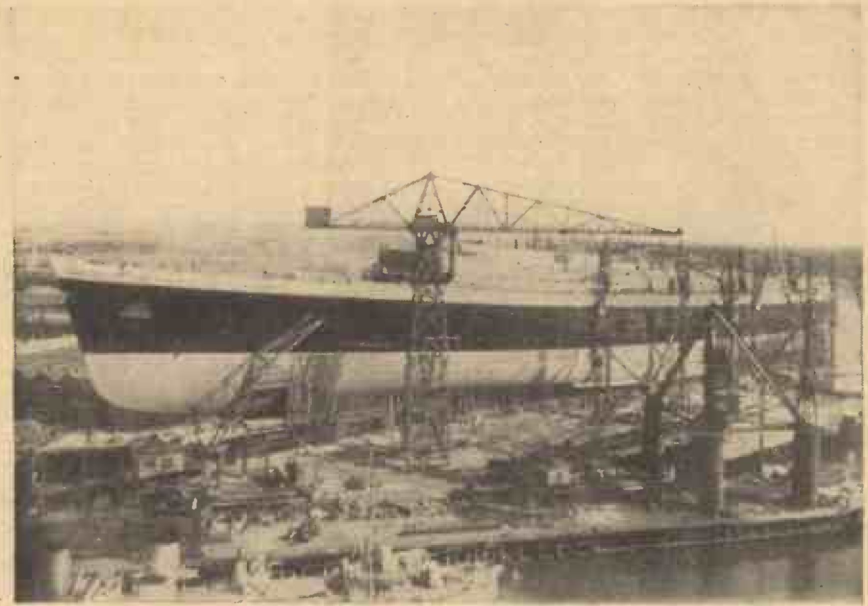


Fig. 11.—The "upside-down" bottle.

THIS MONTH IN SCIENCE AND



The world's biggest liner, "Queen Elizabeth," nearing completion prior to launching.

New German Zeppelin

THE LZ 130, the new German airship, recently set out on its first trial flight. Dr. Eckener, the designer, and 74 passengers and crew were on board. Work on the airship was commenced two years ago, and although built on the lines of the ill-fated Hindenburg, incorporates many improvements.

Control by Telewriters

THE smooth working of a large motor factory employing "flow" production methods depends upon exact synchronisation of operations in every one of the myriad departments. The correct parts and assemblies must be ready when and where they are wanted, for a hitch at any one point may dislocate the entire organisation. The way in which the activities of thousands of men are controlled is one of the real "marvels" of modern manufacturing.

A new system, employing an unusual type of telecontrol machine which reproduces written orders simultaneously at many different points, is used at the Ford factory at Dagenham to assist in achieving this essential correlation of effort throughout the works. The system has proved to have considerable advantages over earlier methods.

It consists of a telewriter transmitting set on the frame assembly, and receiving stations installed at various points in the factory, such as the wheel and tyre assembly, the body department, the main assembly, and the building superintendent's office.

The transmitter is in the charge of the man responsible for scheduling the production, who issues written orders. The order is then produced in a receiving station, and simultaneously transmitted to the other receiving sets, on which it is reproduced exactly as written originally.

Two More Moons

IT is learned that the Harvard Observatory, Massachusetts, United States, have discovered two new moons of the giant planet Jupiter. They were detected through the 100-in. telescope on Mount Wilson, California, which is the largest in the world, but the moons are very faint. Dr. Seth Nicholson made the discovery of the satellites of the planet by examining photographs taken in July and August. They appeared as tiny scratches on the pictures. The total number of Jupiter's moons at present known is now eleven. The ninth was first noticed in August, 1914.

A New Parachute

A BRITISH firm have produced a new type of parachute which is considered to be a tremendous improvement on those already in use. Whereas the present type necessitates a bulky package dangling behind the knees or on the chest this new parachute is part of a flying suit.

5,000 Years Hence

AN 800-lb. "time Capsule" has been recently shipped to New York where it will be packed with records of the civilisation of 1938, and deposited for 5,000 years, 50 ft. into the earth beneath the Westinghouse exhibit at the 1939 World's Fair. The 7 ft. capsule is made of cupaloy, the result of 5 years' research to make copper as hard as steel. It will contain a record of modern achievements in science and in art, as represented in newsreels and books, all reproduced on microfilm.

9,000 Miles Per Second

IN the Science Museum, South Kensington, is a brass box measuring a foot square by two inches deep in which protons can be made to travel at the astounding speed of 9,000 m.p. second. With the energy of a million and a quarter volts behind them, protons, invisible to the naked eye, travel at a twentieth of the speed of light, which is 186,000 miles a second. Professor E. Lawrence, of California, is the inventor of this box, which was formally designed for atom splitting. It was found, however, that by bombarding non-radio-active substances with protons and splitting their atomic structure, entirely different substances with qualities similar to those of radium could be produced.

A scientific authority says, "The box contains a piece of metallic lithium. This is the target or substance, the atoms of which are to be bombarded. The box is sealed and the air pumped out, and it is then slid between the two poles—pieces of electro-magnet. This and the short-wave oscillator are switched on and the protons move with energy equal to a quarter of a million volts behind them. At this speed they bombard the lithium and smash-up its atoms until they change and become the atoms of helium."

The new Graf Zeppelin as she took the air at the start of her trial flight.

THE WORLD OF INVENTION

What the system does, in effect, is to operate several different pens at points widely separated. The original message is written with a lead pencil on writing paper. At the receiving end the order is reproduced on a strip of paper which gradually unrolls as the mechanically-controlled pen traces the words, reproducing the hand-writing exactly.

The system gives immediate communication with many different departments, which would not be possible if the messages were delivered by hand. There is far less possibility of error than would be the case if the orders were telephoned.

Weather made to Order

ALL conceivable combinations of bad weather—storms, dust, sleet, rain, extreme heat or cold—can be created to order. They are produced in a new "weather tunnel," the first of its kind to be built expressively for scientific research into motor-car design and operation.

Thus an engineer may direct a 70 m.p.h. sleet storm directly at a car running at a speed equivalent to 60, 70 or 80 m.p.h. At will the temperature may be dropped to 20 degrees below zero, or raised to 150 degrees above, simulating conditions met in the depths of winter or in the tropics.

The tunnel is 124 ft. long, 35 ft. wide, and 14 ft. high. A 400-h.p. motor drives a 10 ft. propeller to create wind velocities up to 85 m.p.h. Dust or sand blown into the tunnel through a jet is converted into violent storms, while water pipes can produce anything from a light fog to a cloud burst.

Beam Radio

THE first of the test transmissions on the new radio telephone installation for the Hebrides will shortly be taking place. A station 1,000 ft. up on the mountains near Castlebay Barra, is to work in conjunction with another station near Oban. The radio installation is intended to take the place of cables which are often out of action due to the effect of the storms which are experienced in the vicinity.

Rubbered Rooms

A NEW and effective means of sealing doors and windows against gas, and one which lends itself specially to A.R.P. work in hospitals and similar institutions, consists of wooden panelling in which thin strips of latex rubber cushioning (Dunlopillo) have been embedded.

When the panelling with its projecting strips of cushioning is clamped to the door frame and floor, the rubber is compressed to form an air-tight fitment which is neat and absolutely fool-proof.

The panelling itself is no bigger than that required for light picture frames; it takes up very little room, and, in an emergency, can be brought out of store and quickly placed in position.

The rubber cushioning forming the air-lock is more effective than sponge rubber because it retains its vitality and "spring" for any length of time.

Windows and floors, as well as doors, can all be rendered absolutely gas-proof by these unobtrusive wooden fitments.

Swing doors can also be made into a reliable air-lock by the fixing of cushions of latex rubber at the hinges and edges of the door. When the swing door closes, the rubber pads are automatically compressed (as is the cushioning at the base of the door), thus rendering the room itself proof against any contamination from outside.

World's Largest Ship

THE largest ship in the world was launched on September 27th. It was named the *Queen Elizabeth*, and is 10ft. longer than the *Queen Mary*. A feature is that she has only two funnels instead of three, which gives her a more generous allowance of deck space.

Choose Your Own Language

AN innovation recently introduced in the Budapest telephone system enables foreign visitors to obtain information in English, German, Italian and Esperanto. All they have to do is to dial a certain specified number for each language.

A Living Battery

IN their efforts to find just what their batteries can do, Exide technicians have carried their experiments as far as to obtain an electric eel from South America.

These electric eels can generate sufficient electrical energy to stun a horse or even kill a man, and " Exide " as the eel is named demonstrates his ability to produce electricity by lighting a neon lamp. Although " Exide " is only 18 in. long, he is a comparative youngster, and will eventually grow to a length of four or five feet.

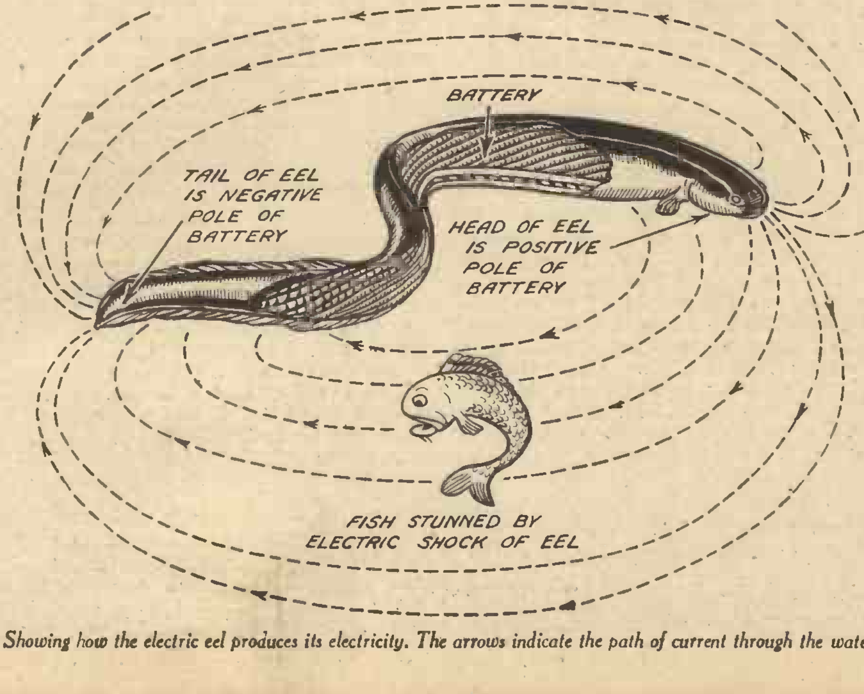
The batteries of the electric eel (see diagram) are composed of hundreds of thousands of minute muscular plates, separated by an electrolytic fluid. Because the electric tissue is a modified form of muscle, it is believed that the chemical processes by which energy is released in human muscles are also utilized in the tissues of the electric eel. Muscular activity is a conversion of energy in two stages: first, from chemical to electrical; second, from electrical to mechanical muscular contractions. In the organs of the electric eel this ratio may be reversed. The eel's electric organs produce voltages 1,000 times greater than is developed by human muscular activity.

Electric Cycles

AN Amsterdam firm state that they have at last designed an electric cycle, for which they have taken out a patent. It consists of a small motor which is fed by a 12-volt battery, charged in such a way that it would enable a distance of 80 kilometres to be covered. The speed of the machine is not stated. The equipment weighs 60 lb., but the sponsers state that this should not prove a drawback. There are over three million cyclists to be seen on Dutch roads, and the inventor hopes that within a few years they will forego their pedals for the electric cycle.

A Chemical Discovery

MAGNESIUM, used extensively in the making of fireworks and flashlights, is the lightest of known metals. It is now an important constituent of the light alloys which are required in large quantities for aeroplane construction.



Showing how the electric eel produces its electricity. The arrows indicate the path of current through the water.

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, free of charge, a copy of their handbook, "How to Patent an Invention."

Noise Production

THIS is the age of the big noise. Many protests are made against the ear-splitting sounds which characterise our modern life. There is an Anti-Noise League, whose aim is to abolish cacophony—a jaw-breaking word for ugly sound. It is, therefore, strange that there should be an application to the British Patent Office asking for protection for a noise-production device. But the mystery is cleared up when one learns that it relates only to noises in toys. To make a toy realistic it is necessary that the familiar sounds associated with the object represented should be correctly imitated. The purr of the motor, the whirr of the aeroplane, and the rhythm of the railway train, when faithfully, if not powerfully, simulated add materially to the effect of the toys. The object of the inventor is to provide means for imitating the power unit of a toy device, for instance, the exhaust of an internal combustion engine in a motor-car.

This should enhance the delights of the nursery.

Mechanical Scarecrow

I NOW comment upon another noisy device which has been submitted to the British Patent Office.

Ever since man first began to till the ground, the bird has levied a toll upon the seed which is sown in the furrows. But it is a moot point whether the tiny marauder does more good than harm. As regards the garden, for instance, the favourite food of the thrush is the snail, and we are told that the bird destroys at least a hundred snails where the gardener can kill scarcely one.

However, the farmer appears to consider the birds as the foes of his fields. And he has adopted more than one method in order to frighten away the depredators. The scarecrow is a familiar object on the land. But its reign of terror does not always achieve its end. I believe that with ironical indifference a crow has been known to utilise the scarecrow as a perch. Robinson Crusoe, to guard his crop, hanged a couple of the feathered culprits like highwaymen at cross-roads, and this proved a deterren to the winged bandits.

Now, the average bird has an inherent fear of a gun. And, therefore, an inventor has recently applied for protection for a detonator which will produce periodical explosions, somewhat on the principle of traffic lights. Consequently, without the continual attendance of a man with a gun—a practice which used to be adopted—a bugus gun will deceive the aerial thieves and keep them at a distance.

The inventor has set himself the task of providing automatic detonator apparatus which is simple, yet efficient. A characteristic of the machine is that it can be easily re-charged with a supply of detonators. And, if required, the time interval between the explosions can be varied.

Another feature of the contrivance is that each explosion takes place outside the apparatus, so as not to interfere with the normal operation of the mechanism.

This device will replace the farmer's boy who, in the good old times, rotated a bird-scaring rattle.

Artificial Noises

THE subject of imitation noises moves me to remark that, in the days of the silent films, the effects were produced by an alert member of the staff, who made them synchronise with the action of the picture. And these artificial noises added materially to the realism of the film. But, as these innocent deceptions were perpetrated behind a screen, the public were not always aware of the manner in which they were caused. I have myself seen a vigilant effects operator—the forerunner of the sound track—at work while a film was being exhibited. By his side was a bath containing crocks, which he vigorously made clatter when anything in the picture fell. He also had a big military drum, the surface of which he brushed with a pair of dandy brushes used ordinarily for grooming horses. This provided a very good imitation of the sound of the waves on the seashore. The noise of a horse's hooves was effected by knocking together the edges of a split coconut shell. A smart rap with a cane upon a leather seat closely resembled the crack of a rifle. And that which feigned to be church bells resulted from the striking of what apparently were suspended gas pipes. As these noises had to coincide with the movements in the picture, a rehearsal was necessary.

Footnote

IT is remarkable how many inventions concern footwear. The attention of the inventor is constantly devoted to shoes. For example, a new pneumatic heel is the subject of a recent application to the Patent Office of this country. The object of the inventor has been the provision of a heel with improved resiliency, wear, and non-skid properties. In this instance, a rubber heel comprises upper and lower plates enclosing an air chamber. The upper plate is provided with reinforcing ribs on its underside.

The next invention to which I refer relates not to " the light fantastic toe," but is specially designed to reinforce the boot of the miner. It consists of an improved guard for the toes of boots. In this case, there is a guard-cap of metal extending over the front portion of the boot, and this is characterised by the fact that a broad strengthening and stiffening bridge of strong leather is arranged between the guard-cap and the front cap of the boot. No doubt the boot of a miner is subjected to exceptionally hard wear. Certainly this type of footwear would have a powerful kick in it.

Shoecraft

SPEAKING of boots, I am moved to remark that a London daily paper has received a protest from a correspondent who objects to the word " cobbler " being used for a heading. He considers that it reflects upon that capable craftsman, the shoe repairer. The paper pointed out that the first definition of a cobbler is one who mends shoes, but that a second meaning describes a cobbler as one who clumsily mends shoes. In this connection, there comes to my mind a crude couplet which was occasionally quoted in the last century. It ran thus :—

" Why is a cobbler like a king?
Because his nose is above his chin.

Modern machinery enables the shoemaker to repair shoes in a very effective manner. I have seen stitching which is almost imperceptible.

There are many handy men other than the shoemaker who have a last and sole and heel their own shoes. I once met that highly respectable member of society, a bank clerk, who shod both himself and his family. He was one of the noble army of amateur practical mechanics.

For Juvenile Jumpers

AN improved hurdle for junior athletes has appeared. We have all seen children in the streets who, by means of a skipping rope at varying altitudes, test the leaping abilities of the sporting juvenile. This improvised method is surpassed by a device of pressed metal, to be fitted to hurdles, which enables the top bar to fall and remain down when struck. It also permits the top bar to be adjusted to any desired height by clamping bolts, which pass through slots in the sides of the hurdle.

This will train our youth to emulate the attainments of the horse in the hunting field.

Dish-washer

MOST housewives dislike that post-prandial necessity, the washing up of the dishes. However, in hotels and institutions these ablutions are often mechanically performed. A patent for a new dish-washing machine has been applied for lately. In the case of previously designed machines of this description, the dishes are placed on a stand in a container, on which one or more jets of water are sprayed from above. The liquid is fed to a nozzle through a flexible conduit or one with turnable joints. This, it is stated, has certain disadvantages, as, for instance, risk of leakage.

The inventor of the improved device has produced a dish-washing apparatus in which a broad, thin jet of liquid is sprayed on the dishes without the use of a movable nozzle or a flexible conduit. A jet is directed from a fixed nozzle against a reciprocal deflector or screen, which deflects the jet on to the plates. The jet, which may advantageously be a round one, does not thus strike the dishes directly. The action seems to be nearly related to the ricochet of a bullet.

How to Moor a Wallet

ANOTHER pocket wallet protector has made its debut on the other side of the Atlantic. This comprises a casing adapted to be detachably secured to a part of the wallet or article to be guarded, and also latch mechanism. It not only nonpluses the thief, but it prevents loss of the wallet due to some other cause. For example, there has come within my ken an accident which occurred to a pedestrian. He happened to slip on the pavement and, in an endeavour to preserve his equilibrium, almost turned a somersault. This was the opportunity for the never-variable law of gravitation, which caused his wallet to fall from his pocket. At the time he was not aware of his loss, and when later he applied to the police, he did not recover his wallet. Now, had he have had the above-mentioned protector fitted, his pocket would not have been picked by gravitation.

Bottle Printing

TO dispense with the adhesive label, a new process for printing on the glass of the bottle has been accepted by the United States Patent Office. It comprises the use of a quick-drying, hard-setting ink, which is covered with a synthetic resin varnish. The bottle is then heated for about a quarter of an hour at approximately 300 degrees F.

DYNAMO.

SYNTHETIC RESIN MOULDINGS

The Material—Process Employed—Types Of Moulding Dyes And Their Manufacture

Fig. 1.—Moulded bakelite articles.

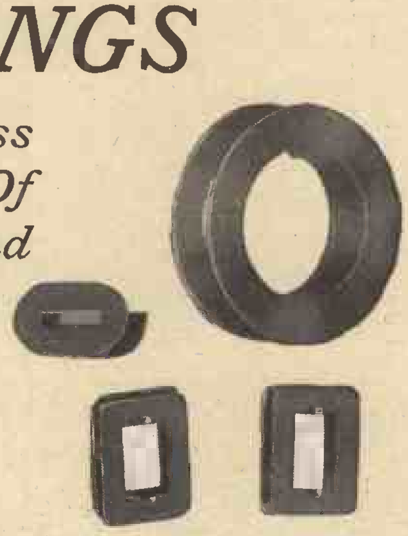


Fig. 2.—Moulded cellulose acetate articles.

THERE are several forms of moulding material manufactured at present, the most familiar being named "bakelite."

It is a synthetic resin produced by a chemical reaction in which carbolic acid and formaldehyde (distilled from wood) play the most important part, but the exact details of the process are omitted as not being considered essential to the present article.

For the manufacture of utility articles obtainable in vast quantities, this resin is mixed with a base termed in the trade a "filler," and this filler varies according to the class of article required to be moulded. As for instance some articles have to be hard and necessarily fragile, others perhaps have to be so light and weak that the filler used is to gain strength, whilst in other cases the filler decided upon is one which will stand the constant contact of boiling liquids. In some moulding powders very finely ground wood is used as the base, other materials include French chalk—china clay—asbestos and wool fibre, also in the majority of moulding shops all the scrap and waste from previous mouldings are reground and used as filler mixed with a further proportion of resin. Bakelite moulding compound is used for fabricating a great variety of articles such as electrical accessories, including wireless components; cups for vacuum flasks, and a vast amount of small attractive articles purchasable at very competitive prices. It is very durable, not greatly affected by boiling liquids, and is a non-conductor of electrical current. The natural colour of bakelite resin is amber, but any other colour is produced by the admixture in the filler of a suitable die.

Cellulose Acetate

This form of moulding material differs considerably from bakelite in structure, also in manufacture, as although the modern method of producing small bakelite articles is by injection (explained later), acetate is always injected into a closed mould, heated separately and being brought to a fluid condition in a container fitted to the moulding press for that special purpose.

In Fig. 1 will be seen a small cup, an ashtray and a wireless control knob, all produced in plunger type moulds from bakelite powder loaded directly into the mould.

In Fig. 2 is shown four coil formers, the largest of which is moulded in bakelite by the injection method, the remainder being fabricated from cellulose acetate.

The Process Employed

The process used in the manufacture of mouldings is fairly simple, and does not call for a great deal of skill on the part of the operator, quickness in ejecting the moulded article, combined with close application to the time allowed for "cooking" (which is the period estimated by the controller as sufficient to produce in the compound a state as near to perfection as possible) are the only points the person operating a moulding press has to consider.

Bakelite moulding work cannot in any circumstances be termed a "pleasant occupation," owing to the heat which is necessary and the annoying smell and rapidity under which the operators have to perform their duties.

With all forms of pressure moulding there are many snags and drawbacks. The mouldings shrink upon cooling—which has to be guarded against and allowed for; also in time they "grow" by the normal action of the pressure confined in the moulded object continually struggling for release. Moulded metal articles are affected by this expansion more than synthetic resin, although in all mouldings it is a serious drawback and considerably restricts the fabrication of moving parts. Experimenting in this direction is continuous, and one enterprising firm is now moulding shaft bearings from bakelite with the admixture of graphite to the resin compound. The advantage of this will at once be understood when it is explained that the shafting is run dry, without oil or any form of lubrication, owing to the graphite reducing friction to a minimum. These bearings have a great welcome in food-producing factories or others where oil becomes a nuisance.

The shrinkage in mouldings is to a great extent overcome by allowances in mould sizes when these are being made, of a percentage averaging 0.006 per inch. The figures representing allowances are usually entered on the mould drawing by the designer, as much experience is necessary in making calculations, also it will be realised that bulk and the filler being used in the moulding compound, will considerably vary the amount of contraction. In some instances the bakelite powder is made into lozenges by the use of special machinery before being loaded into the moulds, which facilitates the accurate measuring of the material being used, but this method has its limitations, as where moulds have fragile or structurally weak internal parts, the danger reduces the practicability.

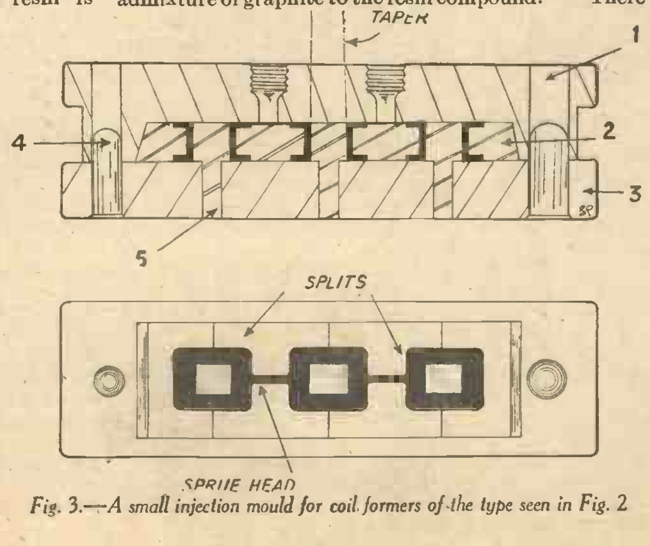


Fig. 3.—A small injection mould for coil formers of the type seen in Fig. 2

Heat and Pressure

There are several practical methods of obtaining and applying these two very essential elements. In the case of heat, steam, gas and electricity can be used efficiently, whilst in the case of pressure, hydraulic and electrical are universal, also hand pressure obtained with a fly press is often used with success where the more elaborate mechanical processes are not available.

For good sound mouldings the heat required should be somewhere around 300°F. to 350°F., and all moulds and moulding apparatus should be maintained at this temperature.

With regard to pressure, this is approximate, but the nearer it approaches that equalling $1\frac{1}{2}$ tons per square inch, the more durable and strong the moulded part will be.

