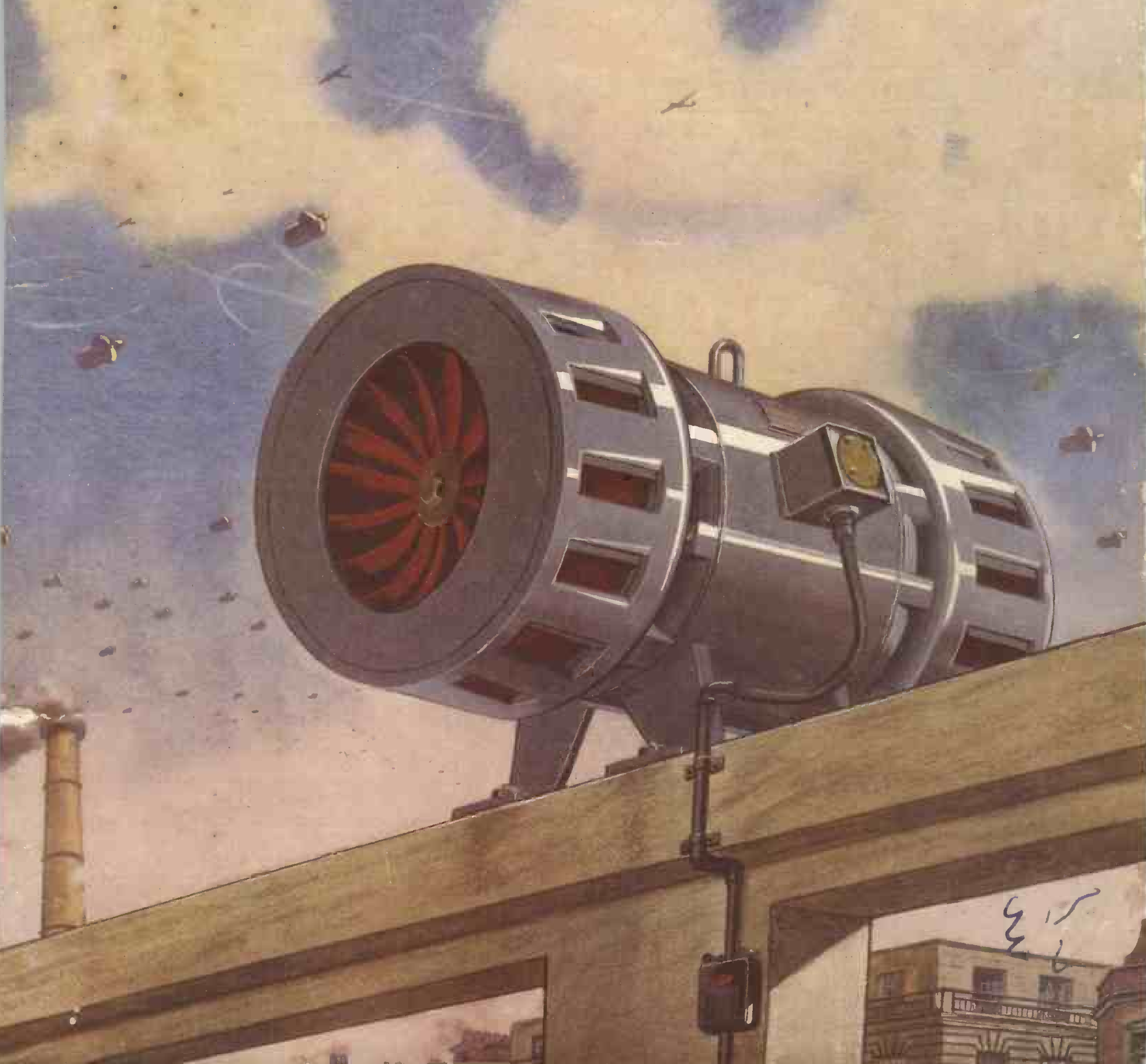
THE AIR RAID WARNING SYSTEM

NEWNES

PRACTICAL MECHANICS

9D.

NOVEMBER 1941



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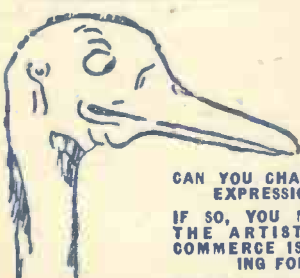

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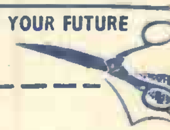

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PRACTICAL MECHANICS

Owing to the paper shortage "The Cyclist" and "Home Movies" are temporarily incorporated

Editor: F. J. CAMM

VOL. IX. NOVEMBER, 1941 No. 98

FAIR COMMENT — BY THE EDITOR

A Few Years Hence

IT is always profitable to speculate as to the future in the light of the present and the past. What are the tendencies of scientific development during the next fifty years? Many thousands of those born within the last few years will live to see conditions fifty years hence. By endeavouring to anticipate the tendencies it is possible to plan for the future. Unfortunately, it has been a natural characteristic of the English to oppose scientific progress. It has always been regarded as one of the necromantic arts, something more appropriate to legerdemain and prestidigitation than with facts or possibility. The whole history of progress is one of national oppression. Hark back a century or so when Arkwright invented the spinning loom. Your history books will tell you that it was regarded as an invention of the devil, something to destroy the livelihood of the people, and therefore something which justifiably could itself be destroyed. You will remember being taught that the millworkers accustomed to the old methods of spinning and weaving went to Arkwright's factory and wrecked his machines. To them there was only one method of the weft and the woof which must be continued in perpetuity. Nothing must be permitted to destroy the even tenor of our way. Inertia—national inertia, has been one of our besetting sins. We do not like change or improvement or progress. We like things to remain as they are, and so the miserable inventor who perceives the imperfection of present systems, and seeks to remedy them must tread the thorny paths of penury.

Laws Against Progress

WE proceed to make laws against progress. You have seen it in your lifetime. When the bicycle was the fastest machine on the road it was regarded as a curse to civilisation, not only by members of the public, but by the Government. Laws were made to prevent the bicycle achieving popularity. Magistrates instructed drivers of horse-drawn vehicles to throw their whips into the wheels of passing cyclists. The cyclists themselves were prosecuted and heavily fined for offences against some oppressive piece of legislation. If you rode a bicycle you were bound to break one or more of the laws made by anserine and abysmally ignorant statesmen and magistrates of the period. Another national failing is that we can provide some crassly stupid person with wide powers, and then proceed to idolise him as though inherently he himself possesses those powers, instead of being the mere tool for their administration. Usually it is found that our so-called "great men" are incapable even of doing that. However, the bicycle in spite of this national antipathy and opposition has proved itself a boon and blessing to the peoples of the whole world, and has paved the way for further progress, in the form of the motor cycle, the motor car, and the aeroplane.