If the pressure is insufficient

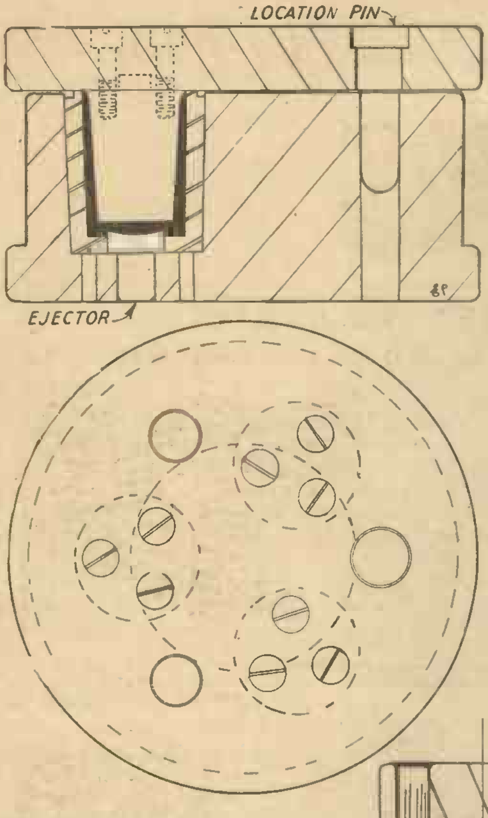


Fig. 4.—A three-impression cup mould.

the mouldings will be weak and fragile — termed in the trade "Cokey."

Mould Loading

Some few years ago the only method of charging a mould was by taking the upper and lower forces apart and inserting the material, but this has now been superseded by the modern method of injection.

For this process special presses or moulding machines are needed, and in the former they are of the double-action variety, viz. the lower platen rises and closes the mould, then a plunger descends, entering a small cylinder, which is screwed into the top of the top of the mould, into which the bakelite powder or lozenge has been previously placed.

Undoubtedly this is a great improvement on charging the mould direct as it reduces the "flash," which is a certain amount of the resin spewed out between the two mould forces by the internal pressure, and is a great trouble should it become thick, having to be trimmed off after moulding as it is very unsightly. A further advantage attached to the material being in a fluxed state when entering the mould is that it is not so liable to injure weak protrusions on the inner surfaces of the mould when it is in operation.

Cellulose Acetate Moulds

Moulds for this material are always charged by the injection method. It differs only from the bakelite injection mould by having a cylinder attached to the press containing a fairly large quantity of the material in a hot fluid state. A great many large and elaborate moulds are used in the process of forming and casting this class of resin; the mouldings, such as cheap fountain pens, pencils, etc., have to be produced in very large quantities to support a competitive market, and maintain a profit

The rapid and effective stripping of these small articles after moulding has produced many wonderful and elaborate mechanically operated moulds, especially for the production of such articles already mentioned, and having internal threads. Rapidity of operation is the most essential point, and the design is always directed with this end in view. One of the most effective mechanically operated moulds at present is made by having a complete circle of stems made of steel which forms the internal bore of a pen or pencil barrel. These stems pass through a plate, and on the back end of each is fitted a small gear wheel, in the centre of this circle of gear wheels, and in mesh with same is a larger wheel to which a handle is attached—when the moulding is completed this handle is given a sharp turn, which causes all the stems to revolve together, unscrewing them from the moulded thread inside the barrels, but even a quicker method than this has been recently invented, and has proved quite practical against considerable adverse criticism, i.e., after moulding, and when the material is still in a hot plastic state, the steel stems with the moulding thread on descend

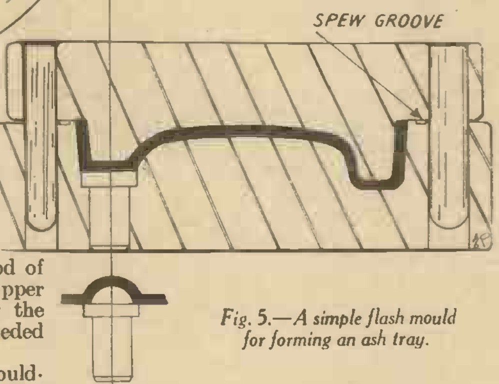


Fig. 5.—A simple flash mould for forming an ash tray.

through the plate, stripping off the barrels. It had been found after considerable experimenting that the moulded thread was not unduly injured, and regains almost its normal shape and size upon cooling. In Fig. 3 will be seen a cellulose acetate mould which produces the small coil formers. The top sketch is a sectional view showing the details, No. 1 being the top force made from good quality mild steel and left soft; No. 2, which is the bottom force made from the same class of material into which the core pins No. 5 made from cast steel, hardened and tempered, are a press fit just burred over at the bottom end to retain them. A slight taper will be noted on the core pins, which is very essential to facilitate stripping.

Location Pins

The location pins made from cast steel hardened and tempered, are of different sizes to locate assembly the same way round each time. In the making of this mould, very little bench work is necessary, and the only real fitting is the three rectangular

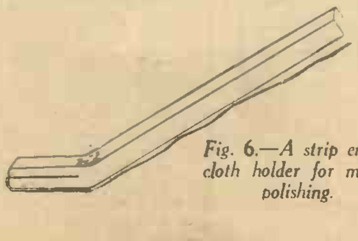


Fig. 6.—A strip emery cloth holder for mould polishing.

core pin holes, which have to be carefully located. The splits, which are made from cast steel are probably the most tricky job, there is really two pairs of each which must be exactly the same to centralise. They are shaped up to a predetermined size, the core pin slots run through on the horizontal milling machine, then the shallow recess end milled in the top and bottom sides of each to form the flange on the coil former. The outside taper is then machined on the horizontal milling machine with the aid of the swivel vice to set up for the angle. In some tool rooms, about .010 in. would be left all round to be ground off after hardening, but in many, just a few thousands would be left on for the fitter to work off with a file, in any case all mould surfaces have to be polished before and after hardening, this is very essential with all moulding dies to avoid sticking, and also to produce a finish on the moulded article.

Polishing

Emery powder mixed with paraffin oil used on sticks of wood or pieces of fibre, are very handy tools, and afterwards a final surface highly polished can be obtained with rouge. Polishing is not so essential with cellulose octate moulds, as bakelite, the moulding pressure being considerably less. In quite a lot of modern tool rooms good quality mild steel would be used for the splits of this mould, and afterwards skin hardened in the cyanide bath, but it must be distinctly noted that it would have to be "black" mild steel which is hot rolled, as "bright mild steel" or "cold rolled steel" would distort in the hardening process, and render the parts useless.

Bakelite Mould Making

The small cup which is shown in Fig. 1 was made in a very simple three-impression mould. The bottom bolster is made from mild steel with cast steel moulding forces inserted into it, after being hardened and ground. The top force is a mild steel plate with plungers to form the inside wall of the cup positioned by a spigot and held on by screws. This type of mould is fairly simple to make. A small protrusion will be noted on the top of the plungers entering the top plate, without this the mould would take twice as long to make, and would mean a great deal more trouble, which will be easily noted by following the procedure adopted for manufacture. (Fig. 4.)

Best quality mild steel is turned in the lathe to size, representing the bottom bolster and the top plate. The top plate overlaps the body, and a step is turned on

(*Continued on page 111*)

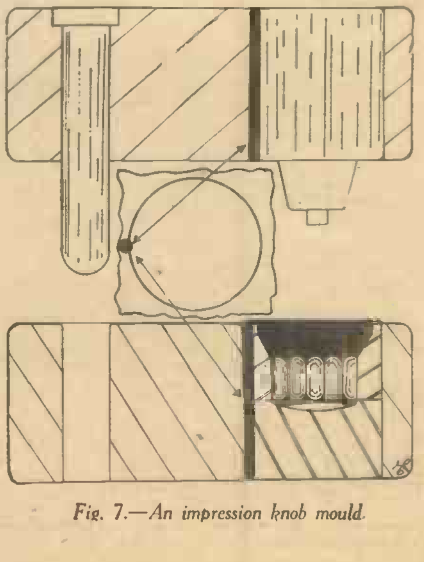


Fig. 7.—An impression knob mould.

MASTERS OF MECHANICS

No. 39. Isaac Newton

Sir Isaac Newton.

ISAAC NEWTON was born at a remote Lincolnshire farmstead near Woolsthorpe, on Christmas morning in 1642. He was a weakly infant and the circumstances of his birth were greatly saddened by the fact that, just previously, his father, a yeoman farmer, had died at the early age of thirty-six.

Isaac's mother, however, soon re-married, and went to reside with her second husband, the Rev. Barnabas Smith, at North Witham, some distance away. The infant Newton was not taken to his mother's new home. He was looked after by his grandmother, Mrs. Ayscough, who came to reside at Woolsthorpe specially for that purpose.

Great must have been the care which Mrs. Ayscough gave to the infant boy, for, with the passing of the years, he completely outgrew his early weaknesses, and, as we shall see later, lived to the ripe old age of eighty-five.

His Boyhood

When Newton was twelve years of age, he was sent to the King's School at Grantham, the nearest town. Strangely enough, he did not show any studious inclinations and, for a time, he was almost the lowest boy in the class. Like Galileo, much of his boyhood time was spent in building working models from scraps of materials and in pondering over their mechanism. He interested himself in astronomy, too, and there is a story that once he tied a lantern to the tail of a kite and flew it after dark, making the local folk believe that a comet had appeared.

Newton, however, even at this immature age, was no characterless lad. One day a schoolfellow kicked him savagely and for no apparent reason. Immediately Newton rose up and fought the lad, giving him a good thrashing.

The incident had its effect on Newton's mind. If, he thought, he could obtain the victory over a fellow pupil with his fists, he could surely do so with his brain. So he set to work in good earnest with his studies and ultimately rose to the top of his class.

His schooldays over, Newton was started at the family occupation of farming. But there was no love for the congenial task of husbandry in him. He preferred reading books on mathematics and physical science. Eventually, therefore, on the advice of the local vicar, Newton was sent back to the Grantham Grammar School, this time with the object of preparing himself for a University career at Cambridge, to which city of learning he went in the year 1660 at the age of eighteen, entering the famous Trinity College there.

The Great Plague

There was nobody very brilliant at Cambridge when Newton went up there. His studies went on uneventfully and at the age of 22 he took his B.A. degree. A year later—in 1665—the Great Plague visited London, killing off no fewer than 100,000 people. The pestilence spread to Cambridge, causing the University to be closed. Newton, as a result, was forced to return to his family farmstead at Woolsthorpe and to remain there for a period of some eighteen months.

The modern spectroscope is based directly upon Newton's discovery of the spectrum.

But the period was, for Newton, not one of idleness. For some time previously, he had pondered deeply over the fundamental principles of mechanics and, in particular, over the elements of astronomy. Especially had the subjects of force and gravitation fascinated him, for he had learnt much from the writings of Galileo about the new conception of the earth, moon, sun and planets.

It was during his enforced stay at Woolsthorpe that the apple-in-the-garden incident is supposed to have occurred to Newton. Whether Isaac did actually conceive his explanation of the operation of the universal law of gravity through seeing an apple drop to the ground in his mother's old orchard at Woolsthorpe, or whether the well-known narrative is only a story, we shall never fully know. It would seem, however, that the story (which was given to the world by the philosopher, Voltaire) has some truth in it.

Law of Gravitation

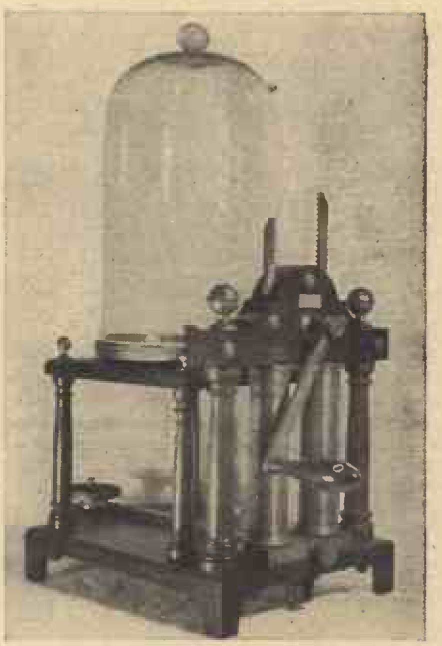
Certainly, though, it was at this period of his life that Newton hit upon the law of universal gravitation which enabled him to give, later on, a definite proof of the laws of planetary motions, thus following up and confirming the great truths which Galileo had previously enunciated.

In 1667, Newton returned to Trinity College, Cambridge, having been elected a Fellow of the College, and from now onwards we find his career one of almost meteoric brilliance in the domain of mathematics, astronomy, optics and theoretical mechanics.

In the realm of mathematics, he invented at this period the binomial theorem, nowadays well known to students of algebra, but his greatest mathematical monument is what we call at the present day the "differential calculus", a mathematical system which has ever been of incalculable assistance to the theoretical engineer and designer.

As a close student of optics, Newton gave several years to the re-formulation of the principles of light. He introduced the reflecting telescope in which the image is not viewed directly through a system of lenses, but is formed at the focus of a large mirror or "speculum", thus obviating the many distortions which a direct vision telescope built on the principle of Galileo introduced at that time.

Newton, too, discovered that if he allowed a narrow ray of sunlight to pass through a triangular-shaped piece of glass, called a "prism", the light ray was not merely reflected or directed out of its course, but that it was actually split up into seven differently coloured component rays which, when allowed to fall upon a whitened sur-



An early air pump, made soon after the death of Newton. With such simple instruments, many of the basic properties of gases were discovered.

face, gave a graduated band of colours known to this day as the "spectrum."

Spectrum Analysis

Here, of course, Newton figures as the father of spectrum analysis, that ingenious principle whereby man has been able to ascertain the composition of other worlds and even of the gaseous atmospheres of worlds separated from the earth by almost inconceivable distances. Curiously enough, however, Newton, although his notes on the subject were voluminous, published very little at this juncture, for the limelight of publicity was distasteful to him.

Newton's view of the nature of light was that it is composed of streams of tiny material bodies which he called "corpuscles", these corpuscles being shot off in vast numbers and at an extremely rapid rate by the luminous body. For a time, Newton's "corpuscular theory" prevailed, but it was eventually overshadowed by the present-day wave theory of light which assumes light to be a manifestation of wave motions in a hypothetical entity which, for convenience, is called the Ether.

It is interesting, however, to note that of recent years, many scientists are inclining more and more to the old corpuscular theory of Isaac Newton and are crediting light with being a stream if not of actual material bodies, at least of energy units or "particles."

Newton was made a Fellow of the Royal Society. The latter body formed such a high opinion of his researches in mathematical science and in the principles of mechanics that they decided to ask his permission to publish much of his work. Newton consented. He revised and collated his many notes, papers and manuscripts and eventually gave to the world his famous *Principia*, or "Mathematical Principles of Natural Philosophy."

Remarkable Book

This book, which was written in Latin and published in 1687, proved Newton to be a man of towering scientific and philosophical genius. It has been aptly called the "greatest single contribution to science ever made by any one man," and, although at the time of its publication there were, perhaps, hardly a dozen men in all Europe who were capable of realising its deeper meanings, the work placed Newton upon a pinnacle of scientific fame.

The *Principia* of Newton is, even to-day, one of the most fundamental treatises in the whole repertoire of theoretical and mechanical science. It is difficult to assess the manner in which engineering science would have grown without the many principles which it lays down. Even the modern views of Einstein upon the conception of the Universe in no way invalidate the conclusions of Newton's *Principia*, the latter being inviolable and absolute.

As a sort of political reward for his work, Newton, in 1695, was offered the post of Warden of the Mint, an appointment which he accepted. Five years later he was made Master of the Mint, the position being then worth about £1,500 per annum. To a certain extent, the post was a nominal one, for Newton still continued his studies at Cambridge for a few years afterwards.

From 1703 he held the Presidency of the Royal Society, an honour which he retained until his death, twenty-five years later.

Nervous Breakdown

And then, curiously enough, in the midst of the years which followed upon his European fame as a philosopher and scientific mechanician, came a period of mental unrest, a bad nervous breakdown. Some have averred that the great philosopher's mind actually became unhinged at this period, but there seems little likelihood of this being true.

Nevertheless, the brilliancy of Newton's career had expended itself. The flame had died down, and during his later days, the great philosopher contented himself in living a tranquil and uneventful life, devoting a good deal of his time to the study of Divinity.

A telescopic view of the moon. By carefully observing the motions of our satellites Newton was led to his laws of gravity.

Some ten years before his death, which occurred on March 20, 1727, he relinquished all his scientific studies. The master mind, which had given to the world more scientific principles than any other single individual had ever previously done, had worn itself out and its owner now lay back to follow, whenever possible, the work of others, whose efforts he encouraged to the greatest degree.

To this period of Newton's final inactivity belongs those oft-quoted words of his:

"I know not what the world will think of my labours, but to myself it seems that I have been but as a child playing on the seashore; now finding some pebble rather more polished, and now some shell rather more agreeably variegated than another; while the immense ocean of Truth extended before me unexplored."

Newton was made a Knight by Queen Anne in 1705—some say as a direct reward for the publication of his renowned "Treatise on Optics". He never married and much of the wealth which came to him in his later years he gave away in the form of presents to friends, acquaintances, and, aye, to the merest beggars.

"How have you managed to make so many discoveries," is a question which was once put to Newton. "By always thinking about the subjects," was the simple reply, an answer which, in all truth, gives the key to the workings of the philosopher's mind.

Newton's Many Laws

The mechanical and constructional world of to-day could not possibly have developed without Newton's many laws and principles of force, energy, action at a distance, light, gravitation and mathematics.

In Newton, the work of Galileo which had been so greatly decried by ecclesiastical "authority," found its fructification. When Newton died, mankind no longer believed that the sun revolved around the earth. The dead hand of Aristotle which had held men in bondage for so many centuries had been forcibly raised. A new spirit of science and of discovery had been let loose upon the world.

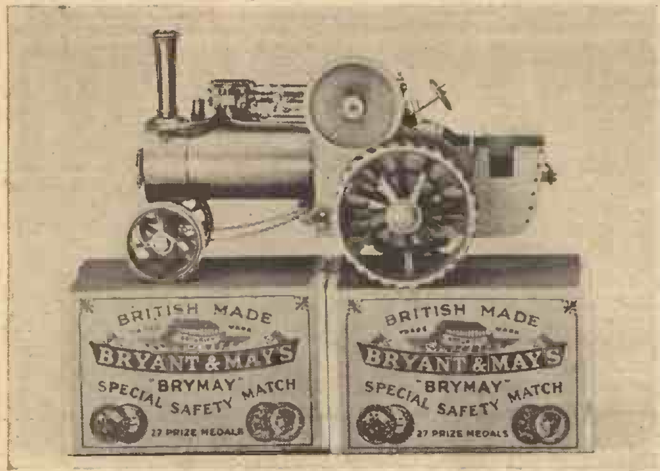
"Let mortals rejoice that there has existed such and so great an ornament of human nature," reads the concluding line of the inscription on Newton's tomb in Westminster Abbey. Yea, and let even modern scientists, too, of all classes, pause at times to render at least some measure of praise to Newton and to his pioneer work, for without the latter, science would have had very few enduring principles upon which to build its edifice.

THE NEW "STREAMLINERS"

Messrs. Bassett-Lowke, Ltd., this season are featuring in their new locomotive range in gauge "O" all the latest streamline locomotives: L.M.S. the "Coronation Scot" and the "Duchess of Gloucester," L.N.E.R. the "Empire of India" and "Dominion of Canada," and these can be supplied either in clockwork or electric a.c. or d.c. at the standard price of 12 guineas, which is remarkably reasonable for locomotives hand made throughout, and beautifully finished.

This year Messrs. Bassett-Lowke have re-arranged their railway lists and in addition to their new edition Section "A" list out this October, price 6d., which covers all gauges, they are producing a booklet "GAUGE 'O' MODEL RAILWAYS" price 3d. devoted entirely to "O" gauge. Why not send for a copy.

The gauge "O" model "Coronation Scot."



Figs. 1 and 2.—(Left).—A miniature single cylinder traction engine. (Right) A copy of "Tit Bits" which measures $1\frac{3}{4}$ in. x $2\frac{1}{4}$ in.

IT'S A SMALL WORLD

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

"HOW tiny! Let me look at it!" Just the words which express most people's fascination for the miniature. It may be the interest they have in very small things made by human hands, or in viewing the magnified work of nature, invisible in its beautiful detail to the human eye except through the microscope.

I am chiefly concerned in the making of large things small, and I think the peaks in this art are approached as the amount of accurate detail in work of this kind is accomplished.

In Fig. 2 is shown what modern printers can do in reducing an ordinary issue of a weekly periodical to $1\frac{3}{4}$-in. x $2\frac{1}{4}$-in Each tiny page is readable and is an accurate miniature of the "real thing."

"Endeavour" Barque

The next model I have taken from my own collection of ships. It is the famous *Endeavour Barque* of Captain Cook, 1/1200th actual size, which makes it 1 inch long! The detail work on this small ship has been most accurately carried out. (See Fig, 7.)

Also by the same craftsman, Mr. George Sell of London, is the infinitesimal 3-masted sailing ship, shown in Fig. 3. It is only half an inch long, and square-rigged with human hair. It is the property of a keen connoisseur of models, Mr. Cyril Derry of London, and he carries it in his watch case (N.B.—the works having been removed!), and here it is shown compared with a penny.

Fig. 3.—A three masted sailing ship which is only $\frac{1}{2}$ in. long, installed in a watch case.

Fig. 4.—A steam plant for a motor boat.

Working Models

Now for something that works! Fig. 1 shows probably one of the most unique working models ever constructed—a model of a model!

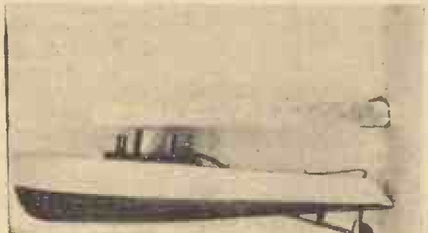
Some readers may remember that Mr. F. J. Camm described in this publication a year or so ago how to make a $\frac{3}{4}$-in. scale single cylinder traction engine from castings by Bassett-Lowke.

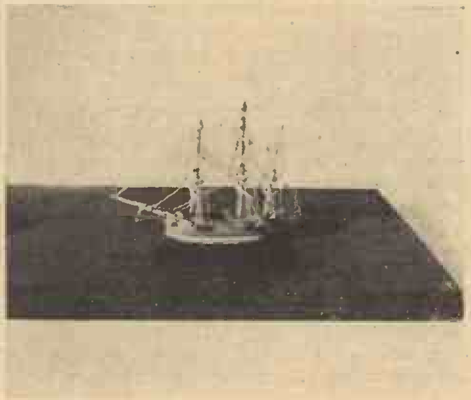
Mr. George Southby of Willesden has made a miniature model from this $\frac{3}{4}$-in. scale model, and here you see it mounted on four match boxes. Some details may not be amiss. The cylinder bore is only $\frac{5}{32}$nds and the stroke $\frac{3}{16}$-in. It has reversing gear and runs well forward or backward, and the steam cock is correctly made with taper plug, washer and nut. The steering gear is a working job, as also is the hand brake, and the engine can be thrown in or out of gear as desired. Mr. Southby runs the tractor on compressed air as steam is apt to spoil a tiny engine, and the most natural speed is 7 to 8 feet per minute.

Miniature Speed Boat

Fig. 6 shows a speed boat by the same careful model maker. This is only $8\frac{1}{2}$ inches long, and has a single acting slide valve engine, bore $\frac{5}{32}$-in., stroke $\frac{3}{16}$, which actually propels the boat along at 3 miles an hour.

Before we leave working models, let us





Figs. 5, 6, and 7.—(Left) Miniature deck fittings. (Above) A model speed boat which is only 8 in. long. (Right) A model of the famous 'Endeavour' Barque.

look at the working steam plant for a model motor boat shown in Fig. 4. Its size can be gauged from the match box, and it is fired with solid methylated spirit, runs for 3 minutes and has a working displacement lubricator!

"Queen Mary"

Modern show-case models of giant liners are full of small masterpieces of detail. You will see on the stern view of the *Queen Mary*, Fig. 5, a group of deck fittings to a scale of ¼-in. to the foot, which needed much care and thought on the model maker's part before they were produced.

Last but not least I would say that the interiors of ship models sometimes call for minute craftsmanship. Fig. 8 shows a portion of a dining saloon on a British liner, about 7 inches long and 1½ inches high. Each of the chairs, and there are over fifty of them made by hand, are scarcely an inch high. It is an interesting fact, too, to note that the small flowers in the vases on the tables, though only ⅛ in. long are real!

These pictures just show a few examples that have come to my notice recently, and I hope they may give you some idea of the exquisite work of miniature modelling.

Fig. 8.—A portion of a dining saloon on a British liner.

PETROL-DRIVEN MODEL AEROPLANES

By. C. E. B.

Fig. 1.—The writer's 8 ft. span simple type low-wing model.

LAST month we showed a land biplane with the engine installed. Its main dimensions are:

Span, 3 ft. 4½ in.; chord, 6⅞ in.; length, 3 ft. Its all-up weight is only 3 lb. It has a pleasantly flat glide after the power is off.

I do feel, however, that people who expect to obtain exactly the same ease of starting and coarse handling that larger engines will stand will never get the best out of the little fellows.

For anyone who is prepared to treat delicately, mixture, control, etc., the little fellows will give great satisfaction. In other words, although they are sufficiently robustly built to stand just as hard knocks, they are not so good for the hard-fisted man.

A very small biplane flying boat was also shown last month with a similar type hull to my large 8-ft. span record-holding flying boat. The glide is so flat that this little boat has made a number of landings on its hull over grass without any damage. The boat slithers over the grass on landing.

This is rather tempting Providence, however, and the boat is being put away until its water tests can be carried out. It ought to be mentioned that this little boat has detachable wings, tailplane fin and tail-boom. It packs up into a small bundle in a few seconds.

Large Models

Although I have made a considerable number of little petrol models that can be called satisfactory flying models, my last being a 3-ft. 6-in. low-wing model, I think I prefer the large model of about 8-ft. span. The little fellows are delightful to carry and pack up, but the big model flies more steadily and looks more purposeful in the air to me. I prefer its steadier and more floating type of glide. Large engines are, of course, easier to start as a rule, as they are naturally less temperamental and have a greater reserve of power. Nevertheless, I would not be without my little models. I also realise that the lure of producing a really tiny model is too great for many people. They so often fall for it as their first model. I shall always advise starting on the larger and easier model first where there is greater latitude for mistakes in weight paring and engine operation. Something between a 6-ft. and 8-ft. span. Having obtained experience on the larger model with an engine of 6 c.c. or 9 c.c., then comes the time for the little highly portable model.

The low-wing petrol model is often looked upon as a dangerous type of model that is likely to be unstable, and damage itself, and I have so often heard the absurd remark that low wings will not glide. Actually, properly designed low wings glide beautifully, both rubber and petrol models. It should be obvious that they are easier to get to glide after power is off than a high wing, because the thrust line can easily be arranged so that it passes through the centre of resistance of the main plane, and so does not tend to pull the nose up or down around the centre of resistance when the engine is firing. Stability on a low-wing model is quite easily obtained if a *really generous dihedral* is used, and the fuselage is built a bit longer than normal, so that the tail-plane and fin run the disturbed air as much as possible from the mainplane. The positioning of the thrust line is important. Also weight should be kept low. Fig. 1 shows an 8-ft. span tapered wing, low-wing model that I built almost entirely of balsa wood. The main spars in the wing are of ¼-in. by ⅛-in. spruce—all other spars are balsa. It can be seen that the wing is detachable and held up to a cut-away portion in the bottom of the fuselage by elastic bands to wire hooks that protrude from the fuselage side. These bands can be seen in the small black marks on the fuselage side in the photograph. The wing fixing is therefore hardly noticeable on this model and yet will give if it hits anything it should not. The wing itself has a nearly straight leading edge and the trailing edge brought forward to the tips to make the taper. This has been proved to be the most laterally stable type of tapered wing shape in full-size research. The wing is also made in two halves and is detachable in the centre for ease of carrying.

Tailplane and Fin

Both the tailplane and fin are detachable and also held on by rubber bands that scarcely show. The fuselage is made up of two sides of $\frac{1}{16}$-in. sheet balsa wood with longerons and uprights of ¼-in. by ¼-in. balsa. Cross pieces are then added and the top and bottom are then also covered with $\frac{1}{16}$-in. sheet balsa. A turtle decking is added, also made of sheet balsa with formers of balsa. A small cabin can be seen on top. This contains the time switch to control duration of flight. The main dimensions of this model are—Wing: 8-ft. span, 16-in. chord at root, 10-in. chord 10 in. from tips. Length overall: 5 ft. 4½ in. Tail: 3 ft. 4 in. span, chord 14 in. at roots, 7 in. at tips. Undercarriage track: 26½ in.

The engine is a 9 c.c. "Brown Junior" and is interesting because it is one of the very first engines of this make that came into this country several years ago. It has never been taken down for decarbonisation or repair. The only modification has been the fitting of platinum ignition points. A mixture of one part heavy motor-cycle oil to 3 parts petrol is always used. Although it is oily and throws oil about, the engine certainly has worn well and still has a hefty power output. I have flown this model on the new Ohlsson engine which is 9 c.c. and a beautiful engine. Its starting is a delight and its power output excellent. It also looks as if it will last.

I have described this low-wing model, as I think readers will be interested in it because the low-wing is a change from the almost universal high-wing model, and because it is such a stable model in every way.

It is a delightfully slow-flying model and its glide is pretty to watch.

AN IMPULSE STARTER FOR MODEL PETROL ENGINES

This device is quite simple to make although it involves a certain amount of lathe work

By W. H. DELLER

THE failure of model petrol motors to start readily arises, most frequently, from the necessity of having to prime the engine or to adjust the carburetter to provide a richer mixture in order to achieve the object.

In these conditions unless a start is immediately effected the engine rapidly "juices up." When this has happened it necessitates the drying out of the crankcase, etc., before operations can be recommenced. Apart from this the wet mixture thus produced tends to destroy the oil-seal between the piston and cylinder which considerably reduces the compression normally obtainable.

No Priming Necessary

Upon the assumption that the ignition system functions perfectly it should be possible to start the engine with certainty without prior priming and with the carburetter set at its correct running position. In order to accomplish this it is, however, necessary to cause the engine to turn momentarily at approximately running speed. While this may prove an easy matter, with the aid of a cord, where the engine is mounted in a boat, it is apparent that where the method of starting is via the prop. some other form of mechanical aid is required in order to impart the requisite speed to the crankshaft.

Where the engine provides the method of propulsion for a model aeroplane the device employed for the purpose under consideration needs to be of reasonably small dimensions and easily portable. The contrivance illustrated fulfils these requirements and has the advantage of being self-contained.

Constructional Details

As will be seen by reference to the sketch shown in half section, which by the way is reproduced approximately half full-size, the main part of the device is housed in a plain metal tube. This, in order to afford a better grip while the rubber is being wound up, may be knurled on the outside as indicated. The tube as shown is 1½ in. diameter x 1/16 in. walls, but no general dimensions are given as there is no reason why the starter should not be made from material that is to hand, in which case many of the leading dimensions will be governed by those of the tube employed.

The right-hand or rear cap is made from brass or mild steel. This is shouldered down to fit inside the tube, being secured by three screws passing through clearance holes into tapped ones in the cap. The centre hole is drilled and reamed to permit the hook-ended spindle to run freely in it and the mouth of the hole is counterbored to receive a special split thrust-washer. It will be noticed that this washer fits into a groove which is turned in the shaft before the hook is bent. The outer end of this shaft is provided with a square and thread to engage and secure the handle. Before bending the portion of the rod forming the hook it is tapered down as shown. The thrust washer is turned to fit the counterbore in the end cap and bored to clear the bottom of the groove in the shaft. To permit assembly the washer is cut across the centre line into two pieces. A washer and split pin on the inside of the cap prevents this assembly from coming adrift.

Some form of check action needs to be fitted to the winding spindle and the spring clutch shown provides a simple solution. A tail on the end of the spring is anchored by means of a small clip or saddle to the end plate.

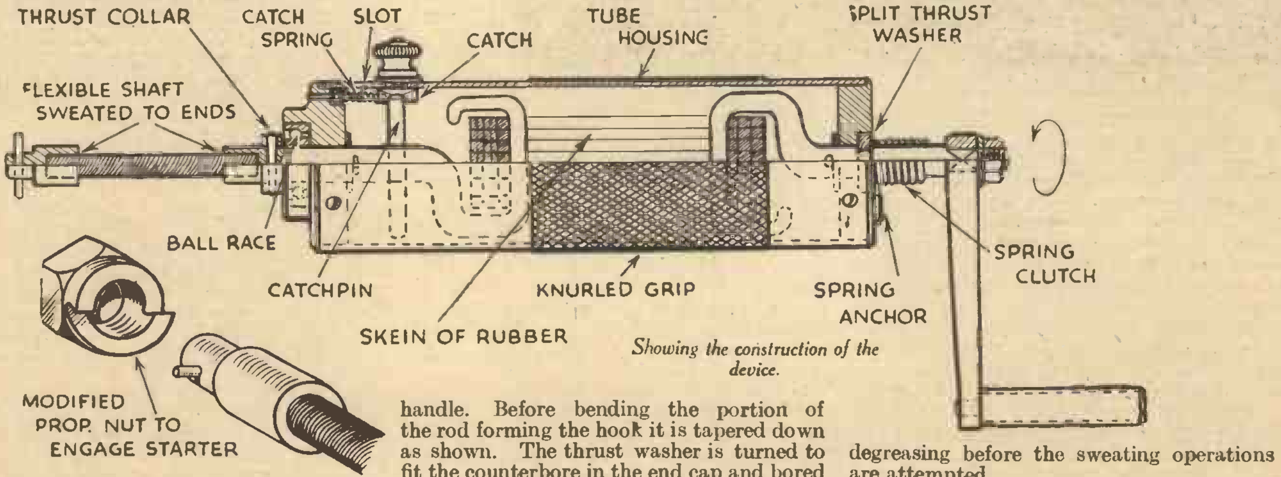
Front End Plate

The front end plate is bossed and bored to receive a small ball race. A thrust brace is really what is required although an ordinary race will serve for the purpose in this instance. At this end the hook ended shaft is similar to that at the opposite end, the difference being that a thrust collar is fitted by means of a pin to butt against the face of the inner race-ring and the front end drilled to receive the short flexible shaft. The front spindle is also drilled and reamed with a cross hole to take a 5/32 in. diameter silver steel pin tightly. This pin is intended to engage with a sliding catch which releases the driving force when required.

The Catch

A 3/16 in. slot cut longitudinally in the top of the tube forms a guide for the catch which is made from a 3/16 in. hexagon headed steel bolt. It is advisable to file a square on the underside of the bolt head to fit this slot. A terminal nut fitted over a plain washer on the shank of the bolt forms an operating knob. For the purpose of returning the catch to the back end of the slot it is backed up by a small spring. This is guided by a pin fitted into the bolt head tightly and guided in a clearance hole drilled, and counter-bored slightly to receive the spring, in the top of the cap. At the front end of the flexible shaft a shouldered thimble is fitted with a cross pin to engage with the dogs cut in the face of the modified prop. nut as shown in a separate sketch.

A piece of shaft from an old speedometer cable will provide the flexible shaft referred to. This will, however, require thoroughly degreasing before the sweating operations are attempted.



Showing the construction of the device.

Rubber Strands

A fair amount of rubber strand is required in the skein fitted over the hooks, but the actual amount will depend upon the size of the engine to be started. As drawn, the ends of the hooks are approximately two inches apart; the centres being made short purposely.

In use the rubber is wound up by making about half a dozen turns of the handle and after engaging the end of the starter in the dog-ended nut on the propeller the engine started by releasing the catch pin, by pushing the knob forward.

Although the device as described involves a certain amount of simple lathe work those who have not the facilities necessary and to whom it may appeal can make it in a less elaborate but at the same time perhaps more cumbersome form. The tube when omitted is replaced by a wooden base and the end caps by brackets attached to the base. The other fittings can, of course, follow the lines more or less of those described.

The Piano—A

MAURICE REEVE, THE FAMOUS P

MR. REEVE

Maurice Reeve.

IN commencing the study of any instrument we must distinguish between the musical and the mechanical, the practical and the theoretical, the artistic and the technical. The latter is nothing but the servant of the former, but if the whole is to function perfectly, the servant must be very efficient !

We have three mechanical sides to the question :—

(*a*) The score.
(*b*) The instrument.
(*c*) The fingers with which we play the instrument.

It is the last of these three points with which we are mainly concerned here, but an accurate knowledge of the score is absolutely essential, to the musician as well as the pianist.

It is the job of the fingers to be able to execute what the eye perceives on the paper, which is our present objective of study. All the finger dexterity in the world would be wasted if the markings and indications contained on any well-written and edited score were not under-tood. It is he thorough comprehension of these which makes the job of the fingers so difficult and their development to their maximum of efficiency so necessary. Therefore an explanation of all that a score contains must come first.

Some knowledge of the instrument we are using will also be necessary.

Every note is represented in two places, and must be sought in both, simultaneously, before the fingers can perform their ultimate task :—

(*a*) On the score.
(*b*) On the keyboard.

A third representation should be developed as soon as possible—the ability to hear notes in our minds before sounding them. The other two are inescapable for every single note we set ourselves to play. Therefore, we have to develop the faculty of finding them with lightning rapidity and unfailing accuracy firstly on the paper with the eye, and secondly on the keyboard with the fingers. A semiquaver played at allegro speed is a very minute fraction of time—there would be several to each second !—and this is what has to be accomplished if we wish to perform the feat successfully. When we open the pages of, say, a Beethoven Sonata, and contemplate the tens of thousands of notes each of which has to be played with exact correctness both as regards its pitch and its value, and then the whole work brought to life by the fingers giving it an interpretation and an artistic consciousness, it will be quickly realised that the task of the fingers in co-ordinating these various elements—the acquiring of a "technique" that will do justice to the music—is big indeed.

This treatise on the elements of pianoforte technique divides the whole study into its several parts with rather greater separateness than the majority of tutors. The object is to present in the clearest possible way the various "ingredients" both of a musical work and the technical equipment necessary to play it satisfactorily. These are followed by the advice on the acquiring of the technique with which we ultimately weld the parts into a satisfactory performance. The subject naturally divides itself into three main groups :—

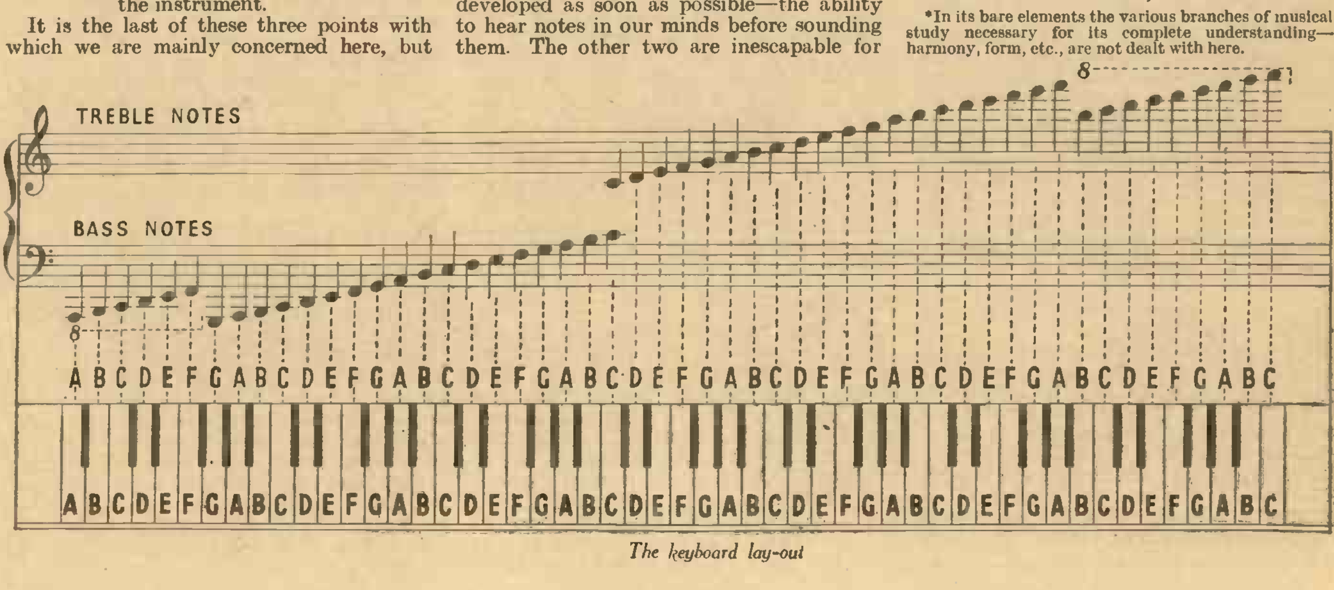
(1) Sound
(2) Time
(3) Technical development

which enables us to unite the elements making up a musical work. The principles underlining a musical and artistic rendering of a score will form the conclusion. Although first in practice, this last point must take back place for the moment as it is impossible to give life and meaning to the music until :—

(*a*) We understand how it is written*, and
(*b*) Until our fingers can carry out orders.

The student, as a performer, is confronted with three tasks, all of which work

*In its bare elements the various branches of musical study necessary for its complete understanding—harmony, form, etc., are not dealt with here.



The keyboard lay-out

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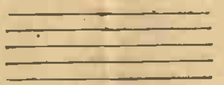
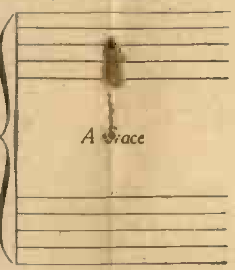
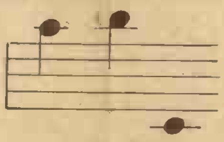


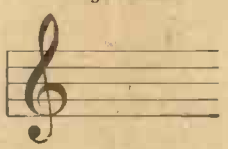
A stave



A brace



Ledger Lines



The G Clef

The F Clef

Middle C is the note which divides the two hands

An octave.

simultaneously in practice, but which must be very thoroughly understood as separate entities.

(1) Sound, which embraces the pitch of individual notes and the combination of various notes into intervals and chords, keys and key relationship, scale and arpeggio sequences, etc., etc.; everything, in fact, which is ultimately embraced in the words HARMONY and MELODY.

(2) Time, including rhythm, accent, phrase construction, which lead, eventually to the FORM and STYLE of the composition we play.

These two elements go equally to make up a musical work. They are one and indivisible, and must always be together in the student's mind during every note he reads.

These concern him as a musician, whether pianist or anything else. Solely as a pianist, however, it can be said without fear of exaggeration that the art of fingering, by which we mean the fingers we use for each note and the way we use them, is of such capital importance, that it can well be considered as the third element confronting us.

In it is bound up the entire business of learning how to play the piano. Without the most careful use and manipulation of the fingers we can neither give expression to our musical personalities through the works which we choose to play, nor can we even correctly execute the merest trivialities of the mechanical or constructional side of the art. It is by far the best plan to read this side of one's studies in with the rest, thus making a habit of correct fingering. After a short while, it ceases to worry us overmuch, our fingers move over the notes in front of us with ever increasing ease and accuracy, and our minds are thus left freer and freer to concentrate on the purely musical side of our studies.

Having decided to combine three elements into our reading, we will study them separately first.

Sound

Musical sounds are shown as *NOTES* written on a STAVE, the notes being placed both on and between the lines.

Almost all piano scores are written on two staves, one for each hand, joined by a *BRACE*.

Notes written off the stave are put on *LEDGER LINES*.

Before notes can be named we must fix *CLEFS*, which are the signs that determine the absolute pitch of the notes. Only two clefs concern the piano student, the G or treble and the F, or bass.

Middle C is the note which divides the two hands on the score and the first ledger line above the base clef and the first below the treble clef represent this note.

The hands can use either stave, as is most convenient.

The Names of the Notes

The white notes are seven in number, named A to G as in the alphabet and repeated over throughout the length of the keyboard, from left to right.

The black notes, in alternate groups of two and three, are also named after the same letters of the alphabet, but with the prefix of sharp ♯ or flat ♭.

Sharps and flats are used to raise or lower notes. The sharp raises it one semitone; the double sharp—×—, two semitones. The flat lowers it one semitone and the double flat ♭♭ two semitones.

The NATURAL, ♮ is used to lower by one semitone a note that has been previously sharpened, and, similarly, to raise to its natural pitch a note which has previously been flattened.

To make a double sharpened note into a single sharp it must revert to its natural state and be re-sharpened ♮♯, and similarly when flattened ♮♭.

The double natural, ♮♮ cancels a double sharp or double flat, that is, it restores them to their normal pitch.

Semi-tone.—One note to the next one—white or black.

Tone—One note to the NEXT BUT ONE.

It will now be seen that the keyboard divides itself into groups of TWELVE notes, seven white and five black. It is from these twelve notes that we get our keys, twelve major and twelve minor. From each note to the next of the same name is called an *OCTAVE*.

The last note of one octave is the first of the next. Thus from A to A is an octave and the one A is called the octave of the other.

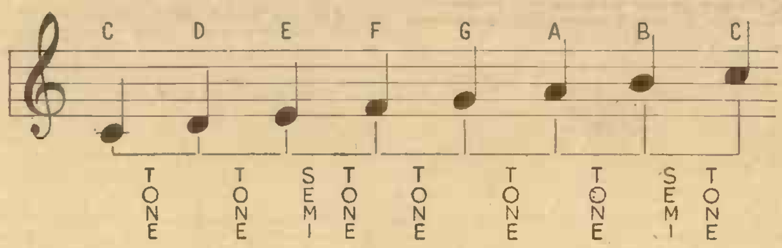
The Progression of the Notes

When we say that a piece is in such and such a key—C major or B minor—we mean that the piece is solely or mainly founded on the major or minor scale which starts from the note specified. There are only two modes but many keys.

SCALE.—Major (greater) as applied to intervals, chords and scales. The major scales—keys—are formed by the following sequence of intervals, commencing on any note :

Tone, tone, semitone, tone, tone, tone, semitone. Whatever note is started from gives its name to the scale or key.

Thus we get the key of C major. The same sequence of intervals, starting on G,



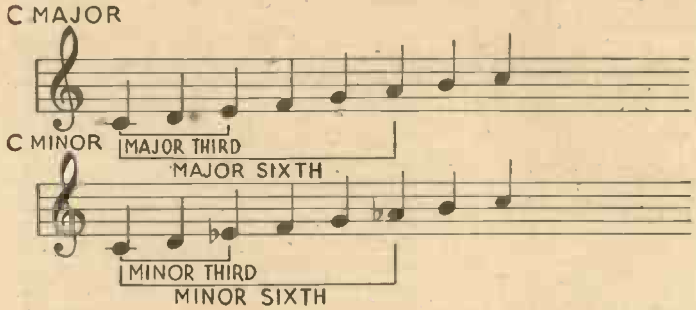
The major scales.

An enharmonic representation of C minor scale.

The relative minor of a major commences on the sixth note of the scale, the seventh note being changed by raising it one semitone.

BEETHOVEN'S INSTRUCTIONS TO CARL CZERNY FOR THE TEACHING OF HIS NEPHEW CARL VAN BEETHOVEN :—

. . . In regard to his playing for you. I beg that not until he has acquired a correct fingering and can play in time and can read the notes with reasonable correctness, you direct his attention to the matter of interpretation; and thereafter not to stop him because of trifling mistakes, but to point them out after he has finished the piece. Although I have given but few lessons I have always followed this method, it soon makes musicians which, at the least, is one of the first purposes of art, and gives the minimum of weariness to both master and pupil.



(Left) Two notes have to be changed to turn a major into its tonic minor scale, the third and the sixth, both being lowered one semitone.

results in the key of G, and when beginning on B flat, the key of B flat, etc.

MINOR (Smaller).—Takes its name from the smaller intervals between the first and third and the first and sixth notes.

Keys are related to each other and are said to be most closely related when there are fewest notes altered. Then the two nearest "relations" are a major and its relative minor, and any major and its dominant major, there being only one note altered: one note being sufficient completely to change the key or tonality.

The relative minor of a major commences on the sixth note of the scale. From that point, only the seventh note is changed, by raising it one semitone—sharpening. When the minor scale begins on the *same note* as any given major scale, it is referred to as the TONIC minor—tonic being the name given in harmony to the *first* note of any scale.

It will be seen that two notes have to be changed to turn a major into its tonic minor scale, the third and the sixth, both being lowered one semitone—flattened.

Melodic Minor

The harmonic minor, with its augmented second, was found to be a drawback, consequently the melodic variety was invented, with its adherence to tones and semitones. But it introduces a further element inasmuch as it gives a different notation descending from that ascending.

This gives us, ascending, a sequence the same, with the one exception of the third note, as the *tonic* major, A; and, descending, it is *identical* to the *relative* major, C. It is a very beautiful mode, and either the ascending or the descending sequence can be used on its own. These are known as the DIATONIC scales—scales in which TONES predominate.

ARPEGGIOS are formed from the chords of the major and minor keys with the notes played separately.

They consist of the 1st, 3rd, 5th and 8th, or 1st repeated, notes of the scale—the same in both major and minor: and are

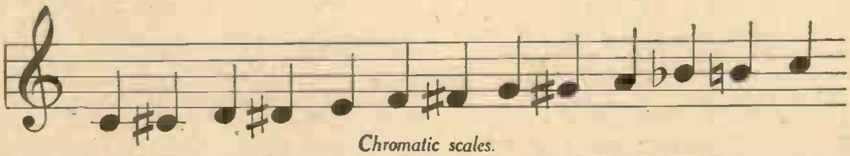
A different notation descending from that ascending.

How arpeggios are formed.

then said to be in the *ROOT* position.

CHROMATIC scales are formed by progressing in semitones, or, in other words, using all the notes one after the other.

The sharps and flats placed at the beginning of a stave are called the *KEY SIGNATURE.* Those occurring during the course of a score, *ACCIDENTALS.*—An accidental lasts for the duration of a bar only; if not cancelled before, the bar line automatically does so.



Chromatic scales.

Time

Note Values and Rests.—As well as having a sound, or pitch, a note must possess a definite value. Thus the two elements, heretofore mentioned, are inextricably linked and should never be read one at a time, as is so frequently done.

Next to each note is its equivalent in RESTS. The value of each succeeding note or rest is one half of the preceeding one.

Quavers and smaller fractions are also grouped together.

A dot by the side of a note or rest ♩. 𝄾· increases its value by one half.

Although note values are based on the rule of "twice one make two," this rule is not immutable, and for the purposes of variety in both rhythm and expression, three, or any odd number of notes can be played to the same value. But this is always notified thus :—

Three, or any odd number of notes, can be played to the same value for purposes of rhythm.