History repeats itself. Upon the arrival of the motor cycle and the motor car, the bicycle ceased to be the fastest vehicle on the road, and from being the persecuted, cyclists became the persecuters. They did not welcome the arrival of a vehicle which did not depend upon leg propulsion. The Government adopted an even more vindictive and repressive attitude than they did towards cyclists. They passed the famous Red Flag Act which stipulated that a motor car must not exceed 5 miles an hour and must be preceded by a man bearing a red flag. The aeroplane followed, and was similarly met with vast numbers of regulations and laws which stultified its development.

Development Losses

OBSERVE the change of attitude when war is declared. The Government at once realises the advantage of the bicycle, the motor cycle, the car and the aeroplane. It wants them in vast numbers, and those who have had sufficient wisdom to continue to manufacture them often at a loss and by means of borrowed money, but in the hope that sooner or later there would be a public demand, have been penalised by Government Regulations which limit their profits to 10 per cent. This sum, whilst adequate in normal times, cannot recoup them for their development losses.

As I have said, we make regulations against progress. We refuse to believe that progress is possible. We do not like to be disturbed from the tenor of our Victorian ways. As the motor car developed and provided possibilities for door-to-door travel, eliminated waste of time at railway stations, provided cheaper and quicker transport, and helped commerce to conduct its business speedily, so the Government endeavoured to prop up the obsolescent railway system which for more than 40 years has been a canker in our commercial system. It has been provided with a Government monopoly enabling it to run on principles which would have put ordinary, competitive commercial undertakings in the bankruptcy court. Very naturally, the railways opposed the development of the motor car, but it is astounding that any Government should support them.

March of Progress

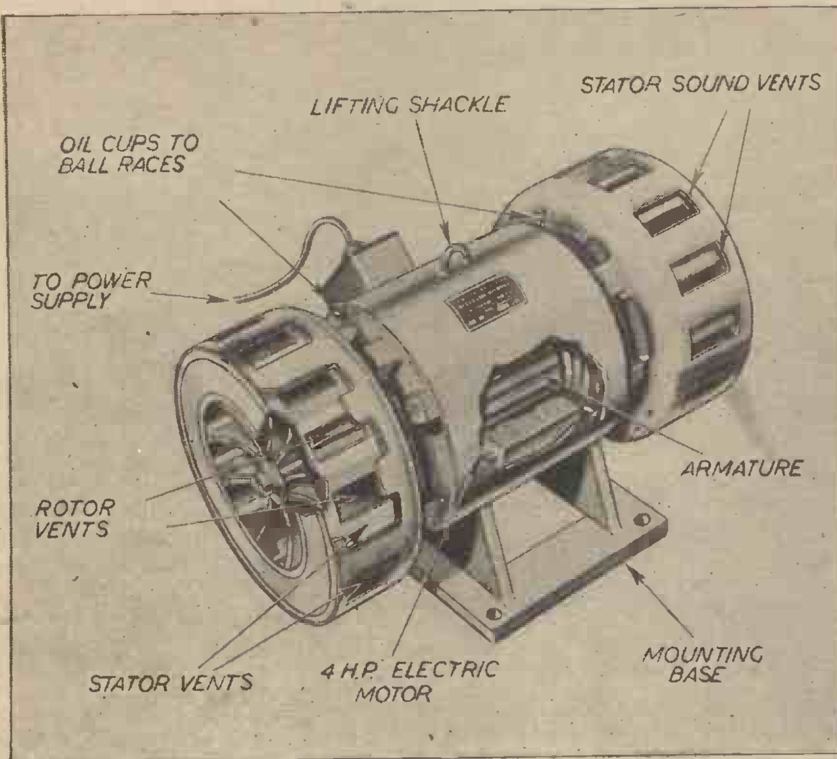
YOU cannot hold back the march of progress. The bicycle and the motor car and the aeroplane are here to stay, in spite of the efforts still made to prevent their development. No Government has yet had the wisdom to perceive this. They continue to make regulations concerning speed and parking, and lights, and one-way streets, and roundabouts, and pedestrian crossings; they view with alarm the accident statistics each year; they continue to think that these accidents are due to the carelessness of motorists, when it should be patent to everyone that if accidents happen year after year to the tune of some thousands, it is the system which is wrong and not the vehicle. We continue to tackle the effect instead of the cause. We extract millions from motorists to rectify these troubles, use the money for other purposes, and endeavour to make our obsolete system work by means of prosecutions. We waste man power in the police force trying to enforce those regulations. We do not provide parking places to enable road transport to progress peacefully. We make parking illegal. We do not make it illegal for manufacturers to sell a car capable of travelling more than 30 miles an hour, we create a speed limit, knowing that every motorist will break it. We, in fact, create a system of direct taxation out of progress, in the form of fines for offences which motorists are bound to commit. That has been the national trait, but I do not think that the British public will tolerate, when this war is over, any Government which, whilst paying lip service to the iniquities of King John, and the liberties created by the signing of the Magna Charta, continues to suppress and repress the march of progress, and the natural tendencies of civilisation. The Government must be alert to this important fact which has been impressed upon the public mind indelibly by the sinister and sintering effects of the present war. The public will not continue to tolerate legislation against progress; and legislation in this country has always been 50 years behind scientific developments and progress.

Index to Volume 8

THE index to Volume 8 of this journal is now ready. It may be obtained for 9d. from the Publisher, George Newnes Ltd. Tower House, Southampton Street, Strand, W.C.2. Binding cases and indexes may be obtained for 5s. from the same address.

The Air-Raid Warning System

How the News is Flashed Through the Various Distributing Centres When a Raid is Imminent



Detailed sketch showing the various parts of an air-raid siren.

STATIONED along our coastline are isolated groups of men whose duty it is to watch and listen. They are men of the Observer Corps, and it is through them that we first know that enemy aircraft are approaching our shores. As the drone of the approaching enemy planes is heard, the Observer phones through to his Fighter Command giving full information, such as number of planes and direction in which they are flying.

Fighter Command now take over, and it is through them that instructions are sent to anti-aircraft batteries and for fighter planes to be sent up to intercept the enemy. In the chart room all reports are plotted, and the movement of every plane is watched and followed. Fighter Command also keep in close touch with the "war room" of the Ministry of Home Security, and they also have to decide whether civilians should be warned, and the Civil Defence brought into action.

The "Yellow"

When the Command are in doubt as to where an enemy plane may be heading, they send out the "yellow" warning. Many people may think that this is done by means of a light, but it is not so, merely a message sent through the G.P.O. to Police Headquarters and the Control Centre of the district, informing them that their services must be ready for action. It does not mean that the sirens should be sounded.

The Chief Constable at Police Headquarters receives the "yellow" direct, and it is then radiated to each Divisional Police Headquarters and all sub-stations where there are sirens. The number of stations varies according to the size of the town, but in a moderately-sized town there would be about fifty. The Fire Brigade Superintendent who controls both the regular brigade and the A.F.S., also receives the signal and the fire services stand to.

Meanwhile, the Control Centre which is the headquarters of the A.R.P. springs to life. As soon as the "yellow" is flashed by Fighter Command to the Controller, he presses a buzzer and all A.R.P. personnel in the building spring to their stations ready for instant action. In the Control Room a yellow disc is placed over the white disc which indicates the "All Clear." Seated in the Control Room are representatives of the telephone, electricity, gas and water services, whilst the chief warden sits at a special table. Numerous other officials also take their places, and cycle and motor cycle messengers are told to stand by. Plotting clerks take up their position among charts and maps and it is their job to show the progress of the raid pictorially. Special pins are inserted in the charts to indicate blocked roads—a yellow pin if blocked by damaged gas mains, a mauve pin if by fire, a crimson pin if by debris, etc.

The medical services also play an important part in our vast Civil Defence Force. Although A.R.P. depots have their own first-aid parties, additional first-aid posts are manned by auxiliary parties who are sent out when the "yellow" is received. Attached to these additional posts are huge vans equipped as miniature hospitals and staffed by nurses of the Nursing Auxiliary in charge of a sister. A doctor is also attached to each van. There is also an emergency Blood Transfusion Service standing by ready to rush instant aid to the severely wounded. Special refrigerator vans convey the blood to wherever it is needed, and also carry the necessary apparatus (already sterilised) for administering the blood.

Another little-known service is the emergency Psychiatry (mental healing) service, which attends to those casualties suffering from shock and nerves.

The Red Signal

As soon as certain districts become within the bombing range of the enemy planes, the Fighter Command gives the red and last warning, and the Control Centre goes into action. The signal is passed on to all police stations and A.R.P. posts and the sirens are sounded (usually for two minutes). It tells the public to go to shelter and wardens and policemen to go to their jobs. The official A.R.P. term for bombs and incendiaries dropping in their area is "an incident," and as soon as one occurs the warden informs his report centre, who in turn passes the message on to the Control Centre, and it is their duty to send out orders to A.R.P. depots.

Finally, we come to the Fire Watcher, whose duty it is to tackle the incendiary bombs. All business premises and factories have their own Fire Watchers and it is their duty to put out the fire bombs before the fire has time to spread.

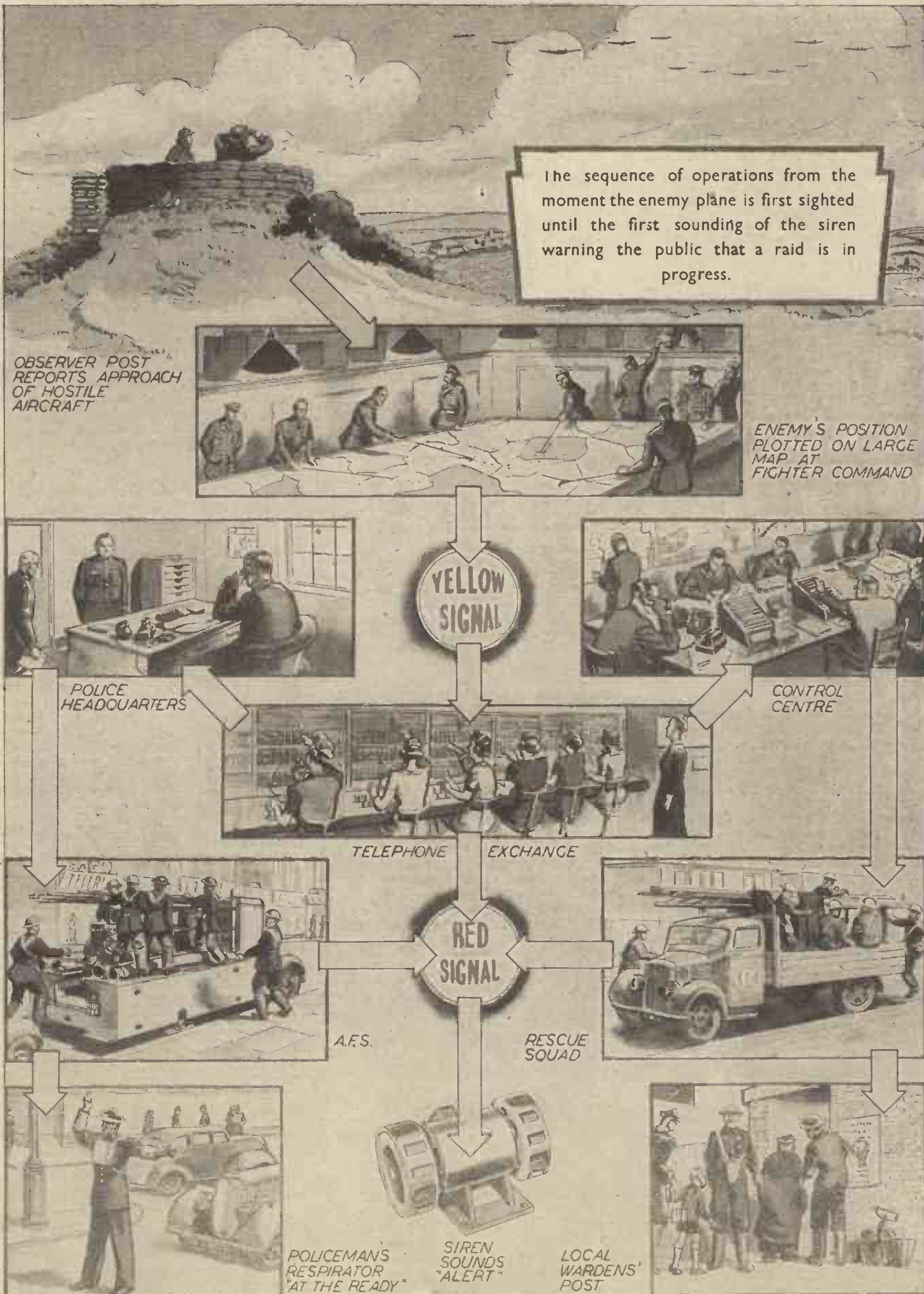
A.R.P. Training

Before A.R.P. personnel can be accepted as such, they have to go through a very intensive course of instruction. Take the warden for instance, he must know how to detect different types of poisonous gases, how to tackle incendiary bombs with stirrup pump and sand; A.F.S. men must know the correct method of tackling fires and first-aid men must know how to attend the injured. All this is taught by special courses of lectures, after which examinations have to be passed. Thus, it will be seen that nothing is left to chance in combatting an air raid.

The Siren

So far we have seen how the siren is sounded, now let us study its method of working. As will be seen from the illustration at the top of this page, it consists of a powerful electric motor, having on each end of its shaft a fan. The fan blades are contained in a wooden case having numerous bevelled openings all round it, and in each of these openings is inserted a loosely-held metal tongue. As the blades of the fan revolve at tremendous speed, they draw in air at each end of the fan which is then expelled with great force through the openings in the wooden casing, thus setting up a vibration with the tongues. The electric motor is controlled by a switch which can either be pushed over to red for sounding the "Alert" or white for the "Raiders Passed" signal. When the "Alert" is sounded, the siren produces a warbling note, whilst the "Raiders Passed" signal is a sustained note. Between sixteen to eighteen seconds elapse before the siren "warms up." The reason why warnings are not synchronised is that each siren is switched on individually from a telephone message.