Diagram of rule for counting note values:—

- semibreve.
- minim—one half.
- crotchet—quarter of semibreve, half of minim.
- quaver—one eighth.
- semiquaver—one sixteenth.
- demisemiquaver—one thirty-second.
- semidemisemiquaver—one sixty-fourth.

There are larger and smaller fractions in the same ratio.

Rhythm

For the purposes of giving form, balance and coherence to a musical work, it has to be given a rhythm—the division of the score into bars and a fixed value to each bar,

Dividing the score into bars.

together with accenting, phrasing and grouping of the notes and bars must be understood. There are three kinds of time—duple, quadruple and triple. Each of these can be both simple and compound.

The numbers at the commencement of a work are known as the "time signature," and denote the time and rhythm in which the piece is to be played. The lower figure tells the kind of note and the upper the number of those notes there are in each bar.

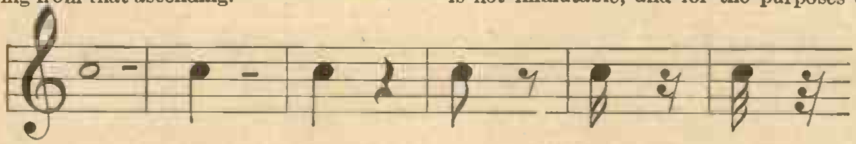
Four is a crotchet, one-fourth of a semibreve—a whole note. Duple time has two beats in a bar. Quadruple—"common time"—four beats. Triple, three beats.

Phrasing—Refers to the proper articulation and accentuation of musical thoughts (of periods and their sub-divisions, phases, sections, etc.); it is in music what stops and the raising and lowering of the voice are in speaking and reading, and accents are vital parts in a complete interpretation of a piece of music. The student should cultivate the habit of reading their various markings on the score as he goes along through a piece, rather than try to add them in after having read the notes first.

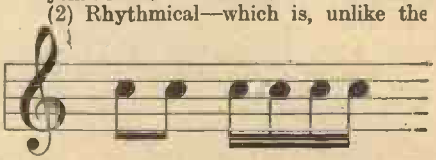
There are three kinds of accent :—

(1) Metrical—giving regularly recurring emphasis—such as the well-known rhythm of a Valse or March.

(2) Rhythmical—which is, unlike the



Semibreve. Minim. Crotchet. Quaver. Semiquaver. Demisemiquaver.



Quavers and smaller fractions grouped together.

Metrical, unfettered, and embraces whole sentences and periods. In short, the words "metrical" and "rhythmical" are used to distinguish the fixed, mechanical bar-accent, from the free, poetic motive-accent.

(3) Pathetic.—Is not dictated by rule, as 1, or intelligence, as 2, but by both *combined* with taste, feeling and imagination.

Having thoroughly mastered those portions of the rudiments and theory of music necessary for the perfect understanding of a score, we can approach the main part of our studies with far greater assurance and composure than would otherwise have been the case—the training of the fingers properly to execute the score and then satisfactorily present the work for hearing. Upon the ability of the fingers to :—

(*a*) Play every note without the least faltering or possibility of striking a wrong one;

(*b*) To give every note its exact value, *i.e.*, to pass from note to note within the specified measure of crotchet, quaver, etc., thus assuring the perfect rhythm and balance of the piece; and

(*c*) To infuse the whole performance with poetic and artistic feeling, light and shade, variety of tone colour, the correct tempi, etc., etc.

depends the measure of your success as a pianist.

Technique

The absolute foundation of pianoforte technique, and the primary ingredient, first, last, and all the time, is the ability of the fingers to make a perfect join between every two notes. This can be said without any fear of contradiction, although many other ingedients are necessary in order to do poetic justice to the music we set out to play. But correct finger work is the root, or the soil, from which all the other products spring.

Two things are necessary—both of them much more easily said than done ! Firstly, we have to bring the five extremely unequal fingers into line. Their great inequalities of length, strength and dexterity must be levelled up as far as possible. And, secondly, they must be trained to proceed from note to note by their own unaided effort (I refer, of course, to legato passages of single or double notes). When variety of expression calls for different qualities of tone and touch, an extension of one's studies to cover these phases of technique becomes necessary. But legato fingerwork, in all shades of tone, still remains the first requisite of good piano playing.

This discussion only concerns the production of a pure finger action, from which the higher, and later, branches of piano technique can grow, at a more or less even grade of tone. The development of tone colour—the ability of the fingers to produce various shades of loud or soft tone for giving variety of expression to the music, depends on the weight with which one strikes the keys, and the height from which one strikes them, too. Also the co-operation of wrist and arm. But this is only referred to here more as information and cannot be entered into at any length.

But even from the earliest stage, an examination of "what happens inside" the piano when one plays a note should be made. The chain of causes from the moment one presses a note down in order to produce sound, to the production of the sound itself, is an important item to get to know. The touch of pianos varies tremendously according to their size and age, and it might take fifteen or twenty times the weight to produce a given tone quality on one instrument than it does on another. It is always a great handicap to a player, on frequently finding himself at different instruments, to have to adjust his technical equipment to the needs of the moment—unlike a violinist, who, presumably, always carries his own instrument about with him.

This slight digression will serve to emphasise the importance of the instrument and its action on the player's fingerwork and the results his fingers produce.

After the first note of a sequence has been struck, three acts should be simultaneously performed at every subsequent note in the sequence :—

(*a*) The note is struck, and sustained.

(*b*) The finger that is to play the note after that is raised from the knuckle to its highest extent, in preparation for the playing of that note, and

(*c*) The *previous* note is released and that finger, also, raised to its highest extent.

The player's position at the piano must necessarily vary considerably according to his or her physique, age, etc. But it can be laid down that a short to average person should sit well into the keyboard with the weight of their body thrown forward to give the maximum control and power to the fingers and arms. The seat should be of a height to enable the forearm and wrists to be absolutely parallel with the ground.

With taller persons the length of their arms and legs will compel them to sit farther away from the instrument without their losing any control of their manipulation of it; there is no need to feel uncomfortable in any way, and on no account should the legs feel cramped or hampered in their usage of the pedals.

This is the correct way to practise, and to gain the maximum of finger dexterity, and response to the most exacting music. Naturally, it only produces one kind of result. As many results are required during the performance of a piece, this action is being constantly varied and adapted to ever-changing needs. But after training on these lines plus speciality exercises, the hands become readily adaptable to these demands.

In raising the fingers in this manner, all stiffening in the wrists and arms must be most carefully avoided. Some stiffening, or tiring, is unavoidable for some time. This is counteracted by frequent pauses for relaxation *without releasing the note being played at the moment.*

Advantage should be taken, on all notes of long value, tied notes, pauses, etc., of letting the hand and arm completely relax by sinking into the note—only for a brief moment, as the preparation for the next note must not be delayed too long.

The observance of rests, too, is not only of the greatest importance æsthetically; but as further "breathing spaces," or chances for relaxation.

Although speciality exercises are necessary for the different phases of technique called upon by all work of imagination and musical value—staccato, double notes, octaves, *non*-legato passages, chords, martellato, etc., etc.; by far the finest exercises for all general purposes are the major and minor scales and their arpeggios. They are also very easily adaptable to several of the aforementioned technical requirements. Furthermore, they are invaluable as ear training and for a development of a sense of key distinction—such a necessary item of one's equipment. And, lastly, their fingering forms the basis for the fingering of all scale and arpeggio note sequences in piano music—surely a fair proportion of the whole of one's task as a pianist !

If all scales are practised with "C major" fingering, they form exercises of the highest standard and greatest value. In fact, they make of the piano a veritable gymnasium for the fingers !

DUPLE TIME

SIMPLE	COMPOUND
2/2 = TWO MINIMS IN A BAR	6/4 = TWO DOTTED MINIMS OR SIX CROTCHETS
2/4 = TWO CROTCHETS IN A BAR	6/8 = TWO DOTTED CROTCHETS OR SIX QUAVERS
2/8 = TWO QUAVERS IN A BAR	6/16 = TWO DOTTED QUAVERS OR SIX SEMIQUAVERS

QUADRUPLE TIME

4/4 OR C = FOUR CROTCHETS IN A BAR	12/8 = FOUR DOTTED CROTCHETS OR TWELVE QUAVERS

TRIPLE TIME

3/2 = THREE MINIMS IN A BAR	9/4 = THREE DOTTED MINIMS IN A BAR
3/4 = THREE CROTCHETS IN A BAR	9/8 = THREE DOTTED CROTCHETS IN A BAR
3/8 = THREE QUAVERS IN A BAR	9/16 = THREE DOTTED QUAVERS IN A BAR

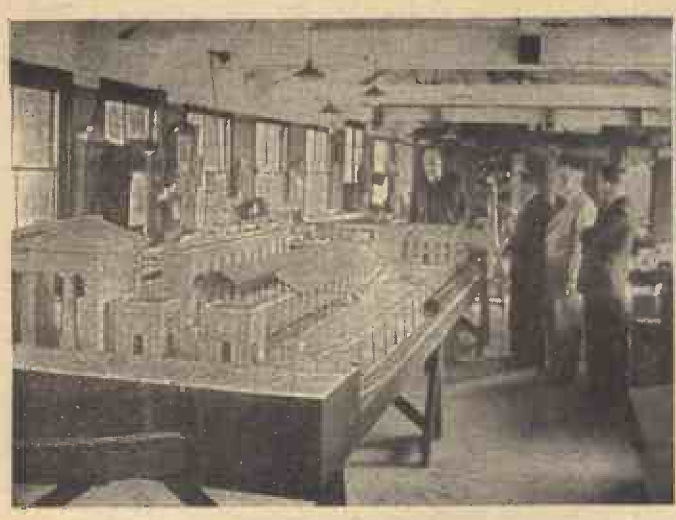
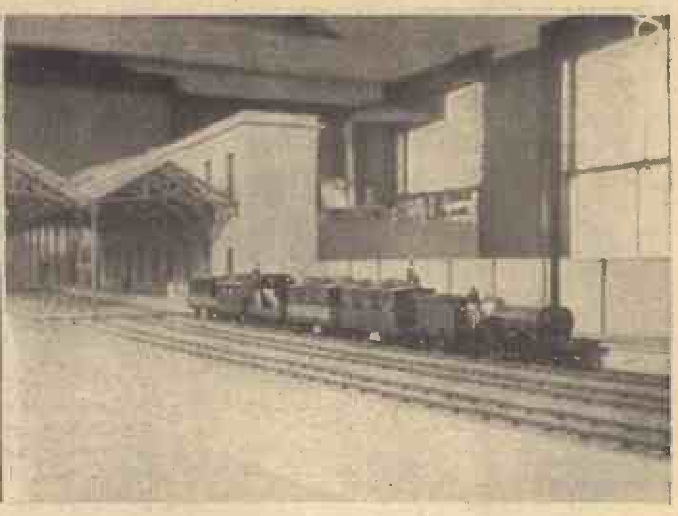
The construction of scales is dealt with under "sound."

Positions of the Hands

The hand should be placed with the thumb well over the keys. This gives greatest poise and balance, and, consequently the maximum freedom and agility—responsiveness of the fingers. It is most important that the thumb should at all times be well over the keyboard and ready for instant use. In addition to the reasons mentioned above, its use may be indispensable in all intervals or chords of a span of five notes and over, and, in single note sequences, it is our sole means of "climbing" up and down the keyboard and maintaining that continuous legato—joining of the notes—emphasised elsewhere, instead of having to proceed by means of kangaroo hops and leaps !

It is a good plan, when placing the hands on the keyboard preparatory to playing, to imagine the keys to be loose and that you are going to pick them up like money off a counter or counters off a table. You wouldn't try to pick your change up with four fingers, leaving the thumb a lone spectator, doing nothing. The tips of all five fingers would touch the surface and "close in" over whatever money or counters happened to be there.

(*to be continued*)

(Left). The model of Euston showing the modern train in the foreground, nearing completion. (Right). Model of the original train leaving Euston Station.

EUSTON STATION 100 YEARS AGO

E. W. Twining

Details Of A Model Which Was A Prominent Feature Of The L.M.S.'s Exhibition Recently Held At Euston

AS most readers will be aware this year of 1938 marks the Centenary of the opening of the first long-distance main line railway, namely that between London and Birmingham. The station which formed the metropolitan terminus of the line was completed in time for the departure of the first through train on September 17th, 1838. To mark this Centenary the successors to the London and Birmingham Company, later the London and North Western Railway and now the London, Midland and Scottish, celebrated the occasion by holding an exhibition at Euston. A portion of this exhibition was centred in the shareholders' meeting room beyond the Great Hall. It was opened by Lord Stamp on Monday the 19th of September and continued for the inspection of the public until Sunday the 25th.

A prominent and picturesque item, which served perhaps as the principal centre of interest, was a model of Euston Station as it was one hundred years ago. This model provides an excellent example of the craftsmanship of two well-known Companies of model makers who associated themselves in fulfilling in a most excellent manner the requirements of Mr. G. H. Loftus Allen, chief of the Publicity Department of the L.M.S.R. The model consists of two portions, one representing the year 1838 and the other this year of grace 1938. The historical section is the work of Twining Models Ltd., whilst the present day is represented by a splendid example of the products of Bassett-Lowke Ltd.

Various Sections

Dealing with the sections of the model in chronological order, the model shows at the left-hand end, to a scale of ¼ in. to 1 foot, the world famous Doric Portico flanked by three of the four lodges with their entrance gates between them. The accompanying photographs will show that Euston originally had two comparatively short bays in the roof covering the arrival and departure platforms, and that one side of one of the bays was supported by the building which contained booking offices and waiting rooms.

The platforms extended to a considerable length beyond the station roof and near the departure platform is modelled an exact replica of the London and Birmingham train as shown in Osborne's original map of the railway. This train consists of a Bury 2-2-0 type locomotive with inside bar frames, 5 ft. 6 ins. driving-wheels and a boiler having a domed firebox covered with copper cleading. Behind the tender there is shown two first-class carriages, then a carriage truck carrying a road vehicle, which was of a new type one hundred years ago, and was known as a brougham, then a second-class open carriage and lastly the mail coach, which also carried first-class passengers.

At the right-hand end of the model there is an overbridge, since removed, with Wriothesley Street crossing it. Between the station and the retaining wall of the approach to the bridge is the carriage shed where coaches were stored and also repaired.

A Feature

The feature about the model which perhaps more than anything gives it interest and life is the large number of model human figures, nearly one hundred in all, in correct costume of the period. The brilliant colouring of some of the ladies' dresses adds greatly to the picturesque effect. The engine driver and fireman are posed on the engine and tender and brakesmen are riding in the seats provided for them upon the roofs of the carriages. All the coaches have a reasonable complement of passengers, many of them looking interestedly out of the windows. The charming feature of these little "people" is that they are all apparently doing something with a definite object in life and have not the appearance of being mere dummies.

Some difficulty was experienced in discovering the correct colours for the coaches, but it was finally found that one hundred years ago some of the first-class carriages had their lower panels painted green of a similar shade to the lagging of the boilers and tenders of the engines. Other coaches were red as were also the mail coaches, whilst the second-class "opens" were all varnished oak. Besides the brougham on the carriage truck, which has yellow panels, there is another on the approach road with a dapple grey horse in the shafts. This gentleman's carriage has panels of blue.

The permanent way, upon which the old train stands, is almost exactly a facsimile in miniature of the original. The rails are of a light pattern carried in chairs without wooden keys. These chairs are spiked down to imitation stone sleepers arranged diamond fashion.

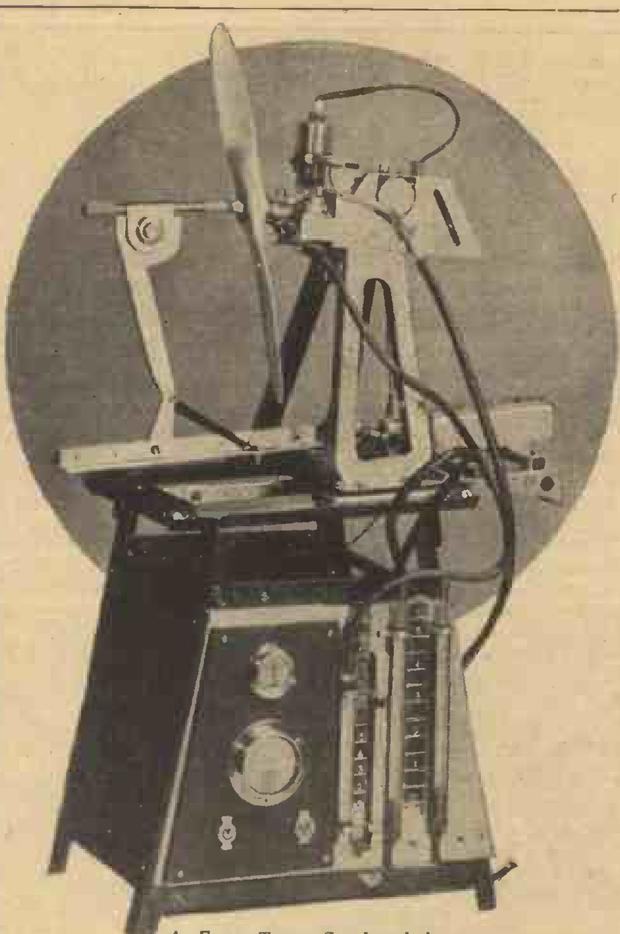
Modern Equipment

Turning our attention to the modern equipment, the track is of full weight bullhead rail on wooden sleepers properly ballasted and laid upon a shelf forming an integral part of the model at a considerably lower level. At each end there is a correctly shaped eliptical arch with a tunnel front in blue brick and between the tunnel fronts is a long retaining wall with buttresses. The train which runs upon this is made up of six coaches hauled by a "Royal Scot" locomotive and represents a typical express which performs the journey between Euston and Birmingham in under two hours. Near the entrance to the tunnel at the right-hand end is a signal of the two colour trafficlight type.

In addition to the model of Euston Station there was an excellent display of other models in the same room including a 1 inch to the foot model of the "Princess Royal" made by Messrs. Bassett-Lowke Ltd., for the Johannesburg Exhibition, and also two 1 inch to the foot scale model coaches with a portion of the roof removed showing the interior—one a first-class kitchen car and the other a first-class dining car. These were also the work of Bassett-Lowke Ltd., and attracted much attention from connoisseurs of good scale models.

MODEL AERO TOPICS

Current News from the World of Model Aviation

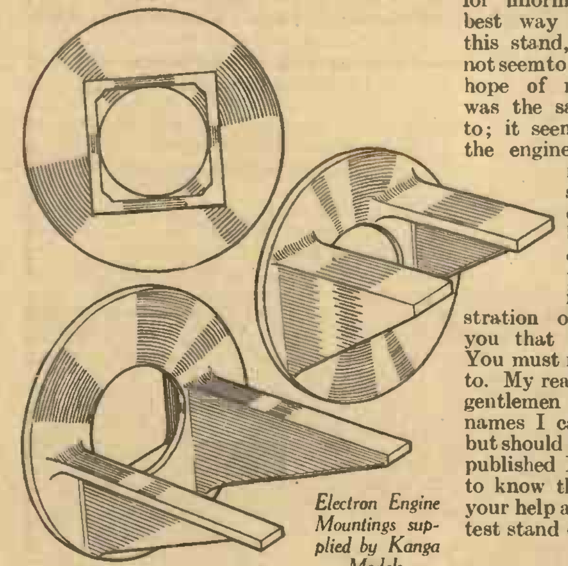


An Engine Testing Stand made by Mr. A. E. Browne.

An Engine Testing Plant

THE design of model petrol engines is showing rapid progress. The somewhat temperamental nature of these small engines is aggravated as the cubic capacity gets smaller, and now that we are down to 3 c.c., 2 c.c., and 1 c.c., the chief problem is to get the engines to start. Most of them have not a wide range of speed. None of them have tick-over, and hence a fairly high crankshaft speed is necessary in order to start them. To get over this difficulty, several torque starters have been put on the market, and elsewhere in this issue we explain how to make one.

Many of the engines which have been designed have been produced by hit and miss methods, but I am glad to know that many firms are now treating the matter seriously, and are installing testing plants so that they can analyse results. One of my readers, Mr. A. E. Browne, of Chiswick, has made an ingenious engine testing stand. He writes : "The stand was built to test small petrol engines and props from 6 c.c. to 10 c.c. It gives a recording for static thrust, engine temperature at different speeds, carb. suction, exhaust back pressure,



Electron Engine Mountings supplied by Kanga Models.

amps. consumed on starting and running, speed r.p.m. is recorded on a speed indicator and rechecked on a Hasler time and r.p.m. clock. The following may interest you. On the tests of a Baby Cyclone engine, fitted with a prop supplied by the Cyclone people, one hour test gave the following :—

2½ lb. thrust at 4,650 revs.; engine temp., 65 degrees cent.; ¼ amp. consumed at above speed, 4½ amp. to start; back pressure, 1 ounce, 1 gram, which, according to information I have secured suggests wrongly designed exhaust pipe; carb. suction is 1 oz. 1½ grams. I have tried a larger and smaller air intake to get greater speed, but find that the one supplied is best. 4,670 is the highest speed I have had from this engine, which has run on and off for about 16 hours. I don't mind saying that this engine has been put through its paces. I have not treated it at all gently, rev'ing from 400 revs. up and down flat out. I must say here that I used only Valvoline oil. I tried another well-known brand which conformed to the SAE 70 degrees specification, but found the engine temperature going up. So I got in touch with the Valvoline Co. and they supplied me with some Valvoline SAE.70, as specified by the engine makers. I ran the engine in with 3 parts Shell, 1 part Valvoline, but I got best results from 5 parts Shell, 1 part Valvoline.

You will remember me writing to you last year for information on the best way to construct this stand, but you did not seem to hold out much hope of me being able to do it. It was the same with other people I wrote to; it seems to me that they just stick the engine in a vice and as long as it runs it's O.K., but they don't seem to find out what the engine can do. I am not a technician by any means, but I thought it could be done and you see for yourself the results. My idea is to use this stand for the demonstration of model engines. I may tell you that the cost has been very high. You must remember I had no data to work to. My readings have been checked by two gentlemen in the aircraft world whose names I cannot repeat here, but should this information be published I should like them to know that it was through your help and advice that this test stand came to be built."

Engine Mountings

LIGHT engine mountings in electron are made in two sizes and supplied by Kanga Models, Ltd., 1, Colonnade Passage, New Street, Birmingham. I show a sketch of them on this page. They are so designed that the engine will knock off in the event of a crash. There is a spigot behind the mounting which fits into a hole cut in the first bulkhead of the fuselage. As supplied they are rough castings and need to be cleaned up, and a file is all that is necessary for this purpose.

Records Passed

C. W. Needham (O1P1 hand-launched), 71.4 sec.

P. M. H. Lewis (R.O.W. Flying Boat), 33 sec.

A. C. Minion (Biplane R.O.G.), 4 min. 57 sec.

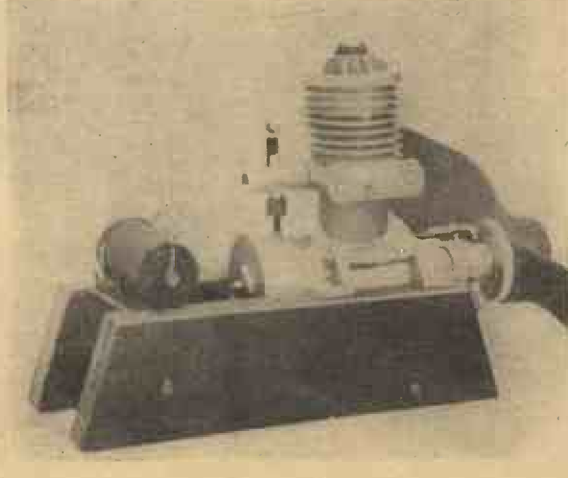
A. B. Rainey (Ornithopter hand-launched), 20 sec.

C. W. Needham (O1P1), 1 min. 26.2 sec.

C. W. Needham (O1P1), 1 min. 27.25 sec.

1939 Wakefield Competition

THE S.M.A.E. have decided that alterations will not be made to the rules for next year's Wakefield Competition, but that



The Hallam 10 c.c. Engine.

alterations and amendments to the organisation side will be discussed.