Air-Raid Warning System Shown Pictorially



The Rotating Cylinder as a Source of Lift

Some Peculiar Properties of this Novel System Explained by R. H. Warring

The Flettner Rotor Ship.

THE peculiar properties that a rotating cylinder exhibits in an airstream is called the Magnus effect, and it will be shown in this article that such a cylinder (or cylinders) may be used in place of the wings of the conventional aeroplane, and the latter still be capable of flight.

It possesses no great advantages over the fixed wing, however, rather the reverse, for its drag is certainly greater and the resulting system, besides being complicated mechanically, is relatively much heavier.

An Interesting Experiment

I do not know of a single example of a "rotating cylinder" type that has yet flown successfully, but short "flights" may be obtained from a cylinder of cardboard by the following method.

A fairly rigid cardboard tube which is reasonably light will do quite well Round this wrap a length of thread, and place on the table as shown in Fig. 1. By giving the thread a sharp pull, the cylinder is pulled along in that direction (i.e. given a forward velocity), and at the same time is made to rotate (i.e. given a rotational velocity), by the thread unwinding. Provided that the pull is strong enough, and the force is applied normal to the longitudinal axis of the cylinder, it will hop off the table for a "flight" of a second or so, thus proving that the cylinder generates lift by virtue of its two velocities.

If the thread is led off from the top of the cylinder, so that the rotational velocity is of opposite direction, then it will not lift, thus showing that the direction of rotation also influences the lift. We shall see in a moment that in this particular case the "lift" force acts downwards.

Lifting Effect

The lifting effect of the first example is considerably enhanced if two end plates are fitted to the cylinder. These should be circular discs of approximately twice the cylinder diameter, so that the whole forms, in effect, a spool. This prevents "end losses," similar to those which occur on a fixed wing, but this will be dealt with in more detail later.

Let us examine the conditions that produce lift, analyse the flow, and try to produce a mathematical expression for lift in workable terms.

The cylinder has a rotational velocity and a forward (i.e. translational) velocity which, combined together, produce a flow giving lift.

Now it is a well-known fact in aerodynamics that any fluid, other than a perfect fluid, flowing past a solid object in its path, has those particles of fluid in contact with the solid brought to rest relative to the solid. (It does not matter whether we consider the body moving with a velocity V through stationary fluid, or the fluid flowing past the body with a velocity of V, the body being stationary. The effect is the same in both cases, but the latter simplifies analysis and is, therefore, usually assumed.)

Our statement above leads to the conclusion that when the cylinder is rotating, the air in contact with the cylinder, or the boundary layer as it is called, is also rotating with it at the same velocity.

Now air not being a perfect fluid, has a certain amount of viscosity, and so layers of air adjacent to the boundary layer are also dragged round with the cylinder.

Thus, when the cylinder is rotating, we have the air also being dragged around with it, or circulating around the cylinder as in Fig. 2. The boundary layer is rotating with the same velocity as that of the cylinder, and adjacent circulatory air flows are retarded by the influence of successive layers. Thus, a velocity gradient exists normal to the cylinder, but the whole mass of air adjacent to the cylinder is circulating.

Translational Velocity

The other component is a forward or translational velocity as in Fig. 2. Now the theory of aerofoils first propounded by Lanchester and later by Kutta, Jonkowski and Prandol, states that when a circulatory system is superimposed on a translational system, a lift force is produced. This force may be reckoned positive if it is acting upwards, or negative if downwards, and depends upon the relative directions of the two flows.

In Fig. 2 both flow patterns have the same direction over the top of the rotating cylinder. Thus, the resulting velocity is increased above that of the airstream, the streamlines are crowded together and there is a decrease in pressure on the top of the cylinder. Underneath the flow directions oppose one another, causing a decrease in velocity and an *increase* of pressure on the bottom of the cylinder. The streamlines in this area are spread apart.

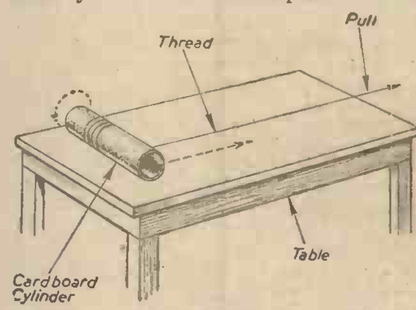


Fig. 1. Experiment with a cardboard cylinder.

Thus, we have a decrease in pressure over the top surface, and an increase on the lower surface of the cylinder, analagous to conditions existing over any normal aerofoil section. In just the same manner, then, there is a lift force produced which, combined with the drag force of the

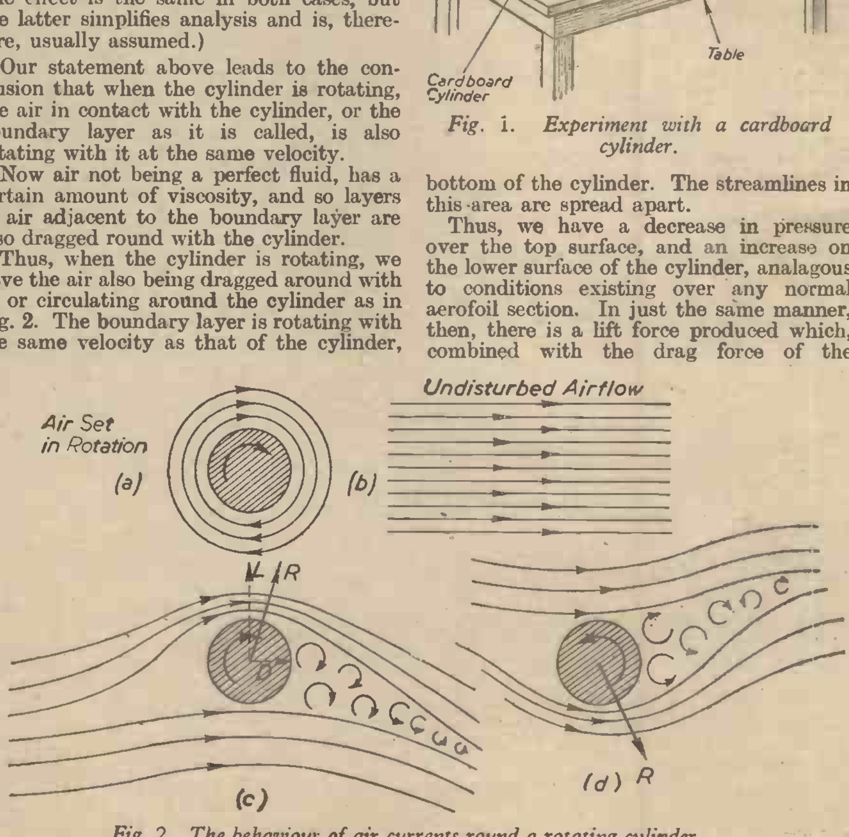


Fig. 2. The behaviour of air currents round a rotating cylinder.

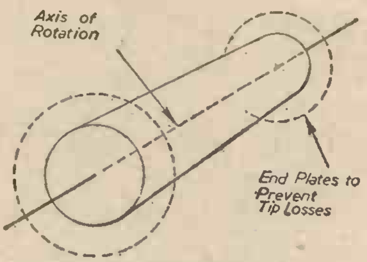


Fig. 3. Showing the position of end plates.

cylinder parallel to the direction of the translational velocity, gives the resultant aerodynamic force R (Fig. 2).

Streamline Distribution

If the cylinder is rotating in the opposite direction, as at d, Fig. 2, the streamline distribution is inverted. That is, there is an *increase* in pressure on the *top* and a *decrease* on the *bottom* of the cylinder giving a negative life, which, combined with the drag force as before, gives the resultant aerodynamic force which now acts *downwards* and backwards.

Behind the cylinder the flow twists up or burbles, and eddies break away and pass downstream, forming a turbulent wake. This turbulence is also present behind a normal aerofoil, but with the cylinder its magnitude is greater, and thus the resulting drag of the system is greater.

Assuming that the cylinder is lifting positively, we can see that there will be a tendency for the air to flow outwards from the high pressure region under the cylinder, and inwards along the top surface to the low pressure in that region.

End Plates

Thus, air is spilling round the ends of the cylinder from bottom to top, destroying some of the lift in these regions. Exactly the same thing happens to any aerofoil of finite span, but its effect may be minimised by the fitting of end plates (see Fig. 3); end plates are shown dotted. These should be simple discs whose diameter is approximately twice that of the cylinder. Note that they act as twin rudders and their area must be taken into consideration in computing side areas and lateral stability.

Calculating Lift

For such a rotating cylinder with end plates we can assume with a fair degree of accuracy that the circulation along the span (i.e. the length) of the cylinder is constant. Now the lift in terms of circulation is given by

$L = \rho\, v\, k\, l$ $\quad v$ = translational velocity.
l = span
ρ = mass density of air
k = circulation

Circulation is defined as the value of the line integral, $K = \int V \cos(v, s)\, ds$ for one circuit of a closed curve.

Now $V\cos(V,s)$ is the tangential velocity and so in the case of the boundary layer we can find K without resorting to integration. The tangential velocity is ωr, where ω = angular velocity of fluid element, and is appreciably equal to the angular velocity of the cylinder, and r is the radius, also equal to that of the cylinder.

Thus $K = \omega r\, 2\pi r$
$= 2\pi r^2\, \omega$

Whence $L = \rho V, 2\pi r^2\, \omega l$
$= \cdot 01495 V \omega r^2 l$ (since $\rho = \cdot 00238$ slugs/cu. ft.)

Thus, there are four variables dependent upon design, V, ω, r and l. Taking each of these in order:—

Lift $\propto V$, but drag $\propto V^2$, and so it would appear that a relatively low value of V is necessary in order to avoid excessive drag. Thus, such a system is not particularly suited for high-speed flying.

The angular velocity ω is limited in practice in order to avoid high stresses and centrifugal forces in the rotating system. On the other hand it should be as large as possible, so that the other factors may have minimum values.

Drag is proportional to l and r, thus is proportional to lr. Weight is also proportional to lr, and so this product should be kept low.

On the other hand, lift is proportional to r^2, that is, if r is increased *three* times *nine* times the lift is obtained, and so the best compromise would seem to be a cylinder of relatively large radius, provided that the weight and drag are not increased out of all proportion.

The drag force of the cylinder may be considered as made up of profile drag, and induced drag. The profile drag of a cylinder when the air stream is perpendicular to the

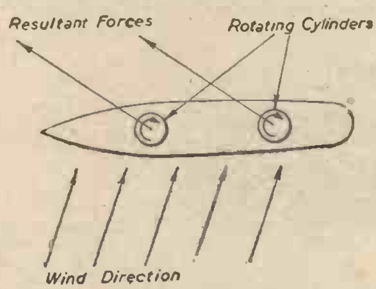


Fig. 4. Illustrating the resultant forces acting on a ship fitted with rotors.

axis of the cylinder is given by

$Do = .000121\, d\, l\, V^2$
d = diameter in inches
V = velocity in ft./sec.
l = length of cylinder in feet.

The dragi s then given in pounds.

The induced drag is rather more difficult to find. Expressed in terms of the circulation, it is

$$Di = \rho_2 \pi \frac{r^2}{l}\, \omega d\, l\, V$$

$$= \cdot 00374 \frac{r^2\, \omega d,\, lV}{l}$$

Total Drag

Thus, the total drag of the cylinder is found by summing these two, i.e.

D (total)Do + Di

$$d\, l\, V \left\{ \cdot 00121\, V + \frac{\cdot 00374\, r^2 \omega}{l} \right\}$$

Compared with that of a normal wing, it will be found that it is considerably greater for all *practical* values of V, ω, r and l, and thus the efficiency of the rotating cylinder is low. The lift/drag ratio may be calculated as a measure of efficiency.

The Magnus Effect has also found application outside of aeronautics. Apparently it was first noticed in connection with the deflection of cannon balls from their theoretical trajectory, and attempts were made to analyse this during the latter half of the eighteenth century without apparent success.

Flettner Rotor Ship

A novel and interesting practical application of the phenomenon was the Flettner Rotor Ship of about eight years ago. Rotating cylinders were fitted to replace sails. Two vertical cylinders were mounted on the ship and were made to rotate about their vertical axes by Diesel motors.

In any wind a " lift " force was produced which could be suitably used to propel the ship in the same manner that sails would normally do. Fig. 4 shows a plan view of the layout. The wind is blowing across the port bow, and the tall cylinders are rotating in the direction indicated by the arrows. The resultant aerodynamic force on each cylinder has a forward component which propels the ship forward.