Results of the Biplane Cup

	Average Sec.	Plugge Pts.
1. H. Holbrook (Lancs.) ...	135.73	67
2. C. S. Rushbrooke (Lancs.)	133.16	66
3. A. Tindall (Lancs.) ...	132.33	65
4. H. Jones (Dartford) ...	124.83	64
5. R.A.H.Johnson (Halifax)	116.66	63
6. P. L. Smith (Lancs.) ...	100.16	62

Speed Contest Results

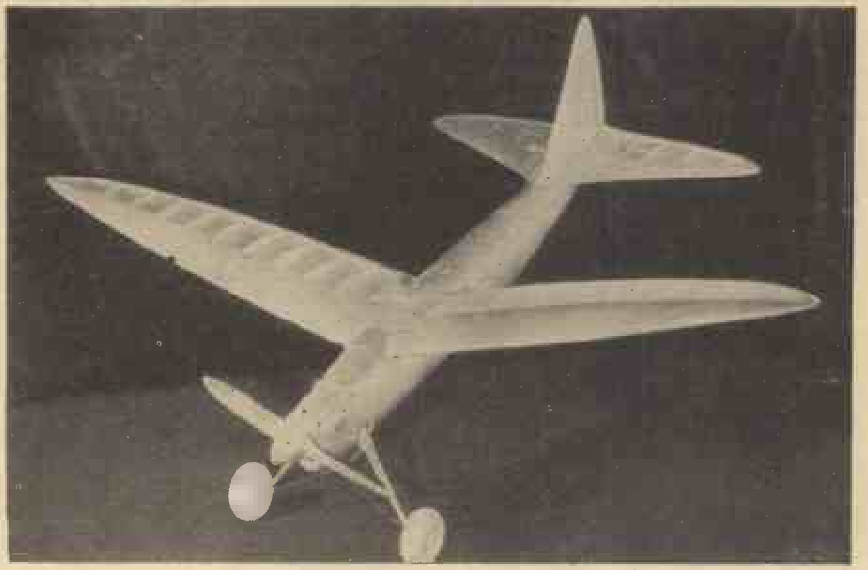
	M.p.h.
I. C. Lucas (Brighton)	34.375
R. Brown (Blackheath)	31.375
H. L. Rogers (Nthn. Heights)	Broken Motor.

There were only three entries.

Farrow Shield Result

	Points
1. Luton and District	804.5
2. Halifax M.A.C.	630.3
3. Bristol & W.M.A.C	606.4
4. Dartford M.F.C.	525.6
5. Lancs. M.A.S.	524.9
6. Birmingham M.A.C.	518.2

Another view of Mr. Wareham's model Hawker Hurricane—the first prize winner in our recent contest.



An attractive model made by The Model Aerodrome.

Bobbins for Elastic

MODEL aeroplanes were well represented at the recent Model Engineer Exhibition, and a great deal of the toil has been taken out of model making by the supply of correct fittings such as bearing, thrust washers, accurately cut wood, rib sections, etc. One of the troubles with elastic driven models has been the tendency for the elastic to climb round the hook, and if the hook is not of the closed variety the elastic when wound comes off and often does considerable damage, especially to balsa models. I noticed on one stand some small bobbins which enable the skein to be made up complete, and then to be dropped on to the hooks at the rear and propeller shaft.

There is a tendency amongst clubmen to adopt the plaiting system with elastic skeins. That is to say, the skein is made up twice the length between the hooks and it is then twisted and doubled and placed on the rear hook. The skein is then stretched whilst winding, and it is claimed that there is less risk of bunching of the rubber at each end of the skein and that more turns can be placed on it.

The Hallam 10 c.c. Engine

THE Hallam 10 c.c. ⅞ in. bore 1 in. stroke engine will meet the requirements of those who require ample power to lift model aeroplanes from 5 to 8 pounds in weight, and is obtainable complete ready to run, or in sets of castings with fully detailed print and materials.

The engine is 4¾ in. high, overall, 1¾ in. between bearers and 2¾ in. wide over side brackets, 5½ in. long from end of tank to propeller nut. The cylinder and crankcase are in one casting with transfer passage cored out. The ends are recessed into the crankcase and secured by 3 one-eighth through bolts and steel liner and cast iron piston are employed with gudgeon pin completely shrouded. The suction tank is machined from a casting and bolted direct to the rear end of crankcase. Exhaust manifold provides easy attachment for ½-in. exhaust pipe. The engine drives a 15 in. propeller 9 in. pitch, with blade area of 20 sq. in. and gives static thrust of 3½ lb. at 3,400 r.p.m.; maximum r.p.m. with flywheel 15,000.

The set of eleven castings, print, nuts screws and materials cost 17s. 6d. The major operation of boring the crankcase requires a lathe that will swing 3½ by 2 in. All other operations can be accomplished with a 2 in. centre. Boring and facing the crankcase costs 5s. The finished engine complete with propeller, coil condenser, on test stand costs £5.

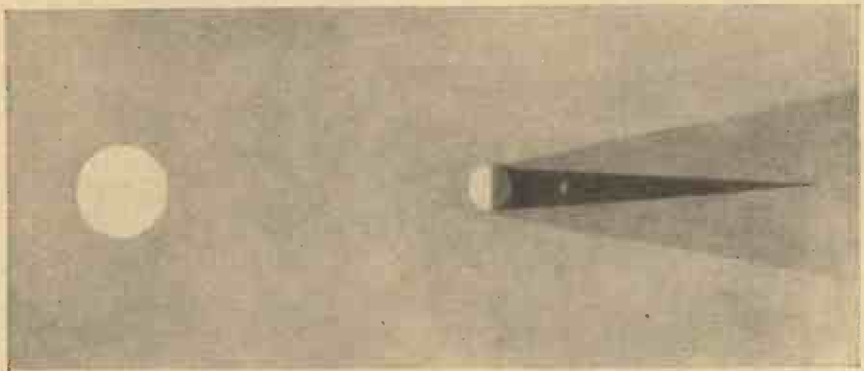
At our Model Hawker Hurricane Contest at Brooklands. The Judges, and an Inspection.

STARGAZING FOR AMATEURS

By N. de Nully

A GUIDE FOR NOV.

THERE will be a partial eclipse of the Sun on the 21st; but since it will not take place until about midnight (G.M.T.) it will not be visible from these islands. The maximum phase of the eclipse will be observable from Alaska. There will, however, be an even more striking spectacle to be seen from this country on the evening of the 7th, when the full Moon will be totally eclipsed by the shadow of the Earth. Our satellite will rise at sunset and begin to be slightly dimmed by the penumbra, or "false shade," at 7.39 p.m. At 8.41 p.m. the Moon will enter the umbra or true shadow and be entirely immersed by 9.45 p.m. Totality will last until 11.8 p.m., after which the eclipsing veil will commence to draw off and the disc will be clear again at twelve minutes past midnight. By 1.15 a.m. (morning of the 8th) even the faint penumbra will have disappeared and normal brilliancy have been restored. It is to be hoped that the weather will be fine.



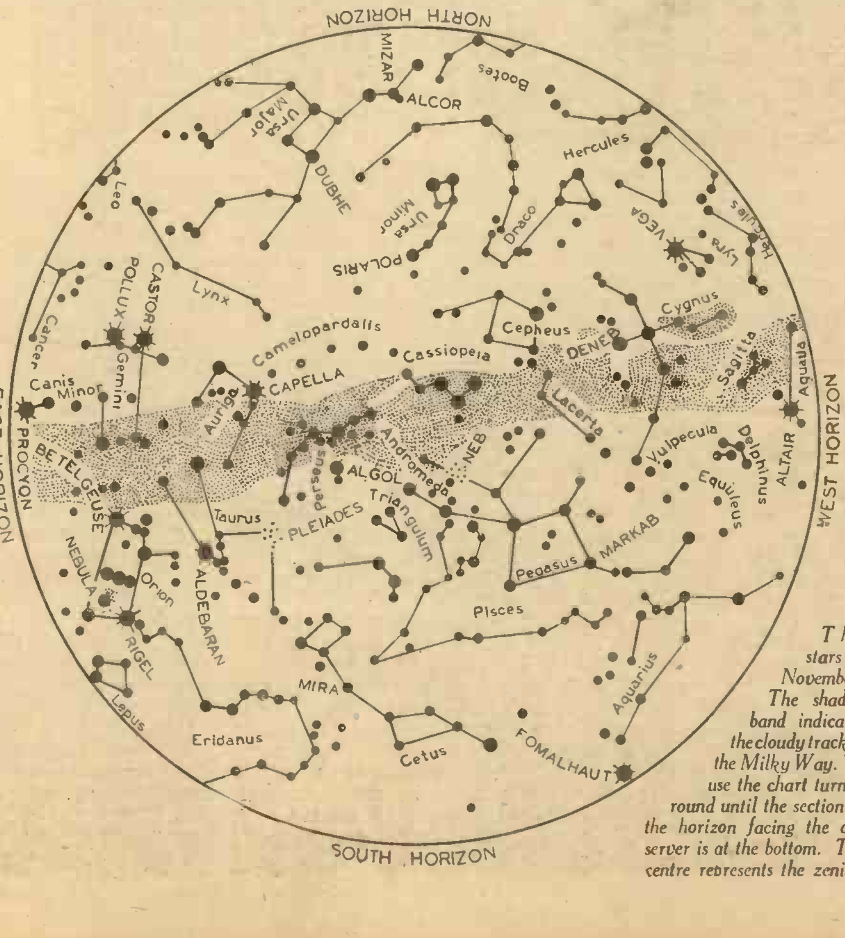
Diagrammatic drawing of a total lunar eclipse showing the moon passing through the earth's shadow. Note the fainter penumbra on each side of the earth.

Features of a Lunar Eclipse

A total eclipse of the Moon is one of the most weirdly impressive sights in Nature. The tint of the darkened disc is usually coppery; but the predominant hue depends upon the state of our atmosphere during the progress of the phenomenon. If the air is abnormally transparent, the colour may be almost blood-red. If loaded with dust, haze or heavy clouds, the tinge will probably be leaden-grey; and this has been known to be deep enough to blot out the Moon altogether! The usual dull illumination of the obscured disc, even during totality (except on the rare occasions of complete obliteration), is due to the glow from an immense ring of refracted sunlight that surrounds the black body of the interposing Earth as seen from the Moon. To Lunarians situated within the limits of the broad track of the Earth's shadow—if there are any such beings—the appearance presented will be that of a total eclipse of the Sun lasting for nearly an hour and a half; whereas the maximum length of such a spectacle viewed from our world can barely exceed seven minutes. In spite of this abnormal prolongation, the delicate solar corona would almost certainly be overpowered by the radiance of the rosy encircling terrestrial aureole. The length of a lunar eclipse is regulated by the width of the section of the umbra traversed. This varies according to the distance that our satellite may be from us and we ourselves from the Sun at the time. On the forthcoming occasion the passage will occupy an hour and twenty-three minutes, the maximum possible being about two hours and the minimum anything down to a grazing contact. This particular eclipse will commence in a darkening sky with the Moon well up in the south-east. A naked-eye view is perhaps the most impressive; but a binocular, or telescope using an eyepiece of sufficiently low power to include the whole face of the Moon, will enable the steady progress of the shadow to be more closely followed as it slowly creeps over craters, mountain ranges and vast plains. It is estimated that when the direct rays of the "midday" sun are cut off, the temperature on the Moon's surface drops from 250 degrees fahr. *above* to 180 degrees *below* freezing.

The Planets

Mercury will not be perceptible this month and Mars continues a "morning star." Venus is now less than 30 million miles distant, but is becoming increasingly difficult to discern as it drifts farther into the brighter regions of twilight. At present the planet sets at 5 o'clock but may be glimpsed with binoculars immediately after sunset during the first week of the month. It will be in "inferior conjunction," and at its closest to us as it passes between the Earth and the Sun on the 20th; though of course it will then be lost in the glare of daylight. Jupiter is low in the south and sets at midnight. Transits of one or other of its principal satellites may be found in progress at 7.15 p.m. on the 7th (the evening of the lunar eclipse), 18th, 29th and 30th. On the 29th, at the same hour, there will be but two "moons" visible through small telescopes; of the missing pair one will be on the disc and the other hidden in eclipse. Later on, at 8.41 p.m., there will be an apparent further reduction to a single "moon" for a couple of minutes. This rather exceptional minimum will be worth watching for if clouds are absent. The discovery of two more minute satellites is reported from Mt. Wilson Observatory, increasing the number to eleven. Saturn rises slightly before sunset and will be



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

fairly high in the south by about 10 o'clock, arriving at that aspect half an hour later each night. Its ring system is temporarily a trifle less open than a few weeks ago, but it is still an attractive object in instruments of adequate aperture.]

Once again there is a possibility of seeing some remnants of the long-lost famous November Leonid meteors, on the nights —or perhaps early mornings—of the 15th, 16th and 17th. The Moon will be absent so, if the sky is clear, at least a dozen or more celestial rockets should be forthcoming. Nevertheless, hopeful watchers must be prepared for disappointment. The radiant point in the constellation Leo (the Lion) will rise in the north-east shortly before 11 o'clock.

Among the stars in mid-evening (two hours earlier than indicated by the star chart) the little group Lyra (the Harp), embracing brilliant Vega, the quadruple star Epsilon Lyrae and the remarkable Ring Nebula, is high in the west. Overhead, the Milky Way arches the heavens, with the constellations Auriga, Perseus, Cassiopeia and Cygnus embedded in its pearly track. Due south, half-way between the horizon and the zenith, stands the Square of Pegasus linked to straggling Andromeda—celebrated for its great spiral nebula. Almost on the southern horizon shines the giant red sun, Fomalhaut, in Piscis Australis, while to the south-east glitters the beautiful Pleiades cluster, and the ruddy star, Aldebaran, on the verge of that more scattered group, the Hyades. In the east stately Orion, with its conspicuous "belt," and the brilliant star, Rigel, is coming into view. It will soon dominate the winter firmament, aided by flashing Sirius and Procyon in Canis Major and Canis Minor. All the foregoing features have already been described and illustrated in past numbers of this magazine. The information there given, as well as the series of twelve star charts (of which the one in this issue is the last) embracing the entire circuit of the heavens, will serve equally well for future years.

Notes

Experiments made in Germany tend to show that the ordinary form of Newtonian reflecting telescope, if used in conjunction with a "Barlow" lens, is more suitable for planetary photography than the Cassegrain type generally employed in the big observatories for that purpose. It is also stated that the best kind of camera lens for "snapping" shooting stars is one giving a field of 30 to 40 degrees in good focus, and of aperture ratio F/4.5, with focal lengths of from four to ten inches. Plates, not films, are recommended.

What is there between the stars? It has for long been supposed that the intervening void, though physically empty, is pervaded by a mysterious medium vaguely styled the "aether." But, for the past forty years, it has been becoming more and more evident that interstellar space contains a small, though negligible, quantity of such matter as ionized calcium, sodium, potassium, titanium and perhaps also dust. It is consequently thought probable that these impalpable particles may account for the faint luminosity of the sky even on the darkest nights.

Gold—And the Philosopher's Stone

The Quest of the Alchemists

THE Philosopher's Stone or "Grand Alkahest," as it was known, was that nebulous "something" which the alchemists were convinced would, once found, transmute the baser metals into the king of all metals, and make them rich beyond the dreams of avarice. Up to about thirty or forty years ago these old alchemical ideas and the weird formulae of such men as Paracelsus, Ramond Lully, and van Helmont were looked upon as childish and utterly futile delusions, but recent investigation and advances in science have proved that while the methods were all wrong, the basic idea was right for transmutation is not only possible, but has actually been accomplished. It is interesting to note, in passing, that not only has the old lure persisted, but some of the ancient phraseology has survived, for the origin of the quest was alleged to have been in Egypt, and under the instruction of the Egyptian god Thoth—or Hermes—and the ancient alchemists sealed crucibles, alembics and retorts with the seal of Hermes. To-day we speak of vessels or containers being "hermetically sealed," but we do not stop to think of the origin of the term.

The alchemical theory was that all natural substances were originally of one substance, and that the varied forms of nature existing were due to a multitude of influences acting on this substance in a myriad different ways. In view of the fact that the modern atomic theory is practically the same, we have a very interesting parallel. The idea is to obtain by purification, distillation, etc., the nearest possible approach to this original substance, or "prima materia," as they termed it, and then to treat it with the mysterious and elusive elixir or philosopher's stone, when, they believed, gold would take the place of the raw material. Much arduous labour and years of unremitting effort were spent in the search, while the two most favoured materials were mercury and sulphur, possibly because they were, visually, the nearest approach to silver and gold.

Right down to the time of van Helmont—who died in 1644—claims were made in all seriousness by students who really believed they had performed the great transmutation, but from that time until quite recent years the beliefs of alchemy were shelved with fairy tales and superstitions.

The Alchemists Were Right

Now, however, the dream of those old enthusiasts has come true, and transmutation is an accomplished fact, though not in the sense they looked for, because they strove with the idea of making large quantities of gold for gain, while the scientists of our day labour to effect the change for the purpose of obtaining more insight into the atomic theory of matter.

In the case of radio-active matter, transmutation is going on all the time, but this is Nature's own work and cannot be duplicated. Man has, nevertheless, transmuted several of the elements by artificial rearrangement of their atomic structure, and it is most intriguing to note that one of the latest successes—by M. Nagaoka, the Japanese physicist—is with mercury, just as the alchemists predicted; surely an amazing coincidence? Nagaoka's process is interesting and comparatively simple.

He simply passed a high-frequency spark, from an induction coil, across a gap with a tungsten wire at one side and a surface of mercury at the other, but the spark was four feet long and of enormous potential, which continued for some hours. To keep the terminal voltage high the mercury was covered by an oil film, and, at the conclusion of the process, the mercury and oil remained as a pasty, dough-like mass, which contained minute quantities of gold.

The "royal" metal has also been produced, accidentally, in mercury vapour lamps which have been run on too high a voltage, traces of gold being found in the black deposit formed in the lamps. Up to now no really sound reason has been advanced for this discovery. It almost seems as though, ere long, the transmutation of many more elements will be possible, but there is no call for us to get excited, as Nature has a way of ordaining that the processes necessary make the cost of production far greater than the intrinsic value of the material obtained.

It is only because of its relative scarcity that gold has value greater than other metals and if it were cheap some other rare and suitable basis of exchange would be forthcoming. In a sense this would be all to the good, for gold has many values apart from currency. Its amazing malleability enables foil to be produced as thin as .00001 mm. in thickness, while the fact that gold and oxygen cannot combine directly under any circumstances accounts for its being absolutely untarnishable.

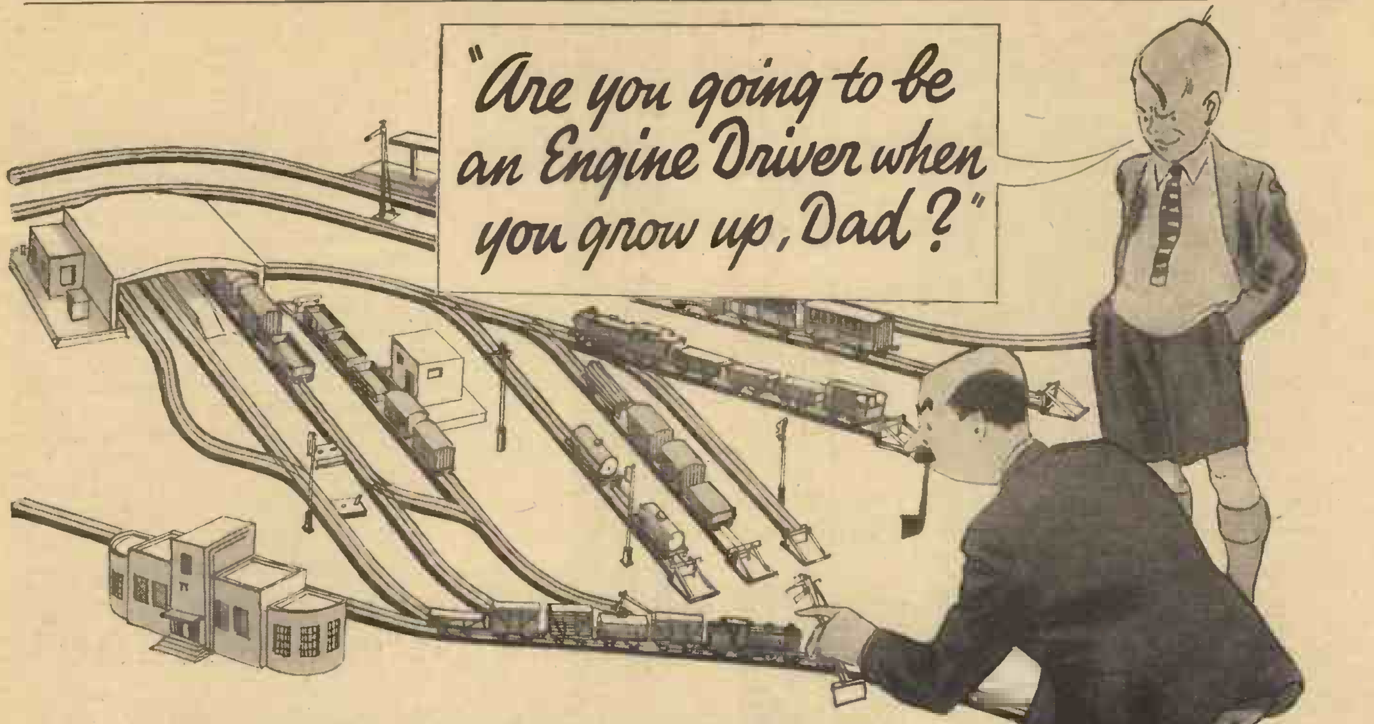
Jewellers' white-gold is gold with 25 per cent. of platinum, while 12 per cent. of palladium gives a still whiter alloy. Thirty or forty per cent. of silver gives green gold, a singularly beautiful metal, while 20 per cent. of that common metal, aluminium, gives an alloy of a superb purple colour, but it is, unfortunately, much too brittle for use in jewellery.

A World of Gold

It is not to alchemy or modern chemistry that we may look for the greatest potential gold mine, but to astronomy, for some very strange facts have come to light recently, which make it quite within the bounds of possibility that we have, close to us, a planet, or rather two planets, *made of solid gold*!

The neighbour in question is Eros, the little asteroid which, apart from our own moon, is our nearest celestial relative. For a long time this tiny body was regarded as one sphere, but has now been proved to consist of two, each eight miles in diameter, revolving once every five and a half hours and ten miles apart, but tied together by the invisible string of gravity.

Now, astronomy is able, by a simple formula, to estimate the mass of any heavenly body or bodies, and investigation shows that while the volume of the Earth is 500,000,000 times that of Eros, its mass is only 177,000,000 times as much. In other words, Eros is proportionately three times as heavy as Earth, though our planet is the heaviest of all others.



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"PRACTICAL MECHANICS" WIRELESS SUPPLEMENT

A 2½-WATT BATTERY-OPERATED AMPLIFIER

A Simple, Compact and Very Efficient Amplifier for Pick-Up and Microphone Work when Electricity Supplies are not Available

By "Experimenter"

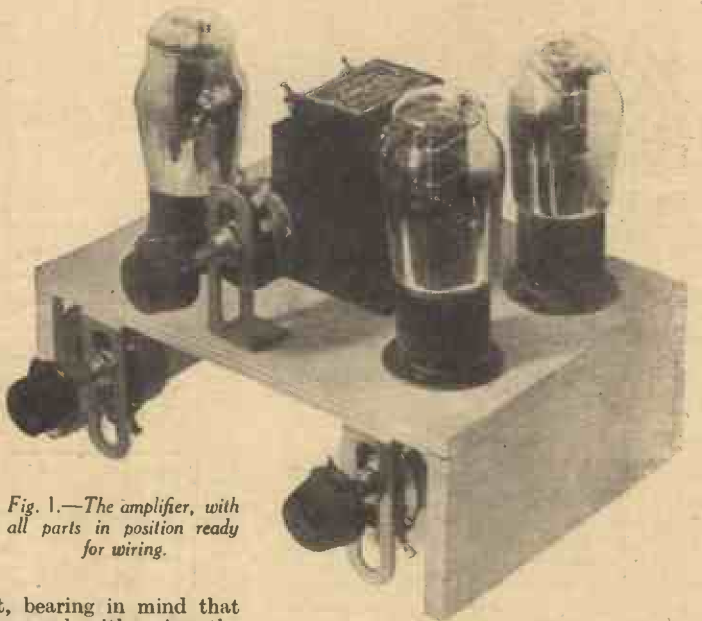


Fig. 1.—The amplifier, with all parts in position ready for wiring.

OWING to amplifiers being so often associated with high-power outputs, it has become common to think of them as being essentially mains operated, therefore, in view of this and the number of requests received for a battery-operated outfit, the unit mentioned above has been designed.

The first consideration with any battery-operated apparatus is current consumption. The second, at least so far as amplifiers are concerned, is the output obtainable. Bearing in mind the fact that these two requirements are very closely related to each other, and that dry H.T. batteries are likely to be the source of anode current supply, limits to suit both factors had to be selected, and it soon becomes apparent that it is absurd to think in terms of 4, 5, or 6 watts output, as so many constructors would desire.

If one can eliminate the question of dry H.T. batteries by, say, using large-capacity H.T. accumulators, or, for example a Milnes Unit, then the output can be raised considerably, but, even so, one cannot soar to the large outputs obtainable from some of the mains-operated "power" amplifiers.

So many pick-up enthusiasts appear to have the impression that unless an amplifier can deliver, say, 5 watts of undistorted output, it is not worth considering for record reproduction. It is a matter of personal taste, but, bearing in mind that one is usually concerned with using the equipment in a room of average size, it is suggested that such power is out of all proportions.

From the reproduction point of view, by which I mean judging aurally, I maintain that an output system capable of handling 2 watts is more pleasing, when it is fully loaded, than a 5- or 8-watt outfit with the volume turned down to the same output. However, whatever the pros and cons of the case may be, it is always wise to remember that the ear is not too critical as regards intensity of sound when considered from the point of view of watts. For example, it would take a very experienced ear to differentiate between 3 and 5 watts output, therefore I have selected a happy medium, remembering other limitations and decided on an output of 2½ watts.

The Circuit

The valve sequence is one L.L.2 which has an amplification factor of 30 feeding into two pentodes, P.P.225's, arranged in quiescent push-pull, the coupling being provided by a Varley Q.P.P. transformer type D.P.36 which is parallel fed to allow the utmost inductance to be obtained from the primary winding to ensure a good bass response.