Naturally, the direction and velocity of motion is dependent upon the wind strength and direction, and thus has the same limitations as an ordinary sailing ship. As

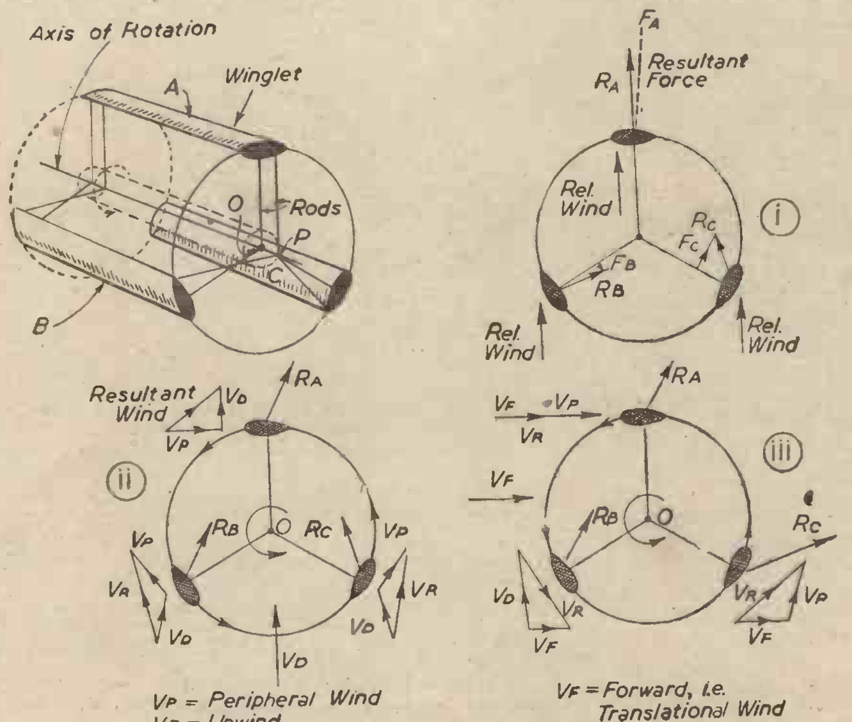


Fig. 5. Diagrams showing the streamline distribution.

an additional disadvantage, it requires the use of some motive power to drive the cylinders, and for these reasons is a scientific "curiosity" rather than a practical venture.

The Cyclo-Gyro

Whilst not relying on the same principle the cyclo-gyro is briefly described here as the comparison is interesting.

This machine derives its lift from a system of small wings rotating about a horizontal axis which is perpendicular to the direction of flight. Each winglet is connected by an arm to the horizontal axis, O, and by another rod or link, P, which can be moved at the control of the pilot, and thus the altitude of the winglet changed during flight (Fig. 5).

Any number of winglets may be used to make up the complete "paddle wheel," but only three are shown on the diagram for the sake of simplicity. They are engine driven, but a clutch device is fitted so that they may be disengaged in the event of engine failure when the machine will parachute gently downwards by virtue of the aerodynamic forces produced by the freely rotating paddles.

Consider first the case when the whole system is stationary, and imagine that the whole be suddenly dropped so that it falls straight downwards. The resultant wind is thus vertically upwards, diagram (i), and the resultant force on each of the winglets A, B and C is as shown by the arrows.

It will be seen that each of R_A, R_B and R_C, have a small force component F_A, F_B and F_C, acting in the same direction which will thus start the system rotating in an anti-clockwise direction. Revolving vertically, we see that there is also an appreciable (total) upward component which acts against the weight of the machine pulling downwards.

Now, when the system starts rotating, the direction of the relative wind is altered, being now the resultant of the peripheral wind and vertical (upward) wind, as in diagram (ii).

Aerodynamic Forces

Treating each winglet separately as an aerofoil, we can find the resultant aerodynamic force on each, and sum for the complete system. As the peripheral velocity (and thus the peripheral wind) increases, we see that the resultant force acts more and more in a normal direction to the periphery. That is, as the rotational velocity of the system increases, the accelerating force on the winglets gets less, until it disappears altogether, and an equilibrium position is reached when rotation is maintained at a constant rate. Any decrease in rotation brings the accelerating force into operation or any further increase or *retarding* force, and so the resulting system reaches equilibrium once more.

There is still an upward component of the resultant aerodynamic force, which is a maximum when the equilibrium position is reached, and thus slow descent is possible. In fact, the descent of such a 'plane closely resembles that of an autogyro—qualitatively at least.

Now, by an alteration of the setting of P with respect to O, and driving the paddles by the engine, forward motion of the whole is possible. The generalised scheme is shown in diagram (iii), and the resultant wind is now that of the forward wind, and the peripheral wind.

The direction of the resultant aerodynamic force on each winglet is now such as to retard rotation, and thus has to be overcome by the engine. The upward component (total) is relatively large, and thus supports the weight of the machine. Should it exceed the weight, then the machine climbs.

Performance Calculations

From this elementary treatment it is possible to carry out simple performance calculations, treating each winglet as a separate aerofoil and resolving the resultant aerodynamic forces tangential to the periphery, giving accelerating force, or retarding force, and thus power required, and vertically, giving the lift and thus weight supported.

It is a considerable improvement over the rotating cylinder, and has, in addition to greater efficiency, one great advantage that, in the event of the power failing, slow descent is possible. If, on the other hand, the cylinder loses its rotational velocity, the lift disappears.

The "P.M." Master Battery Clock

A "P.M." Master Battery Clock made by A. E. Damen.

IN our issue for May, 1940, we published constructional details of the "P.M." Electric Clock, and several readers have since built it. Recently, we received from two of these readers the following interesting letters. The first one is from A. E. Damen, of Southampton, who writes as follows:—

"I am enclosing a photograph of an Electric Master Clock which I have constructed with the aid of *Practical Mechanics* articles and blueprint.

I find the clock is a perfect timekeeper and very reliable; it gave me great pleasure in constructing it.

I may say, in passing, that I have taken *Practical Mechanics* for years and regard it as a very sound journal."

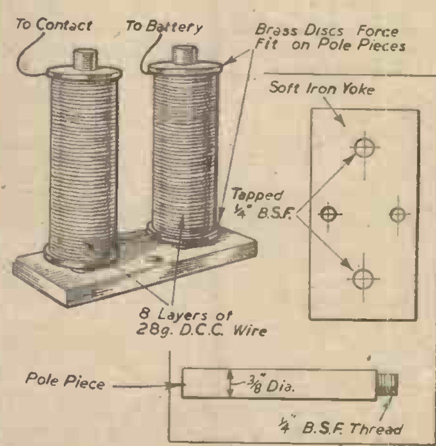
B. J. Frost, of Hitchin, sends the following notes regarding the coils for the electro-magnet. He writes:—

"Over a year ago I made up the *Practical Mechanics* Master Battery Clock, but until recently I have not been able to get sufficient pull on the magnet to give the pendulum more than two- or three free swings without an impulse.

Since making up this clock, I have experimented with many different windings, etc., and have at last overcome the difficulty by using coils as shown in the accompanying sketches.

Another point which greatly improves the timing for the slave clocks is by removing the seconds wheel from its shaft, and reversing it so that the part of the shaft which usually protrudes through the clock face projects through back of clock frame, to which can be soldered a much longer contact wire. This eliminates the trouble caused by wire taking too long to pass over the contact screw.

I hope this information will be of use to other readers who have constructed the clock."



Details of electro-magnet of B. J. Frost's electric clock.

The Stamp Cancelling Machine

An Electrically-Driven Machine Which Cancels 25,000 Missives Per Hour

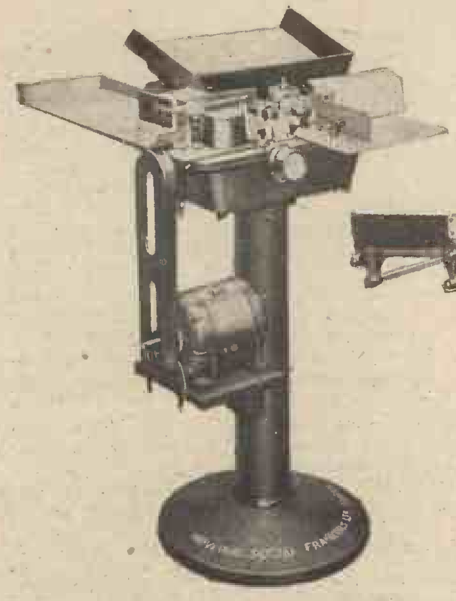
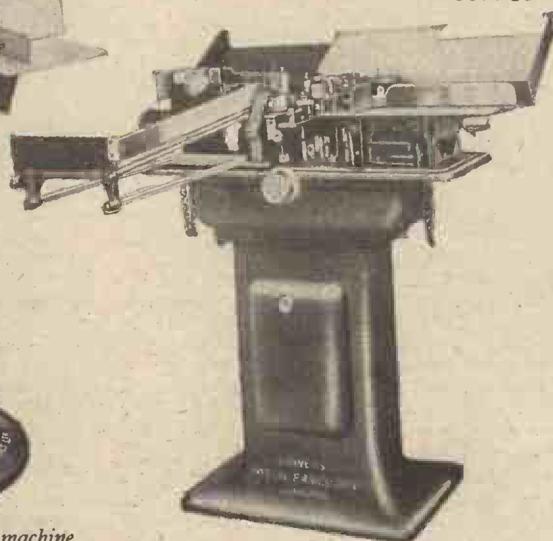



Fig. 1. (Above) A belt-driven machine which has a cancellation speed of 25,000 missives an hour. (Right) Another type of franking machine.

THE stamp cancelling machine possesses several features which are of interest from an engineering point of view. The machine, an illustration of which is shown in Fig. 1, is used by the General Post Office, and will handle a mixed mail of letters and postcards varying from 1 to 10 millimetres in thickness; it is not necessary to separate the letters from the postcards, as the machine differentiates between them, as will be described.

The machine illustrated is belt-driven by a ½ horse-power electric motor, and has a cancellation speed of 25,000 missives per hour. The margin of skipped cancellations allowed before the machine requires adjustment, is 1.5 per cent., i.e., it must not miss cancelling more than three letters per each 200 put through. During one G.P.O. test the machine averaged 580 pieces of mixed mail per minute with only one skipped cancellation per 500 pieces.

The fastest type of machine in use is known as the "Flier," and its speed of cancellation is 50,000 pieces per hour.

Before being passed through the machine, all letters must be faced with the postage stamps in the same relative position. In addition, letters containing hard substances such as keys or coins, and items which are exceptionally large are picked out, and passed to a position where they are hand stamped.

Operation

The "faced" letters are fed to the machine from the metal plate on the right-hand side. A stack of letters is placed on the platform with the addresses upside down. This brings the stamp into the lower left-hand corner. In the illustration of the machine, one envelope is shown on the platform in the correct position for cancelling. The letters are tapped against the upright plate on the left of the platform, to bring all the edges of the letters together.

The subsequent operations will be best understood by reference to Fig. 2, which shows a plan view of the top of the machine, with the unessential details omitted. Wheels A and B are the feed wheels. Wheel C is known as the separator. These wheels have rubber bands round their peripheries in order to get a grip on the letters. Wheel F is the impression roller, also rubber-edged.

The hub G carries the marking die with the name of the town, and the wavy lines which obliterate the stamp. The die fits into slots on the hub and can easily be removed for the purpose of changing the date and time type. The semi-circular wavy line die is screwed in position, and can be removed, if it is desired to replace it by an advertising plate such as the familiar "Buy British Goods."

The die hub only revolves when letters are passing. The inking roller IR bears lightly against the die hub and revolves when it revolves. The die is thus inked once for every revolution.

Wheels A to F revolve continuously when the motor is running, and the wheels B and C revolve in opposition. Wheel C is adjusted by means of the knurled screw S1 until it projects one thirty-second of an inch beyond the face of the corved metal guide. This assembly is pivoted at P. The gap between wheels B and C is adjustable by means of the knurled screw S2, and the adjustment is set so that the two wheels are almost but not quite touching.

When the machine is in operation, the first letter will be carried forward by feed wheel A. Wheels B and C revolving in

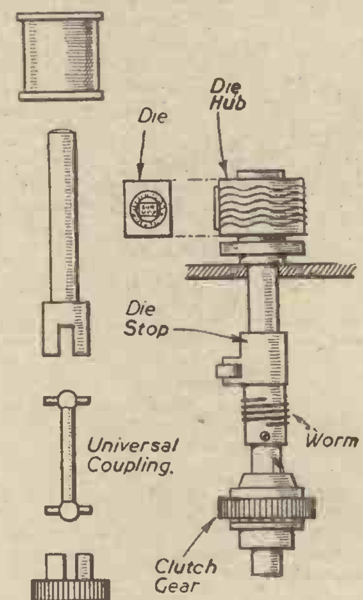


Fig. 3. Showing an exploded view of a coupling, also the die hub spindle with cam and clutch.

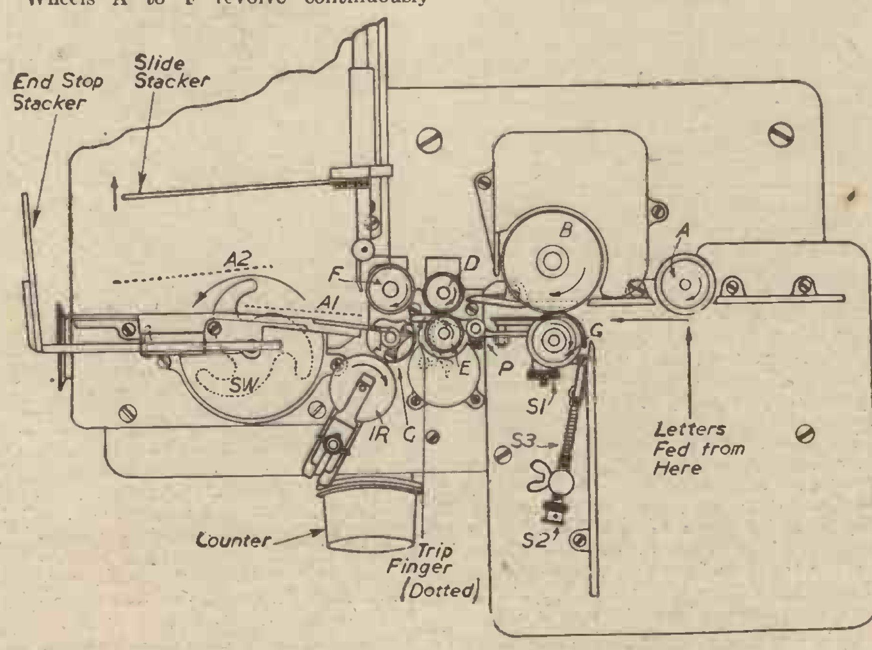


Fig. 2. A plan view of the top of the machine, with the unessential details omitted.

opposition set up a shearing action. Wheel B tries to carry the letter further forward, whilst C (the separator) tries to throw it back. By this time, however, the second letter will have been thrown forward by wheel A and will have taken up a position between the first letter and wheel C. Wheel B will, therefore, carry the first letter through, and wheel C will hold the second letter back until the first one has passed. In this manner only one letter or postcard is allowed to enter at a time. The gap between the two wheels will vary according to the varying thickness of the mail passing through; wheel C and its assembly swinging on pivot P against the compression spring at S3.