The normal output of one P.P.225 with 135 volts on the anode and auxiliary grid, and with its grid biased 12 volts negative, is 1,000 milliwatts, or 1 watt, therefore, with two in the above output circuit, it is safe to estimate that at least 2½ watts will be obtained, providing the anode and bias voltages are correctly adjusted.

The current consumption of the L.L.2 with 135 volts on its anode, is approximately 3 mA's, while each P.P.225, under normal working conditions, will draw as much as 18 mA in the anode circuit and 2 mA in the auxiliary grid circuit. These figures, at first sight, seem rather drastic for battery operation, but one must not overlook the fact that with Q.P.P. output the two P.P.225's are so heavily biased that their standing current becomes very low and large current surges only take place during the handling of powerful passages in the input signal.

It is impossible to go into the whys and wherefores of Q.P.P. operation in this article, but it will suffice to say that the whole secret of satisfactory output, and distortion-free reproduction, is the correct adjustment of the grid bias with relation to the actual anode potentials.

The output from a normal pick-up will provide adequate input for the output valves as the L.L.2 has a fairly high magnification factor, while the coupling transformer has a ratio of 1 : 9. So far as microphones are concerned, a lot depends on the type and their actual efficiency, and with a high sensitivity model a satisfactory output will be obtained; but with others having a lower output, such as high quality transverse current and moving coil types, it will be advisable to provide a simple "head" amplifier in the form of,

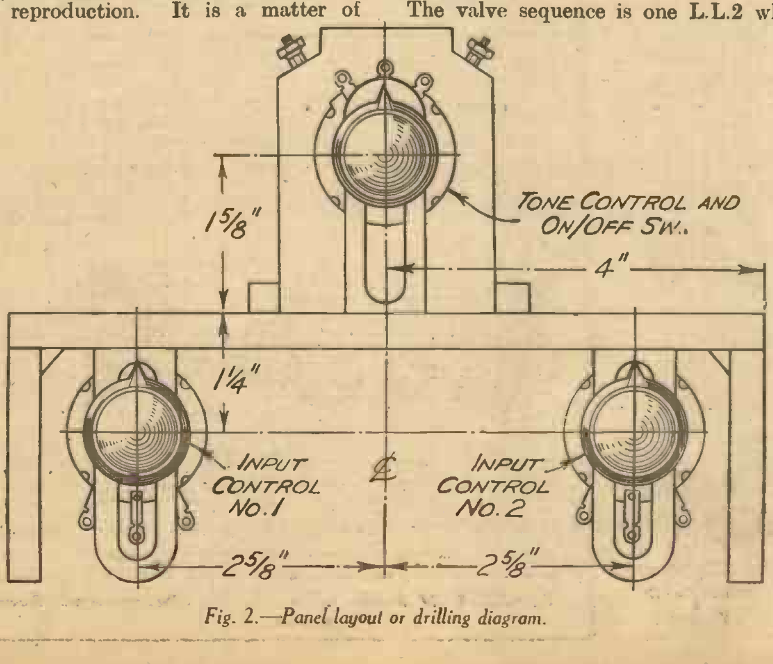


Fig. 2.—Panel layout or drilling diagram.

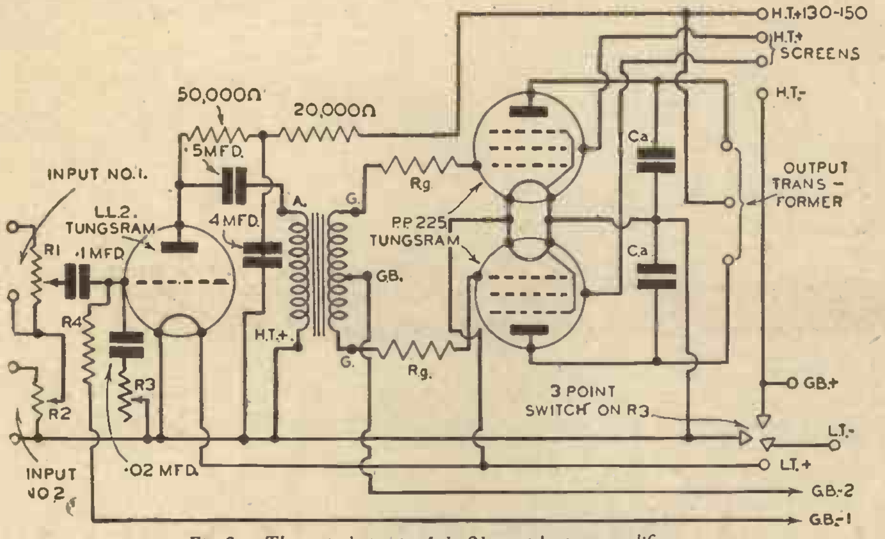


Fig. 3.—Theoretical circuit of the 2½-watt battery amplifier.

The transformer is placed so that the grid leads to the two output valves are short and direct, the resistances Rg being included to prevent, in conjunction with the two fixed condensers Ca between each anode and the negative line, parasitic oscillations which are sometimes generated in symmetrical push-pull circuits.

The anode circuit of the L.L.2 is decoupled by means of a resistance and a condenser to eliminate any possible instability through battery coupling, but the anodes of the P.P.225's receive their H.T. via the output or speaker transformer. No output transformer is included in the amplifier as the majority of modern moving-coil speakers are fitted with a multi-ratio transformer which usually allows satisfactory matching to be secured.

Particular attention must be given to the connecting wires associated with the two input controls. As these potentiometers are in direct contact with the input grid, it is essential to cover all connecting wires with metallised braiding.

say, a good straight H.F. pentode resistance-capacity coupled to the L.L.2.

Input Controls

Two variable controls are provided to allow two inputs to be controlled and "mixed" before being fed into the grid circuit of the L.L.2, thus allowing two pick-ups or one pick-up and a "mike" to be used according to individual requirements. This item is always very handy as it increases the uses of the amplifier considerably apart from giving the operator greater scope so far as results or effects are concerned.

The third control R.3 is a combined potentiometer and switch, the potentiometer section being used as a tone control while the switch is wired to cut off all batteries. It will be noted that the tone control is really a low-note booster or high-note cut-off, but the values have been selected to provide a most satisfactory variation in the tonal response and it will be found very useful for the elimination of record surface noise or needle scratch. It must be appreciated, when considering this arrangement, that the natural characteristics of the amplifier are on the high side, so any additional form of high-note booster is not required; in fact, it would be detrimental.

Layout

It will be seen, from the illustrations, that a small simple chassis has been used to hold all components, as this allows a clean top deck to be obtained and facilitates wiring. It will be quite an easy matter to build a compact cabinet round the chassis or, if a more professional appearance is required, to make a cover to fit into the top of the chassis out of stout perforated zinc.

LIST OF COMPONENTS

One 50,000-ohm 1-watt resistance, Erie.
One 20,000-ohm 1-watt resistance, Erie.
Two 50,000-ohm half-watt resistances, Erie.
One 1-megohm half-watt resistance, Erie.
One 4 mfd. fixed condenser, type 50, T.C.C.
Two .1 mfd. fixed condenser, type 250, T.C.C.
One .02 mfd. fixed condenser, type 300, T.C.C.
Two .001 mfd. fixed condenser, type 300, T.C.C.
One 4-pin valveholder, chassis type, Clix.
Two 5-pin valveholders, chassis type, Clix.
One 25,000 ohm potentiometer, with three-point switch, Erie.
Two .5-megohm potentiometers, Erie.
Two socket strips, P.U., Clix.
One Q.P.P. transformer, type 36, Varley.
One L.L.2 valve, Tungsram.
Two P.P.225 valves, Tungsram.
Wooden chassis, screws, wire and Systoflex.

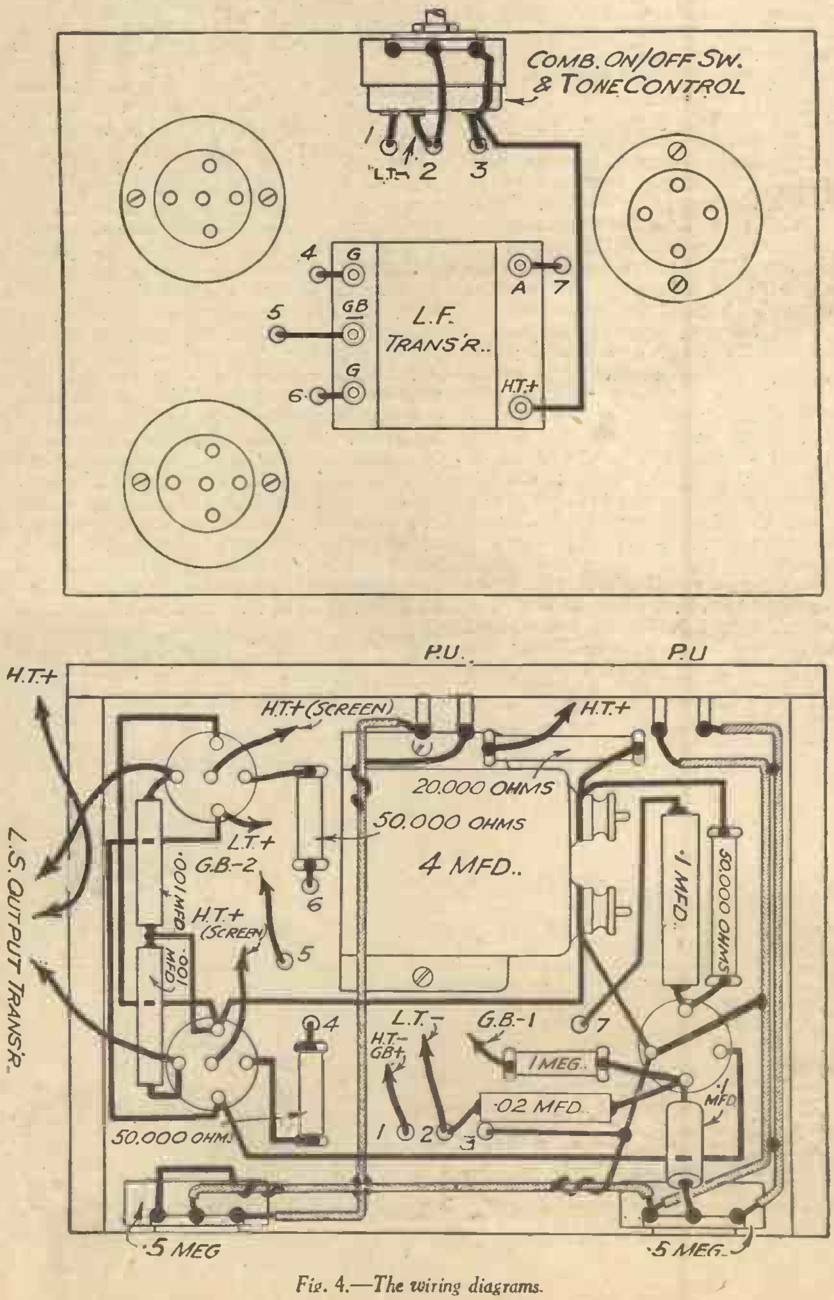
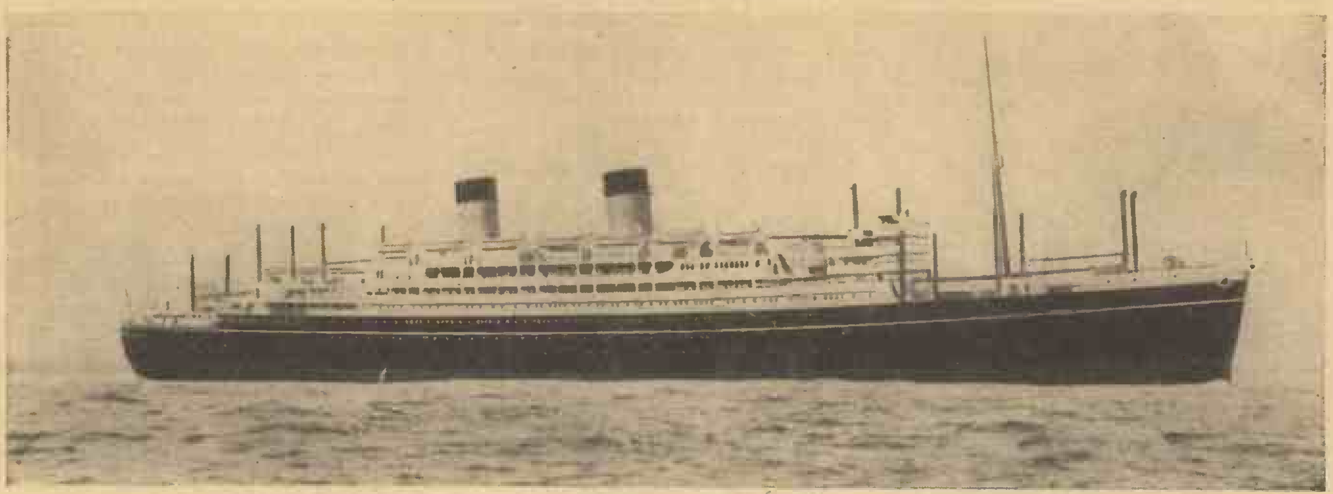


Fig. 4.—The wiring diagrams.



A 1/8 in. to the foot model with the sea added, showing the realism apparent when set in its natural surroundings.

MODELLING THE "DOMINION MONARCH"

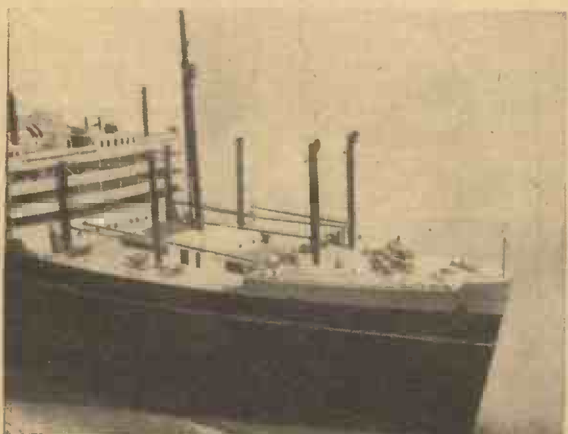
Two views of the 1/8 in. to the foot model.

WE show on this page photographs of the modelling of the *Dominion Monarch*, which, when she is completed in February next, will be the largest quadruple-screw motorship ever to be built in England, and the most powerful in the world. Messrs. Bassett-Lowke, Ltd., of Northampton, were entrusted with the making of several *Dominion Monarch* models both to 1/4-in. scale and 1/2-in. scale, and even before the ship was launched (in July) from the Wallsend-on-Tyne yard of Messrs. Swan, Hunter and Wigham Richardson, the builders, there was a large 1/4-in. scale model of the ship on view in the New Zealand Pavilion of the British Empire Exhibition at Glasgow—as long ago, in fact, as May last.

The ship has been built for Messrs. Shaw Savill and Albion Co., Ltd., to inaugurate a new route for passenger traffic to New Zealand, and one of the new models of the ship will be on show shortly in the London office, in Leadenhall Street, of her owners.

The *Dominion Monarch* will sail from London and will call at Teneriffe, Cape Town, Durban, Fremantle, Melbourne, Sydney and New Zealand, a voyage occupying about 35 days. Thus the mother country will be linked up with three of her greatest Dominions and a new direct connection established between South Africa and New Zealand.

With one raked mast placed forward and two stream-lined funnels, a striking and pleasing profile is obtained and the general appearance of the ship is enhanced by the owners' well-known colours of black, buff and white.



A bow view of the 1/4 in. to the foot model.

Putting the finishing touches to a 16 ft. long model of the "Dominion Monarch."

INTRODUCING—

ELECTRO-PLATING OUTFIT

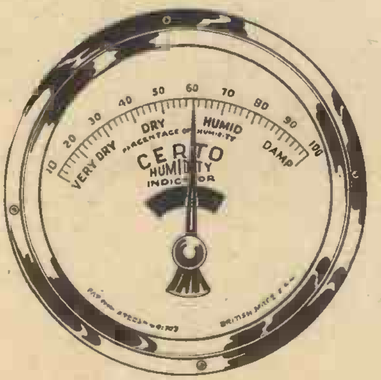
WHEN one thinks of electro-plating articles at home, one generally assumes that expensive apparatus will be necessary. This is not so, as it is now possible to obtain a complete electro-plating outfit for the reasonable price of 6s. 9d. By following the simple instructions enclosed with each kit, you will be amazed at the ease with which you can plate such articles as taps, door knobs, fittings, etc. The outfit is not a toy but apparatus that has been scientifically devised by experts [206].

SELF-HEATING SOLDERING IRON

WE show on this page the latest type of soldering iron which is self heating. It is known as the "Soldo" and can be used in any conditions that may arise, especially where it is not possible to obtain heat by the ordinary method. To heat the iron place a mox-intense heat tablet inside the special container in the head of the iron, and ignite the tablet by means of a fusee. In a few seconds the iron will be at soldering heat. The iron should be used in conjunction with "Soldo" patent tinning compound. The complete soldering outfit containing 1 iron, 10 mox-intense heat tablets and one box of fusees costs 15s. Extra mox tablets can be obtained at 3s. for 10 including a box of fusees [207].

A HUMIDITY INDICATOR

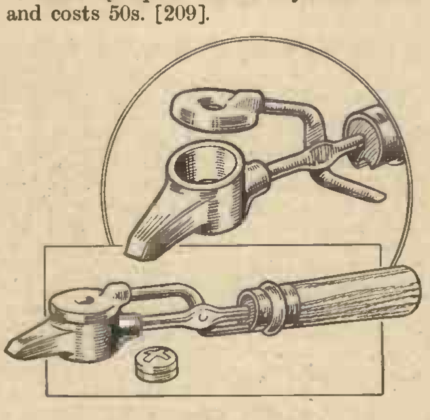
KNOWN as the Certo Humidity Indicator, a device has appeared on the market which indicates the amount of dampness in the atmosphere. It can be used for health purposes by indicating dampness in a room, also dampness in a bed if placed between the sheets. The instrument can be used as a weather indicator providing it is hung in a position where it comes into contact with the outside air. When the pointer moves towards damp it indicates approaching rain and when it moves to dry, fair weather. This is due to the fact that damp winds are forerunners of rain and dry ones are not. It is obtainable in red, blue, black and walnut and costs 7s. 6d. [208].



A humidity indicator which has a number of uses.

HIGH-POWER MICROSCOPE

ON this page is shown the "Omag" high-power microscope which is extremely useful where an expensive laboratory apparatus would be superfluous and a pocket lens insufficient. It is fitted with a sliding eyepiece which gives magnifications from 20 to 35 times and has finger-tip control for fine focusing. It is illuminated and takes a No. 8 dry cell. A feature is that the internal reflecting system gives the object under view a plastic appearance. It is sold complete with a dry cell in a box and costs 50s. [209].

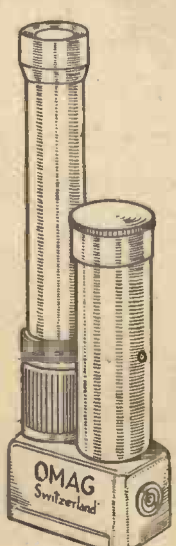


The "Soldo" self-heating soldering iron showing the fuel container in the bit.

FOR DRAUGHTSMEN

TWO useful gadgets for draughtsmen are the quick-opening drawing pen and the "Polyflex" adjustable curve. The pen has a pocket knife action enabling it to be instantly opened for cleaning without the necessity for releasing screws, etc. Made throughout in stainless steel in two sizes, 6 in. and 4½ in., it costs 8s. with round ivory handle, 8s. 6d. with square ivory handle and 7s. with round ebonite handle.

The adjustable curve consists of a rubber covered, triple steel spring, rigidly attached at one end to a square steel bar, the other end being secured, by means of a roller, to a slide which may be clamped at any position on the square bar. The bar is divided and figured, so that any particular setting of the curve can be noted and repeated at will. The construction of the curve and the method of adjusting can be seen from the illustration. It costs 10s. [210].

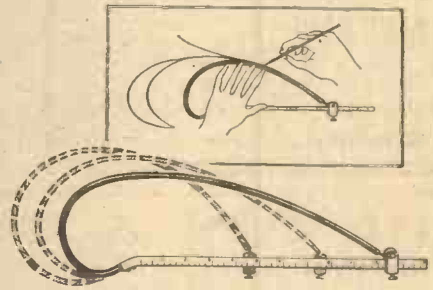


A high-power microscope which gives a magnification from 20 to 35 times.

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

A DISTILLER

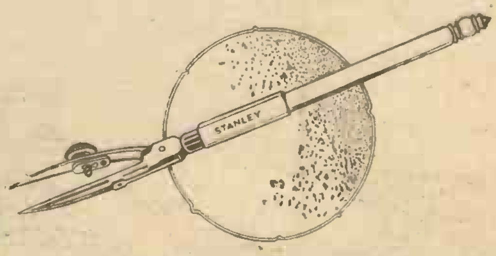
DISTILLED water has a number of practical uses in the household, and a device known as the "Autostil" has now appeared on the market which will give an unlimited supply of guaranteed chemically pure distilled water. It is electrically operated and entirely automatic in action, and only requires filling with tap water. It is quite easy to instal and with electricity at ¾d. a unit, distilled water can be produced at approximately 3d. a gallon. The "Autostil" distilling plant is of robust construction, has a number of outstanding features, and is sold complete and ready for attachment to the mains. Its output is one pint of distilled water per hour, consumption 500/600 watts, and works off 200/250 volts A.C./D.C. The plant measures 2 ft. x 1 ft. 8 in. x 10¾ in. and weighs 16½ lb. The standard model costs £7 10s., and the non-automatic model £6 10s. [211].



The "Polyflex" adjustable curve.

"AERONAUTICS"

HAVE you seen "Aeronautics" George Newnes new Part Work for all who are interested in flying.? Written by expert pilots, engineers and designers, it presents, in simple language, all there is to know about flying—the theory and practice, airmanship on the ground, aerial communications and operations, servicing and upkeep, military flying, and in fact it covers all the aspects of modern aircraft. An aerodrome data sheet is included in every part throughout the work, which will be completed in about 32 weekly parts. The work, which is profusely illustrated with photographs, drawings, plans, tables, data, etc., should be invaluable to all civil air guards, and everyone interested in flying. Parts 1 and 2 are now on sale everywhere—price 1s. 0d. each part [212].



A new quick-opening drawing pen which has a pocket knife action.

WHEELS FOR MODELS

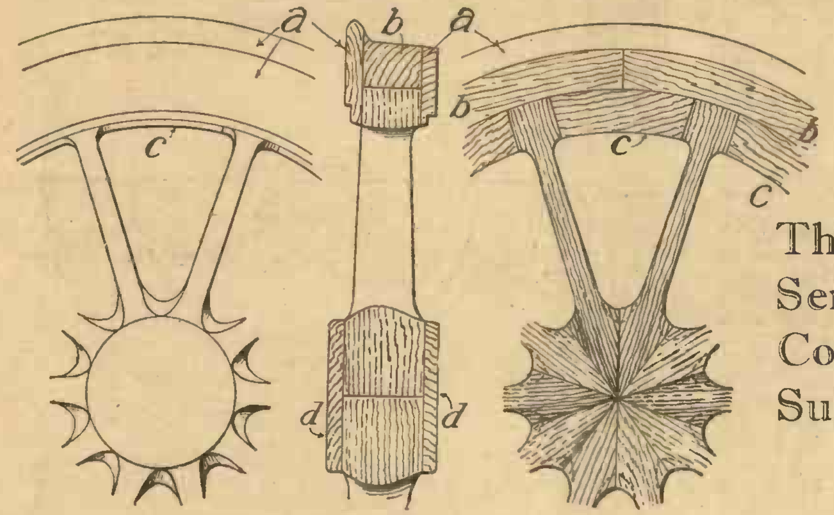


Fig. 26.—Foundry pattern for a locomotive wheel.

By "Handyman"

The Fifth Article of a Short Series Dealing with the Construction of Wheels Suitable for every Type of Model.

THE method followed by most model engineers when making patterns for their locomotive models is to plane up a flat piece of mahogany or other wood, mount it in the lathe, turn it to shape and afterwards pierce it for spokes with a fretsaw, finishing with chisels, gouges and glasspaper. Such a procedure is perhaps good enough for small wheels, if they are to be sent to the foundry at once, but for large patterns, or even small ones which are likely to be wanted again after a lapse of time, the method is unreliable, because wood, when cut to such a form, in unstable. Shrinkage is almost certain to take place and they will become oval, and possibly warp. If it is desired to cut small patterns from the solid, it will be much the safest plan to use the very best plywood which can be bought; gluing up several thicknesses, if necessary, and making sure that all the laminations of each thickness are thoroughly well glued. Unfortunately, in plywood, when cut into small pieces, there is often an insufficiency of glue and the consequence is that the laminations come apart.

Another good plan when making small wheel patterns is to buy some straight-grained mahogany veneer, the thickest obtainable, and make one's own plywood, by gluing piece after piece of veneer together, each with the grain running in a different direction, until the requisite thickness for turning the pattern is obtained. All superfluous glue should be squeezed out and the plywood, thus made, should be dried under considerable pressure; after which it can be treated as ordinary wood except that the finishing of spokes will have to be done chiefly with files and glasspaper.

Built-up Patterns

Large wheel patterns, that is to say, for locomotives of 1 in. scale and upwards, should, in all cases, be built up and one of the best forms of construction which can be adopted is that shown in Fig. 26. Here it will be seen that each spoke is a separate piece of wood, straight in the grain, mitred at the hub so that all the spokes meet at the exact centre of the wheel.

At the rim the spokes butt against a ring, *b*, which can be of as many segments as may be thought desirable. On a ten-spoke bogie or tender wheel the number of segments may be five, each one therefore will cover two spokes. Short fellowes, *c*, fill in the spaces between the squared ends of the spokes and covering the sides of both fellowes and rim segments there will be two rings of thinner wood, *a*, *a*. To cover the mitring of the spokes at the hub two discs, *d*, *d*, are glued on.

The turning of the pattern in the lathe should be done after building up and the final shaping of the inner faces of the fellowes towards the hub should be done after the turning is finished. The surfaces to be turned will, of course, be the backs and fronts of hub and rim and the flange and tread of the tyre.

Loco. Driving Wheels

The foregoing will apply to the making of patterns for all engines and tender wheels, but the driving and coupled wheels will require the addition of cranks and balances. The cranks will be the same size and shape for both driving and coupled wheels and so can be made a part of, and be built into, the wheel by modifying the inner ends of the spokes and adding the usual pear shape instead of the discs, *d*, *d*. When we come to the question of balances, however, the case is different. On any coupled engine the coupled wheel balances are of different size from those on the driving wheels and all in a different position in relation to the cranks; so, in order to avoid the necessity for making two (or perhaps more) wheel patterns, the simplest way will be to make two balances each divided longitudinally, and of such form that they will be notched out to fit over the spokes in any position on the wheel. Two balances will be needed because that for the driving will be larger than the one for the coupled wheel.

Of course, the pattern will have to go twice to the foundry. After the first wheels, say the driving, are cast, the balance is changed and the pattern sent again for casting the coupled wheels.

Machining the Wheels

When the castings are received they are held either in the chuck or on the faceplate of the lathe with the back face outwards and the back is machined. They are then reversed on the faceplate and the tread, flange and face of the tyre turned, also the face of the crank. In the same

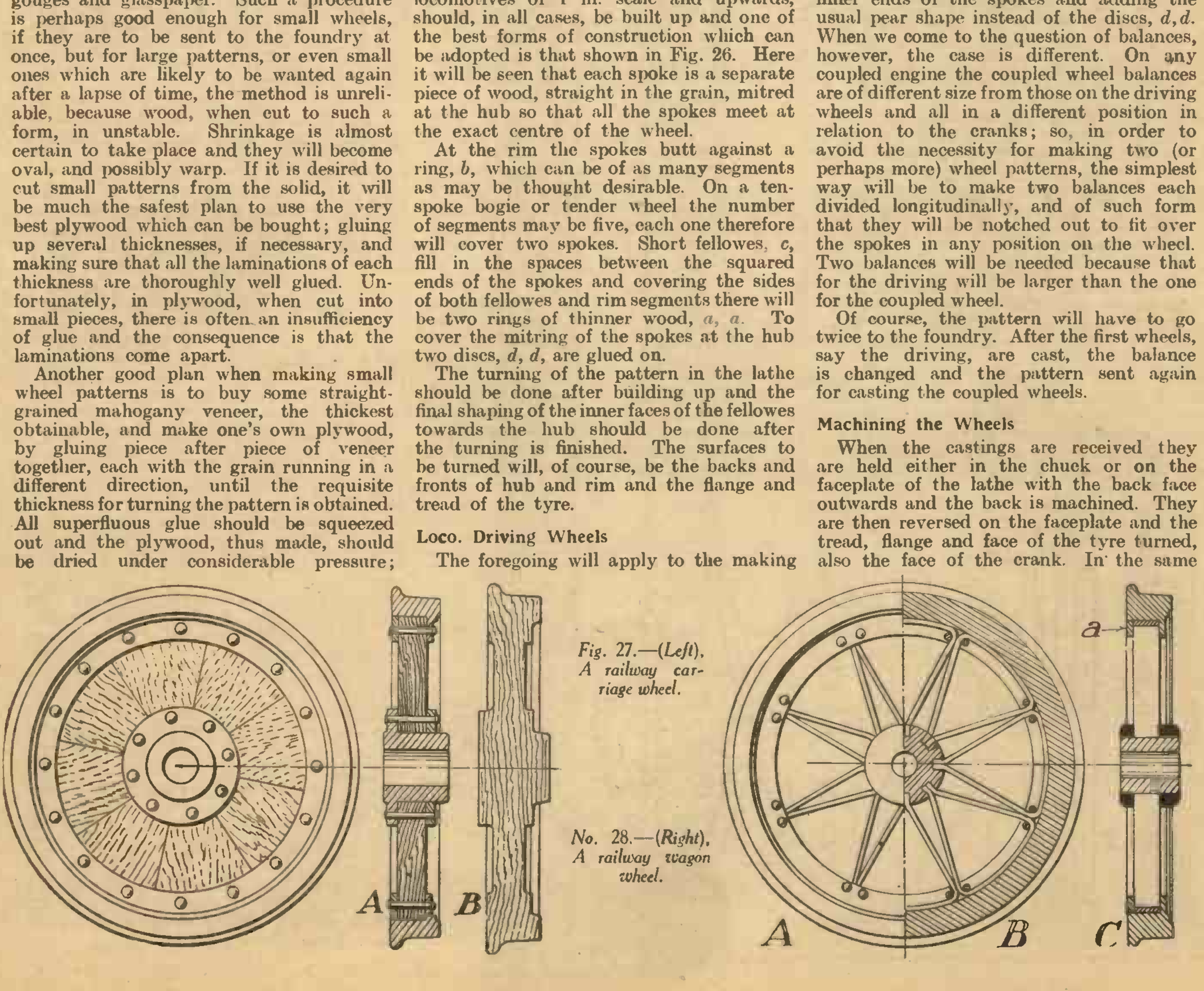


Fig. 27.—(Left). A railway carriage wheel.

No. 28.—(Right). A railway wagon wheel.

operation the hub is first drilled and then bored out, with a boring tool in the slide rest for the axle.

All the wheels of the same diameter should be bored dead to a uniform size and this size should be settled by a cylindrical gauge, like a mandrel, with a slight taper at the end to allow of entry into the bored hole. The axle ends will be turned to one or two ten thousandths of an inch larger than the bore and when the wheels are ready they are forced on to the axles, either in a screw-press or a very large vice.

The axles should have been turned between centres, and, when the wheels are on, the axles are again so placed in the lathe. A very light cut is then taken over the tread and flange of the tyre to ensure their absolute truth, finally finishing off with emery cloth.

Railway Carriage Wheels

Fig. 27 shows the standard, wooden centred, wheel in front elevation and at A in cross section. This latter shows the modified construction which can be adopted whilst retaining the wood. The hub and tyre can be of cast iron, the two rings through which the rivets pass can be of either steel or brass. Such a wheel built up in this manner looks well with oak centres, left unpainted, but varnished.

If the model-maker considers that the building of many wheels, such as this, involves too much labour, the only way is to cast them wholly in metal, and a wooden foundry pattern is shown in cross section at B. The pattern can either have the rivets put in, so that they reproduce in the castings, or, in order to get sharper and cleaner form to the heads, the castings can be drilled and rivets knocked in.

Railway Wagon Wheels

Fig. 28 shows a practically unmodified form of wheel for four-wheel wagons. Obviously, as there is no other way of reproducing this than by building it up, the open type of spoke can only be copied in large scale wheels, Small wheels will be cast with solid spokes.

In the model shown the hub, of brass or gunmetal, is slotted by saw cutting right across and the two ends of each pair of spokes are soldered into each slot, the slots beyond the spokes being filled in with solder.

The triangular outline of two half-spokes is obtained by bending strip brass in a suitable jig, carefully made to measurement from a drawing. The tyre can be of cast iron and this should be bored out to fit tightly over the skeleton spokes.

In the drawing A is a half elevation, B a section taken parallel with the face and in line with the face of the spokes and C is a cross section. The rivets shown in A and B should pass through the ring, *a*, and so secure the spokes to the tyre.

From the railway we will go back to the road and treat, first, on wheels for light vehicles such as private motor-cars and light vans. These are of three principal types: the disc wheel, the pressed and welded steel-spoked wheel, and the wire-spoked wheel. We will deal with them in the order mentioned.

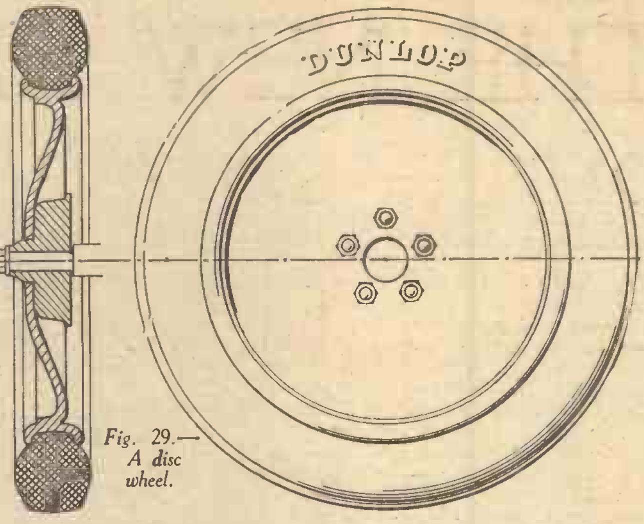


Fig. 29.—A disc wheel.

The Disc Wheel

Fig. 29 shows in cross section and front elevation a disc which makes, perhaps, one of the prettiest wheels of this type on the road. It is that fitted to the Rover "9" car. Either one of three methods may be adopted in modelling this. Perhaps the most simple is to make a pattern and get castings off in brass or aluminium; another is to mount two pieces of thick metal—brass or aluminium would be best—in the lathe and turn a pair of moulds; then cast all the wheels required in type-metal. A third way is to turn all the rims from a cylindrical casting, or else spin them from short rings cut from copper tubing and stamp, or rather press, the centre discs from annealed sheet copper by first making a pair of dies—very similar to casting moulds—in cast iron or mild steel. The discs would be soldered on to the hubs, which would be either cast or turned from brass rod, and soldered also into the rims. If the discs are not soldered to the hubs proper studs and nuts can be fitted, as in full-sized practice, so as to make all the wheels of the car interchangeable.

Steel-spoked Wheels

The full-sized wheel, shown in Fig. 30, is made by welding two steel stampings together, the weld being made on the centre-line of every opening between the spokes and in a plane parallel with the faces of the wheel. The simplest, and perhaps only, practicable way to reproduce this type is to make a foundry pattern and get castings off in brass or aluminium.

The Wire Wheel

The wire-spoked, built up, wheel presents, at first sight, what appears to be a terribly tedious job; and so it would be if we were compelled to make five, or it may be six, wheels for one miniature car by building them exactly like the prototypes; that is to say, by forming heads at one end of the spokes, screwing the other end and making and tapping nipples. To build six wheels 288 spokes and the same number of nipples would be required.

As several model cars had to be built, some years ago, the writer devised a comparatively simple way of reproducing the wire wheel, and the drawings here given show how the job was done.

Briefly, the principle adopted was this: instead of any one spoke terminating in the hub it was merely laid in a groove in the hub and continued onward to form a second spoke; the spokes therefore were put in in pairs. At the rims they were soldered into fine saw-cuts. The hubs, which were made for the cars referred to, were not of the same shape as here shown, but the drawings now given indicate an up-to-date pattern.

(to be continued)

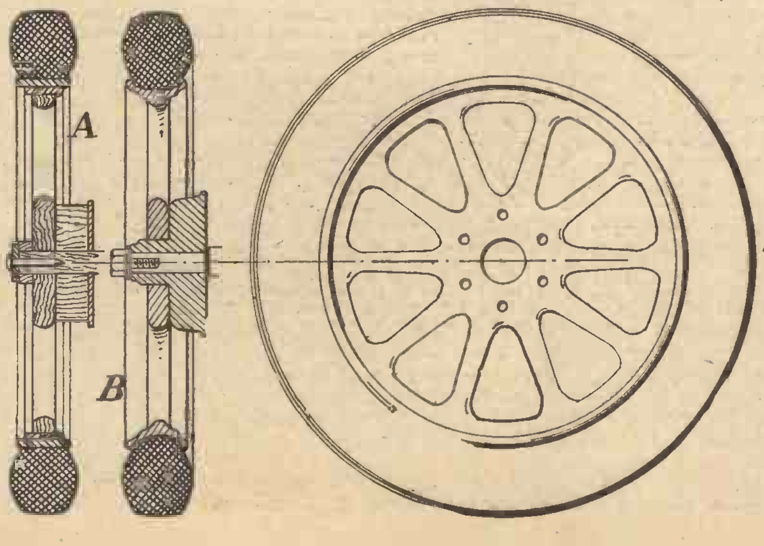


Fig. 30.—A steel-spoked wheel.

WATCH REPAIRING AND ADJUSTING

(continued from page 62)

try the clearance. Some balances carry a number of timing washers—very small washers placed under some of the balance screws to bring the watch to time—and occasionally a washer hangs below the rim of the balance, an unsuspecting evil. Do not attempt to file away the washer. Reduce the thickness of the pallet bridge if there is still insufficient clearance.

The clearance between the pallets and the underside of the pallet bridge should also be closely examined. With most modern watches the upper pallet pivot should rise so short that there is hardly any clearance, and I have often seen bright marks on the pallet arms made by contact with the pallet bridge. This contact is caused by the jewel hole being set too high. To prevent this friction file off the corner of the bridge from the underside and reduce the general thickness. File carefully, for should the jewel setting be disturbed, the bridge will be ruined. Fig. 4 shows a section of the pallets and pallet bridge.

THE NEW PATENT ACT

By A. Milward

ON August 1st, 1938, there came into force certain amendments of the Patents and Designs Acts 1907-1932 which may prove of interest to all concerned in the protection of inventions and designs.

The amendments made in the original Acts with respect to Patents, affect more particularly the right of an inventor to be mentioned as such in any patent granted for an invention, on the Complete Specification and in the Register of Patents.

The duration of the term of a Patent is also affected.

The actual deviser of an invention or part of an invention may now have his name mentioned in the Patent, but the mention of the deviser does not confer or derogate from any rights under the Patent.

It is possible for a Patent to be granted to a person who is not actually the inventor of the invention, for instance, a Patent can be granted on a communication from abroad or under the terms of the International Convention for the Protection of Industrial property without the name of the actual inventor appearing, and the object of the present amendment of the Act is to allow the actual inventor to be named with the attendant honour and glory attaching to the actual inventorship of an invention.

Duration of a Patent

The duration of a Patent granted after August 1st, 1938, instead of being 16 years from its date (i.e. the date of application for Patent) is for a term beginning on the date of the Patent and ending at the expiration of 16 years from the date on which the specification accepted as a complete specification is treated by the Comptroller as having been left.

Other minor amendments have been made which are not specifically referred to above, for instance, fees hitherto payable for the late filing of certified copies in connection with Convention applications, both Patents and Designs, have been done away with and fees reduced for the late entry of subsequent proprietors, notices of mortgages, licences or documents in the Register of Patents, and the Register of Designs.

The new Trade Mark Act which came into force on July 27th, 1938, makes many drastic alterations in the law affecting the registration of Trade Marks.

Trade Marks

When the Register of Trade Marks was first established in 1876 by virtue of the "Trade Marks Registration Act, 1875" (38 & 39 Vict., Ch. 91), a classification of goods in respect of which Trade Marks had to be registered, was prepared. This classification extended to 50 separate classes, and up till the present time has not been altered or amended, but under a new Act a new classification has been prepared which will doubtless in the near future entirely supersede the old classification, in fact all applications for registrations of Trade Marks filed after the July 27th, 1938, will be made under this new classification, which now comprises only 34 classes. Many of the old classes have become unwieldy, particularly for instance Class 42, which covered substances used as food or ingredients in food, and Class 50, the miscellaneous class. Under the new classification the miscellaneous class has been done away with, and articles of food are subdivided into four separate classes.

On the other hand the 13 textile classes in the old classification have been reduced to 5 classes in the new classification.

There is provision in the new Act for bringing Trade Marks registered under the old classification into the new classification, which in certain cases appears to be advantageous.

An Important Item

One of the most important sections of the new Act is in respect of the assignment of registered Trade Marks, hitherto a Trade Mark when registered could only be assigned and transmitted in connection with the goodwill of the business concerned in the goods, for which it had been registered, and was determinable with that goodwill. Now, however, a registered Trade Mark is assignable and transmissible either in connection with the goodwill of a business or not.

Further a registered Trade Mark can be assigned in respect of all the goods in respect of which it is registered, or only some of them. This section applies not only to marks registered in the future, but also to marks already registered.

Hitherto Trade Marks have been registered for a first period of 14 years, and capable of being renewed from time to time for like periods of 14 years, whereas in future the registration of a Trade Mark shall be firstly for a period of 7 years, but may be renewed as hitherto from time to time for further periods of 14 years.

Under the old Act, a Trade Mark to be registered under part B of the Register, had to be bona fide used for a term of not less than two years before the date of application for registration, whereas under the new Act this proviso is omitted.

Under the new Act it is possible for a person other than the owner of a registered Trade Mark to be registered as a registered user of the Trade Mark in respect of all or any of the goods in respect of which it is registered (not, however, in respect of a defensive Trade Mark) either with or without conditions or restrictions. The application for registration as a registered user must be made jointly by the owner of the mark, and the proposed registered user. The Registrar has power to refuse such an application if in his opinion the grant would be contrary to the public interest. A registered user has no assignable or transmissible right to the use of the mark.

A series of Trade Marks may be covered by one registration provided that the several marks are for the same description of goods in any one class, and resemble one another in material particulars so as not to substantially affect the identity of the Trade Mark.

Removing a Trade Mark

Under the new Act provisions for removing a Trade Mark from the Register for non-use have been strengthened. Under the old Act, non-user of a registered Trade Mark for five years preceding the application for removal of the mark had to be proved, whereas in the present Act it will be sufficient to prove in order to remove a Trade Mark from the Register, (1) that where a Trade Mark has been registered without any bona fide intention to use the mark, and in fact where there has been no bona fide use of the mark up to one month from the date of the application for removal from the Register; and (2) that up to one month before the application for removal a continuous period of five years or longer had elapsed in which there had been no bona fide use of the mark.

In order to prevent the unjustifiable use of a Trade Mark which has become well known for certain goods being used by another trader in respect of other goods, a new form of protection is made available by the present Act and known as a "*Defensive Trade Mark.*"

Where a registered Trade Mark consisting of one or more invented words has become so well known in connection with the goods in respect of which it has been registered and used, that its use in relation to other goods not covered by the registration nor used by the proprietor of the mark might be taken as indicating some connection with the owner of the mark, it is possible for the latter to register the original mark as a Defensive Mark in respect of any other goods. Such Defensive Trade Marks are registered as associated Trade Marks, i.e. assignable and transmissible as a whole only, and are not liable to be removed from the Register on the ground of non-use.

If a registered Trade Mark consists of or contains one or more words which, through use, becomes solely identified with or descriptive of a particular article or substance, i.e. the said word (or words) becomes the only known name in the trade for that particular article or substance, then the registered proprietor of such a Trade Mark has no longer any exclusive right to the use of such descriptive word or words.

It has frequently happened that a word is invented, registered as a Trade Mark, and used in connection with a particular article or substance which forms the subject matter of a Patent, so that the only practical name or description for such a patented article or substance is the Trade Mark; in such a case, after a period of two years from the lapse of the Patent, the proprietor of the Trade Mark has no longer any exclusive use of such a Trade Mark.

Further, no word which is the commonly used and accepted name for any chemical substance can be registered as a Trade Mark in respect of a chemical substance or preparation, or if already registered as a Trade Mark, may be removed from the Register.

It is possible under the new Act to register a Trade Mark which the applicant does not use or propose to use, provided the said mark is intended for use by a company or corporation to be constituted, and provided an undertaking is given to assign, and the mark is actually assigned, to said company within a stipulated period.

A new section (37) of the Act deals more fully with "certification" Trade Marks, and is in place of the old section (62) dealing with special Trade Marks whereby any association or person undertakes to certify the origin, quality, accuracy, or other characteristic of any goods by a particular mark. A certification Trade Mark is registerable only under part A of the Register, and is registerable only by any person or persons not carrying on any trade in the goods of the kind certified.

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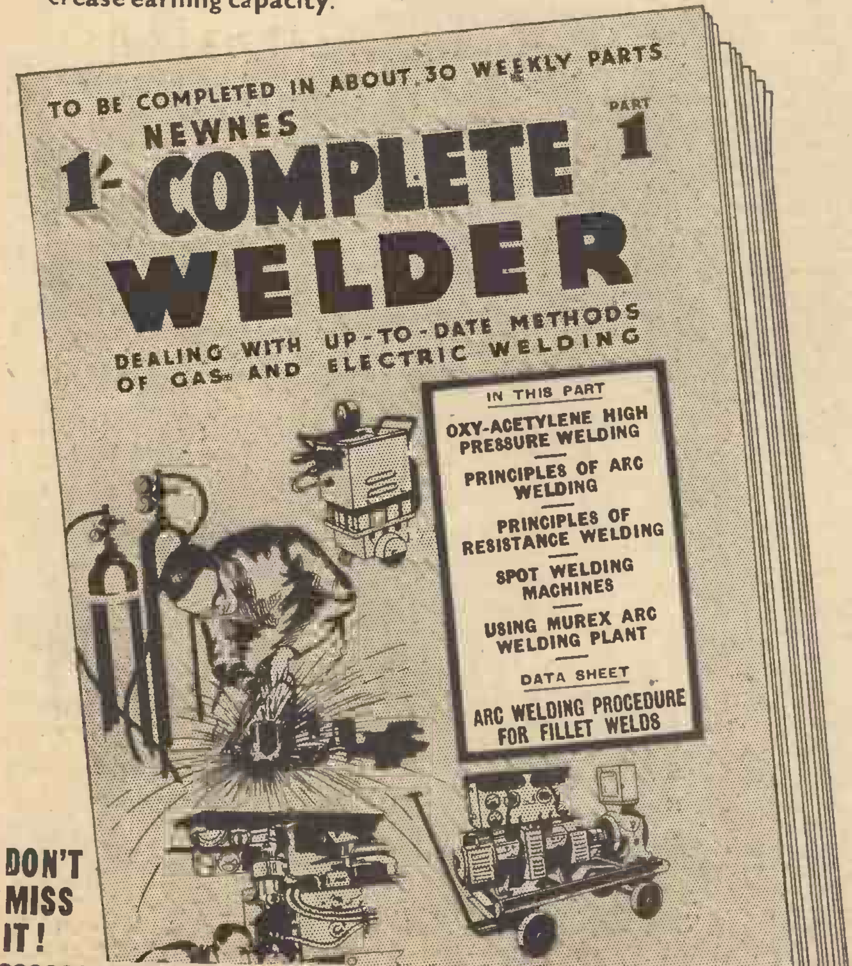

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BOOKS *worth* READING

THE WATCHMAKER AT THE BENCH.—By Donald de Carle. 244 pages, 138 illustrations. Sir Isaac Pitman & Sons, Ltd., London. 8s. 6d. net.

This is the third edition of an extremely practical work intended for the watchmaker, the student and all interested in the watch trade. There have been very many books written on watches and clocks, few of them, however, are of a practical nature, and most of them deal with obsolete methods which do not apply to modern watches which are now chiefly mass produced. This present volume, however, deals with modern methods. It explains the arrangement of the workshop, filing, turning, polishing, hardening and tempering, drilling, examining the movement, the main spring and barrel, the train, the lever escapement, the balance and balance spring, types of movements, escapements, chronographs, repeaters and other complicated watches, watch cleaning, pivoting, wheel cutting, etc. It is an ideal book for those who wish to know how to repair a watch in the correct way, how to understand its principles, and most important of all how to make the watch keep accurate time. The illustrations are an important feature of the work and are in line and half-tone. The book is well indexed.

AUTOMATIC TELEPHONY.—By C. W. Wilman. 208 pages, 103 illustrations. Technical Press, Ltd., London. 10s. 6d.

This is a revised second edition of a book which is an attempt to deal in an elementary manner with the principles of automatic telephony. The author in the preface uses the archaic expression: "The art of automatic telephony." It is not an art; it is a practice or a science, and I deprecate the consistent application of the word art (the art of eating, the art of talking, the art of writing, the art of swimming, the art of typewriting, etc.); authors of technical books please note. The present book is based upon lectures given by the author to students at the Coventry Municipal Technical Institute, preparing for the automatic section of the final examination in telephony of the City and Guilds of London Institute. The book deals with remote control of switches, trunking principles, subscribers' equipment, relays and their time-elements, impulsing conditions, selector mechanisms, traffic, line switches and line finders, group and final selectors, selector circuits, inter-change connections, the director system, small exchanges, party lines, etc. An index is included. The book is of an elementary character and gives a very clear explanation to non-technical people of the subject of which it treats.

AIRPLANE STRUCTURES.—By Niles & Newell. 2 vols., 452 pages and 178 pages fully illustrated. Chapman & Hall, Ltd., London. 25s. and 13s. 6d. respectively.

The authors of these two volumes are respectively Professors of Aeronautic Engineering at the Leland Stanford Laboratory and Associate Professor of Aeronautical Structural Engineering at the Massachusetts Institute of Technology. The present volumes are second editions. The purpose of the volumes is to meet needs of instructors giving courses in aeroplane construction, and describes the application of the fundamental principles to practical work, and it is also intended as a text book. They are, of course, highly technical volumes dealing with stresses and strains, and this aspect of aeronautics is most exhaustively and authoritatively dealt with. The volumes deal with design procedure, the specification, selection of a power plant, performance computations, weight control, design of wings, balance computation, location of wings, the wind-tunnel model, the Mock-up, detailed design, the forces acting on an aeroplane, loading conditions, flying and landing conditions, wing and tail flutter, reactions, shears, moments and influence lines, the laws of statics, reactions, bending moments, beam deflections, design of beams, torsion, truss analysis, graphical methods, design of simple ties and columns, deflections, etc. The books are very well produced, nicely bound, fully illustrated, and an ideal work for the student as well as for the experienced designer. Throughout the work suitable problems are included together with answers. They are books which I warmly recommend to all those interested in the design of aeroplanes. They are well indexed.

YOUR MIND AND MINE.—By R. B. Cattell. 314 pages, fully illustrated. Scientific Book Club, London. Price 2s. 6d.

This most interesting volume is an account of psychology for the inquiring layman and the prospective student, written by the psychologist to the City of Leicester Education Authority. It is an inquiry into the working of the brain, and the contents deal with the search for mind in the nervous system, intelligence, creative mind and the abilities of man, the natural history of intelligence, passion and impulse, Freud's Exploration of the Borderland of Madness, dreams and laughter, love life and lunacy, victims of the will to power, the complete architecture of character, the mind out of gear, order in diversity, psychological types, wonders of the body-mind relationship, applied psychology in the school, the factory, the police court and the Houses of Parliament. This is, indeed, a remarkable group of subjects and it is most fascinatingly dealt with, the text being illustrated by numerous drawings in line and half-tone. The book is written in simple language. It is a book which every teacher should read, for then it would not be possible to have backward pupils. It enables the teacher to analyse the minds of each pupil, and to adopt the appropriate treatment. The man in the street, also, should read this book for it will tell him how to rectify backwardness and other human failings. An index is included.

SCIENTIFIC RIDDLES.—By Professor J. Arthur Thomson, M.A., LL.D. 384 pages. Scientific Book Club, London. Price 2s. 6d.

The author reminds us that nature bristles with marks of interrogation and that it is one of the joys of life to discover the answers to them. The solving of one riddle often discloses others, and the following list of subjects show the scientific riddles discussed in the book: How did life begin, Characteristics of living creatures, What is Protoplasm? What are Chromosoms, What is a Nerve Impulse, Why do we Fall Asleep, Suspended Animation, Are Animals Afraid, Why do we Laugh and Cry? What is the Meaning of Colour? Hormones and Enzynes, How do we Catch Colds? Why does our Hair turn Grey? Why Must we Die? Problems of Natural History, Riddles of the Countryside, Cuckoo Puzzles, The Cat's Nine Lives, Is there Natural Wireless? Do Animals Think? Is Telepathy a Fact? Crystal-gazing, Why do we Dream? Does the Past Die? Whence came Man? The book is fascinatingly written in everyday language and as the chapters are complete in themselves the book may be opened at any particular chapter and read with great interest.

THE AIR AND ITS MYSTERIES.—By C. M. Botley. 296 pages, illustrated in line and half-tone. George Bell & Sons, Ltd., London. 8s. 6d. net.

This is a popular book intended to give those who live in an air-minded age an insight into the mysteries of the air. It is not a book on aeroplanes, but on air. The way of the wind, cloudland, the drops that water the earth, the thunderstorm, weather, climate, the atmosphere and light, the realm of sound, the highways of the air, towards the unknown regions. It is not a text-book but a popular exposition of these subjects, which can be read by the non-technical. The book is indexed.

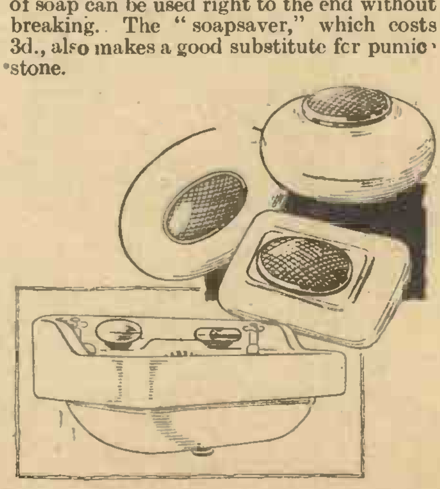
SCHOOL CRAFTWORK IN WOOD.—By Edward W. Luker. 152 pages. The Technical Press, Ltd., London. Price 7s. 6d. net.

The author states that this book is intended for craft teacher-students in training, for those preparing for examinations and for teachers. It deals with practical lessons in woodwork, timber, tools, design, solid geometry, isometric and oblique projection, and includes a great number of designs and exercises in joints, etc.

A "SOAPSAVER"

Save-on-Soap Disc

AN ingenious and reliable little appliance which will save money on your soap bill, and which has many other uses besides, has recently appeared on the market. As can be seen from the sketch the device is made in round and oval shapes to fit all types of soap. The inside has several little spikes which pierce the soap and hold it firmly. The outside is finished with a slightly raised and roughened surface which enables the "soapsaver" to obtain a grip on wet and slippery surfaces. The device prevents soap wasting when left in a wet toilet basin, and the smallest pieces of soap can be used right to the end without breaking. The "soapsaver," which costs 3d., also makes a good substitute for pumice stone.



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POTASSIUM FULMINATE

"POTASSIUM fulminate is used in the preparation of fulminic acid. Can you tell me how this is made?" (P. S., Liverpool.)

FREE fulminic acid is obtained by the action of sulphuric acid (in excess) on a solution of potassium fulminate. The free acid is extracted with ether. Potassium fulminate is formed by the action of potassium amalgam on mercury fulminate solution.

A STAIN ON CLOTHES

"HOW can the yellow stain of trinitrophenol be bleached? A small quantity got on to my trousers, and when they were cleaned at the cleaners, the latter failed to remove the stain." (A. T., Harrow.)

IN practice, this stain is practically non-removable. Chemical workers who acquire this stain usually employ an acidified paste of bleaching powder in an endeavour to remove it, but even this powerful agent is not always successful. Sodium hydrosulphite (*not* hyposulphite) solution is sometimes used in the treatment of these stains.

CATALYSTS

"REFERRING to the article in 'Practical Mechanics' on catalysts, surely the contact process is obsolete. Is not iron mixed with molybdenum used in the Haber process, and not uranium?" (A. L., Walsall.)

FAR from being obsolete, the contact process for the manufacture of sulphuric acid, whereby sulphur dioxide is combined with oxygen to form sulphur trioxide by passage over a heated catalyst, has displaced almost completely the older "chamber" process for the production of this acid.

Various catalysing metals are used in the Haber process of atmospheric nitrogen fixation. Besides uranium, which was one of the first to be used, may be mentioned platinum, osmium, molybdenum, iron oxide, nickel and, of course, mixtures of these.

MAKING CHLOROFORM

"CAN you tell me how to make chloroform from methane?" (E. M., Brighton.)

CHLOROFORM is formed when methane is mixed with chlorine in sunlight. Methyl chloride, methylene dichloride and carbon tetrachloride are also formed in this reaction (which is not a practical one for laboratory purposes) and the small amount of chloroform formed would require separating from these other products.

If you wish to make chloroform, keep to the well-known bleaching powder method described in any practical textbook of organic chemistry.

SODIUM AND DRY ICE

"I UNDERSTAND that sodium will not react with water at temperatures above —98 C. Can you explain why sodium reacts with dry ice and why action ceases at —98 C?" (S. L., Glamorgan.)

SODIUM reacts with dry ice because the heat of combination melts the ice locally, and thus enables the reaction to speed up. As reacting substances are cooled they (usually) become progressively less reactive until, eventually, a temperature is reached at which the mutual influence of the two substances ceases. It is a sort of "critical temperature of reactivity," below which no mutual reaction or interaction can take place.

MERCURY FULMINATE

"HOW is mercury fulminate made? I dissolved Hg in HNO_3, added alcohol and collected and dried ppt., but could not get it to detonate by heat." (E. K., Wolverhampton.)

YOU must allow us to decline from giving you information concerning the practical preparation of mercury fulminate. The preparation of *all* fulminates is an exceedingly dangerous task unless carried out by expert hands, and if you persist in attempting to make this chemical you will, sooner or later, have a bad explosion in which you may suffer severe injury.

REMOVING RED INK

"BLUE inks can be removed by the $KMnO_4$ and hydrogen peroxide method, but how is red ink removed?" (S. C., Bristol.)

ORDINARY red ink is best removed by wiping it over with a soft rag charged with an acidified solution of bleaching powder.

WHAT WOULD HAPPEN?

"IF a mixture of sodium peroxide and aluminium powder were placed in a tin in which a small hole had been bored and the tin thrown into a pond, would a violent detonation take place?" (E. M., Watford.)

IN the instance you quote, there would not be any detonation. The tin would sink to the bottom of the pond and you would see nothing more of it. Actually, the water would combine with the sodium peroxide to form caustic soda and hydrogen peroxide:—

$$Na_2O_2 + 2H_2O = 2NaOH + H_2O_2$$

Heat would be evolved in the reaction, but this heat would quickly be dissipated in the cold water of the pond.

STIMULATING MUSCLES

"I REQUIRE a drug which will stimulate the muscles of the body. I have tried caffeine, but it was not very effective. Is theobromine any use?" (E. T., Sheffield.)

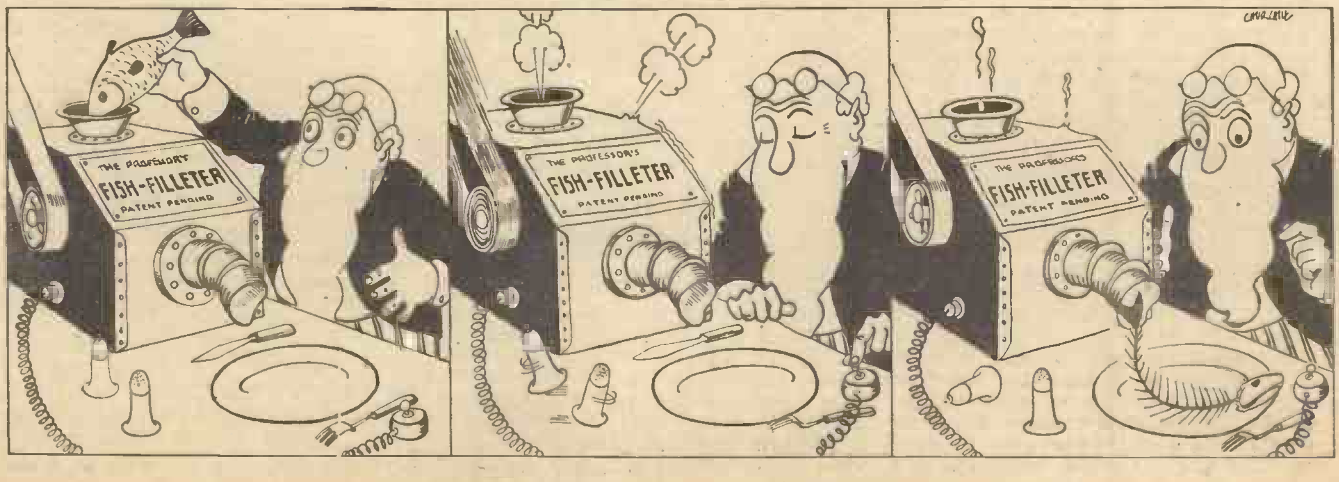
QUININE sulphate dissolved in dilute phosphoric acid and taken a teaspoonful at a time is probably the "drug" you are seeking. Caffeine is quite a good stimulant, but all other similar drugs are dangerous and should be avoided. Theobromine is useless for your purpose.

THERMITE BOMBS

"I UNDERSTAND that a liquid has been discovered which will put out thermite bombs. I know that its identity is secret, but can you give me any hint as to its composition?" (T. T., Devon.)

WE have never heard of such an extinguishing liquid and our practical experience is that a thermite conflagration, once properly started, is unextinguishable. However, the hypothetical liquid which you

THE PROFESSOR .... RATHER FISHY



mention may be some organic halogen compound, say a chlorine compound which, on being heated, will release chlorine and so tend to "blanket" the fire.

MAKING CARBONS

"HOW are gas carbons formed into special shapes, such as for cored arc carbons, etc.?

"How could I deposit a thin coating of pure carbon (in the form of gas carbon preferably, but this is not essential) upon sheet metal, the carbon to be in good electrical contact with the metal, and impervious to liquids and gasses?" (E. D. S., Montgomeryshire.)

CARBONS for arc lamps are produced from specially selected grades of gas carbon which is finely ground, mixed with a little graphite to act as a binder and then moulded in long cylindrical moulds. The carbon mixture is rammed into the moulds by means of a drop hammer, after which it is hydraulically compressed. In an alternative process, the carbon mixture is hydraulically compressed and then forced through a nozzle, in virtue of which process, long rods of the carbon are obtained. These are then cut into convenient lengths. Finally, the carbons are baked in special ovens in order to consolidate their composition and to render them more enduring. After this process, the carbons are shaped, sorted and packed.

Cored carbons are produced by similar means. In the first place, the carbon "rods" are "hollow moulded" instead of being made solid. After the baking treatment, the core mixture is rammed into the hollow carbons and compressed by carefully controlled hydraulic pressure.

We fear that you will find it very difficult to deposit a firm and enduring layer of gas carbon upon a sheet of metal. The only way is to make up a suitable carbon "mixture," say one containing 95 per cent. of fine-powdered gas carbon, and 5 per cent. of graphite. Mix this into a paste with glue solution. Coat the paste on to the metal surface and allow it to set, under strong pressure, if possible. At this stage, the carbon layer will not be a good conductor, owing to the insulating properties of the admixed glue. However, on heating the carbon-coated sheet of metal to the charring point of the glue, the latter will be resolved into carbon and the conductivity of the carbon layer will increase.

The minimum amount of glue should be used since, upon heating, the glue will tend to swell up, thus interfering with the homogenity of the carbon layer.

We feel bound to say, however, that, even in the best of circumstances, the carbon coating of a metal plate prepared in the above manner will tend to flake off. In order to secure permanent attachment, some form of hydraulic pressure is essential, for carbon cannot be deposited electrolytically.

An exceeding thin and fairly tenacious coating of carbon may be laid on a metal surface merely by roughening up the metal with sandpaper and then by rubbing a mixture of finely powdered carbon and graphite over it. The carbon will be in good electrical contact, but the layer of it will not be thick enough to be impervious to liquids and gases.

DISSOLVING RUBBER

"IS it possible to dissolve rubber? If so, what chemical is necessary, and how is it done? Would it be practicable to dissolve ordinary rubber motor tubes and apply the liquid on cloth to make it waterproof and give it a rubber facing and also to keep it flexible? Any information would be appreciated.

"Is there any chemical which would securely join two pieces of celluloid?" (R. D. T., Berwick-on-Tweed.)

NATURAL rubber dissolves with fair readiness in a variety of organic solvents, among which may be mentioned toluene, xylene, carbon bisulphide, coal-tar naphtha, carbon tetrachloride, ethylene-dichloride and trichlorethylene.

We would advise you to use a solution of ordinary naphtha for your solution experiments, bearing always in mind the fact that this liquid is inflammable.

Inner tubes can be dissolved by shredding them and by soaking the shreds in naphtha for two or three days. During this time, the rubber softens, and it is thereafter easily dissolved by vigorous stirring. During this final solution stage, the solution should be warmed by standing the vessel containing it in a larger vessel of hot water.

After satisfactory solution of the rubber has been obtained, the liquid should be filtered through several folds of fine cloth and stored in tightly corked bottles.

Fabrics may be "rubberised" by the use of this solution, but the process is at the best a messy one when conducted on the small scale, and the rubberised fabrics are nearly always permanently tacky. However, for the sake of interest, the process is worthy of a trial.

Celluloid cement is the best substance for joining celluloid. It is made by dissolving clean scrap celluloid in amyl acetate until a liquid of the consistency of thin varnish is obtained. Both the pieces of celluloid which are to be joined are smeared over with the above cement, placed together and then placed under light pressure for a few hours. By this means a fairly strong and permanent joint will be effected.

When dissolving the scrap celluloid in the amyl acetate, allow the celluloid to soak in the liquid for a few hours, during which time it will soften considerably. Then complete the solution of the celluloid by vigorous shaking.

CHEMISTRY AT HOME

"I WISH to study chemistry at home. Therefore would you please advise me as to the best way to start, what plan I should follow and what books and apparatus I may need? I should particularly like to study chemical analysis." (T. S., Kent.)

IT is not easy to study chemistry seriously on one's own, for the study requires much systematic work, accompanied by regular practical experimentation.

If, therefore, you can attend some part-time class in your nearest technical institute, we should strongly advise you to do so, even if it is only for a short time, for such instruction will go far to enable you to realise the general extent of your chosen subject.

Assuming, however, that this is impossible, and that you have no previous knowledge of chemistry, we would advise you to obtain a good elementary textbook of inorganic chemistry, as, for instance, Parrish's "Introduction to Inorganic Chemistry" (Longmans). Read this through in a general sort of way and then, after purchasing the necessary pieces of apparatus and chemicals from one or other of the advertisers in "Practical Mechanics," fit up a small workbench and carry out the experiments in conjunction with your reading, making sure that you fully understand the nature and import of each experiment before you proceed to a new one.

Afterwards, you can proceed to a more advanced textbook of inorganic chemistry, such as Newth's "Inorganic Chemistry" (Longmans). You can also take up the study of Organic Chemistry—the chemistry of the carbon compounds—by beginning with a book such as Perkin and Kipping's "Organic Chemistry" (Chambers).

Chemical analysis is not a subject which can be learned solely from books. In order to pursue this subject, you must have a well-equipped laboratory, and it is here, we think, that you will really need to attend a course of practical instruction at a technical institute if you wish to become really proficient in this branch of chemistry.

An inquiry to the Institute of Chemistry, 30 Russell Square, London, W.C.1, would reveal whether or not there are any suitable teaching institutes in your district. This body would also inform you whether there are any private teachers of chemistry in your neighbourhood.

REPLIES IN BRIEF

G. T. (Surrey).—This machine is hardly large enough for serious work. Rotary electrodes and the bars can be used, but this transformer is not big enough for this work. You should be able to weld the 16-gauge sheet quite well. Strip the secondary, count the turns per volt, and re-wind to get a maximum, as explained, of 5 volts. Re-wind with rip .5 in. x .2 in.

J. H. (Tonbridge).—Your best plan is to use a well-made type of mat contact. We have known some of these last for many years without any trouble, but get a good one. A photo-cell is expensive, but the cheapest is the electric eye as advertised in our issue.

G. A. (Kingston Vale).—The trouble is that your machine requires new contacts and probably a new condenser. You can fit new platinum contacts yourself, but a condenser may have to be bought from the makers.

You cannot make a spark coil to do this work; you see the voltage of the mains is too high for a primary winding. We advise you in this case to fit new contacts and not to try and make a coil.

H. B. (Nr. Gloucester).—Your best plan is to connect the meter in circuit the other way round, then it will read discharge. However, if connected in a discharge circuit it should read correctly. The ammeter is most probably stuck, and we cannot say what is wrong with it without an examination, but advise you to check up the connections and clean the pivots, etc.

J. A. (Dewsbury).—We advise you to make both the lamp and reflector movable and to use the 500-watt lamp. The larger lens will be better. You can use the head lamp as a spot, but you will find that it does not give sufficient light for general illumination.

Your enclosed sketches are quite good.

F. C. (Surrey).—Your idea is not entirely new and there has been quite a discussion on the subject in the Press lately. We cannot see that a six-volt battery will last months. Perhaps a week but no longer if the apparatus is some form of induction coil. We would advise you to experiment with an ignition coil on about 2 volts. Use a small pen with bare wire and dry stakes. Connect one lead from the coil to the wire and earth the other. The wire will not keep the animals in if for instance they are scared and rush at it.

SYNTHETIC RESIN MOULDINGS

(*Continued from page 76*)

this also. These two flanges projecting from the mould body are used for opening the mould. The top plate is now marked out in pitched diameter circles (PDC) to the required sizes. These sizes are not important with the exception of noting that the thin part of the wall is sufficient to withstand the great internal pressure which is necessary for moulding. No set rule is laid down, but it is generally safe when this wall is of a thickness which is not less than one half the outer diameter of the moulded object. Each of the circles is now divided up into three equal spaces at staggered intervals of 60, the outer circle defines the position for the locating pegs, and the inner circles the centres for the moulding inserts. The plate and bolster are now clamped together, and the three holes drilled and reamered, which will accept the location pegs, a tight fit in the plate and a nice slide fit in the bottom bolster. These pegs are usually lathe turned from cast steel, and approximately .015 in. is left on the diameter, which is ground off after hardening. One peg is made larger than the other two to ensure that the mould is always assembled in the same position.

When the pegs have been fitted satisfactorily, so that the plate can be put on and taken off without undue effort, it is clamped together again, and three holes which in this case would be ½ in. diameter drilled and reamered right through both top and bottom members, this then represents a datum line for each mould bore. The bottom bolster is now mounted on the lathe face plate, and each hole opened out to a size which will accept the cast steel insert, and this will be ground to suit. Two fairly small holes will be noticed in the bolster—these are to knock the cast steel insert out if need be, and should on no account be omitted. The inside moulding surface of the inserts are then highly polished by rotating at high speed, and a surface produced first with emery cloth dipped in paraffin, and finally rouge powder on a stick. The plungers are turned with a spigot on the top end, which will be ½ in. diameter, and a sliding fit in the hole already in the top plate. This centralises them, and also maintains direct relationship with the bottom force on assembly. Before being hardened, holes are drilled and tapped to accept three cheese-headed screws which are also counter-bored in the top plate, so that the heads are just below the surface. The ejector, which is shown on the sketch, forms the bottom of the cup, and must be a good fit in the cast steel insert, otherwise the moulding material will be forced down between. To minimise the possibility of this occurring a taper of 1 is made on the head part, the moulding pressure then having the effect of effectually closing the surfaces against leakage.

The material used for mould-making varies considerably with the design of the article to be moulded—for this cup mould a fairly low grade of cast steel could be used for those components forming the moulding members, as there are no abrupt protrusions which would be liable to warp or crack in the hardening process, and moreover the machining operations are mostly turning, which is considered the cheapest process, but should the making of these parts include a lot of milling machine work where sharp defined protuberations occur, then the very best quality cast steel is advisable to minimise the risk of scrapping a part in the heat treatment, which would greatly increase the cost and time of production.

Ashtray Mould

The cigarette ashtray mould (Fig. 5) is a single impression mould of fairly simple design, which would be loaded with bakelite powder when in operation to ensure an easy and uninterrupted flow immediately fluxing occurs. Although it appears simpler than the cup mould, the cost would be greater, as it is mostly milling machine work. The procedure would follow very much the same lines as the cup mould, the three holes for the location pegs being bored first to act as a guide for further machining.

The ejector studs form the three half-round sunken slots as well as pushing the job out, and to avoid them twisting, it will be noted on the sketch that the shanks are rectangular. Both forces are fairly difficult to produce, and require a lot of highly skilled milling to reproduce the equally spaced flats which will be noticed on the external circumference.

The polishing will be a tedious process, having to be mostly accomplished by hand. A very simple handy tool for this work can be made from a piece of mild steel with a saw cut in the end, into which a strip of good quality emery cloth can be inserted, and then drawn back along the remainder (Fig. 6). This instrument will be found extremely handy in getting into awkward corners.

Impression Knob Mould

This is a simple form of plunger type mould for producing wireless cabinet control knobs, and although there are many designers adverse to this method, the lower force or cast steel inserts were made up of two parts to facilitate machining. The flutes were produced on a slotting machine, although failing this, they could have been filed by an experienced toolmaker. The mould did not give as much trouble as was anticipated, excepting for occasionally having to be "stripped down," and the flash cleaned away from the butt faces of the inserts. The top insert acted as the plunger, and protruded above the mould when loaded and before being placed between the press platens. To strip after moulding, the tool was placed on metal parallels under a fly press, and the complete top and bottom inserts were pushed right through and then pulled apart by hand to withdraw the component.

Pins were fitted by drilling and reamering holes slightly over the centre line to facilitate assembly, which will be noted on the sketch. (Fig. 7.)

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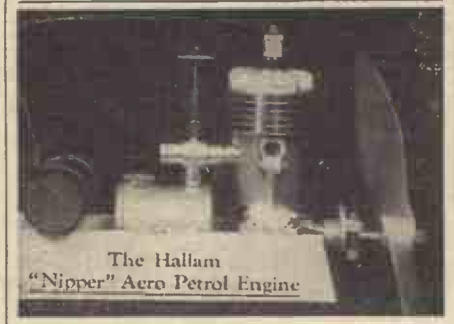

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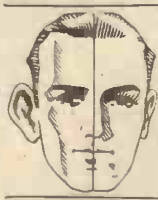

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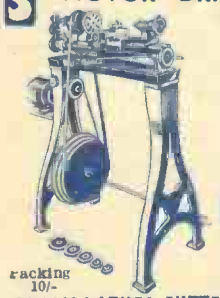

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