Automatic Letter Counter

The first letter now enters between wheels D and E, which are revolving in contact with one another, and in so doing the edge of the letter comes up against a trip finger (shown dotted in Fig. 2). This trip finger, which is very lightly sprung, is pushed forward by the edge of the letter which is stiffened by the grip of wheels D and E, and releases a cam on the underside of the die-hub spindle. This cam allows a clutch (also on the die spindle) to come into action, which causes the hub to revolve once as the letter passes between the die hub and the impression roller F. At the same time the automatic letter-counter registers once.

The letter is then thrown into the position indicated by the dotted line A1 in the path of the stacker wheel SW, which is revolving in an anti-clockwise direction. The fins of the stacker wheel then throw the letter to the position A2. The letters accumulate in this position, resting against the slide stacker which would be in the forward position just clear of the fins of the stacker wheel. As the letters accumulate they cause the slide stacker to be pushed back in the direction of the arrow.

The end stop stacker is adjustable, and can be set according to the length of the mail being cancelled (see Fig. 1).

It has been mentioned that the gap between wheels B and C varies according to the thickness of the mail passing through, wheel B being in a fixed position and wheel C movable. The drive to wheel C must, therefore, be flexible, and this is achieved by means of a universal coupling on the underside of the plate. Wheels D and F are similarly coupled so that they also may move according to the thickness of the letters passing. Normally, they are tensioned inwards by two helical springs. One of these couplings is shown exploded in Fig. 3, which also shows the die hub spindle with cam and clutch. The clutch is normally slipping when the machine is running and no mail is passing. When the cam is released by the passage of a letter past the trip-finger, the time taken for the clutch to come into operation and revolve the die spindle and hub, will decide the position of the impressions on the letter. The tension of the clutch is, therefore, made adjustable by means of a screw in the top of the die spindle. A rod passing down the hollow spindle rests on the upper plate of the clutch so that by raising or lowering the screw, the pressure can be increased or decreased, and the position of the impression controlled.

The drive to the counting meter is taken from the worm wheel shown on the spindle. All gearing on the underside of the faceplate runs in an oil bath, thus reducing the necessity for constant lubrication.

Our Busy Inventors

By "Dynamo"

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

A Long Drop

HALF a century ago the parachute was almost the Eighth Wonder of the World. To-day the parachute is a practical instrument of modern warfare, and it is also the lifebuoy of the aeroplane.

I note that an American has applied for a patent in this country for a parachute training and amusement device. The invention is designed to give military and civilian aviators experience in parachute jumping. A further aim is to provide attendants with training in the use of an amusement contrivance, consisting of a tower and a parachute arranged to be dropped therefrom, while carrying one or more passengers.

Constructed of steel, or timber, and braced against any force tending to overturn it, the tower, for the effective use of the apparatus, should be at least from one hundred to one hundred and fifty feet high.

On the summit of the tower is a lateral platform or boom strong enough to sustain the weight of the apparatus and a hoisting cable.

This gallows-like erection with a long but safe drop will accustom airmen and the public generally to descents from the clouds.

The Ever Ready Pump

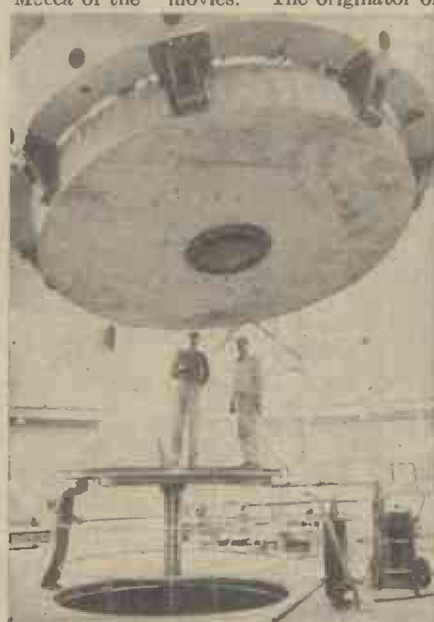
THE incendiary bomb has been the means of starring the stirrup pump. An application for a patent relating to the pump has been accepted by the British Patent Office. The invention concerned has for its object the provision of an attachment whereby the hose may be neatly coiled and its nozzle can be protected from damage. There is also an arrangement for suspending the pump from a wall, when not in use.

The attachment in question comprises a clip adapted to be secured to the barrel or other part of the pump. It includes a bracket on the clip, over which the hose may be coiled and a hook or loop for the suspension both of the pump and the hose.

When the incendiary bomb descends, the stirrup pump is immediately available for the presentation of a stirrup cup, not of fire water but of a flame-quenching liquor.

Novel Sound Effects

IT is fitting that a method of producing novel sound effects should hail from the Mecca of the "movies." The originator of a striking invention of this description resides at Los Angeles, California, and he has applied for a patent in this country.



To aid in the tests in the delicate machinery for the operation of the huge telescope at the Mount Palomar Observatory in Southern California, a dummy mirror of concrete has been put in place as a "stand-in" for the 200-in. glass which is being ground at the California Institute of Technology. Two members of the technical staff are seen standing on a hydraulic elevator inspecting the installation.

The apparatus enables a human being to modulate sound so as to form articulate words and phrases, without the use of the normal vocal chords.

By means of what is termed an electro-acoustic transducer, mechanical vibrations are applied to the skin of the throat. The sound waves thus generated within the vocal cavities may be moulded by the tongue and lips to produce language having the characteristic of the source whence the sound proceeds.

This device will allow startling effects to be obtained. In animated cartoon photoplays, ducks, dogs, whistles, saws and the like may be made to speak. For example, the sound produced by a circular saw cutting a piece of lumber may be recorded.

For the Dumb

THE inventor of a recent device for aiding the dumb states that oscillators qualified to produce any given or desired frequency may also be employed as the source of the sounds. Therefore, the use of such oscillators will be especially helpful to those who, owing to the destruction of their vocal chords, have lost the ability to speak.

An oscillator capable of supplying frequencies similar to those of the speaking voice, can provide voice current to the transducer. This being in contact only with the skin of the throat, can be worn without being conspicuous. The wearer will be able to speak without having to hold a tube in the mouth, as is the case with the artificial larynxes now known.

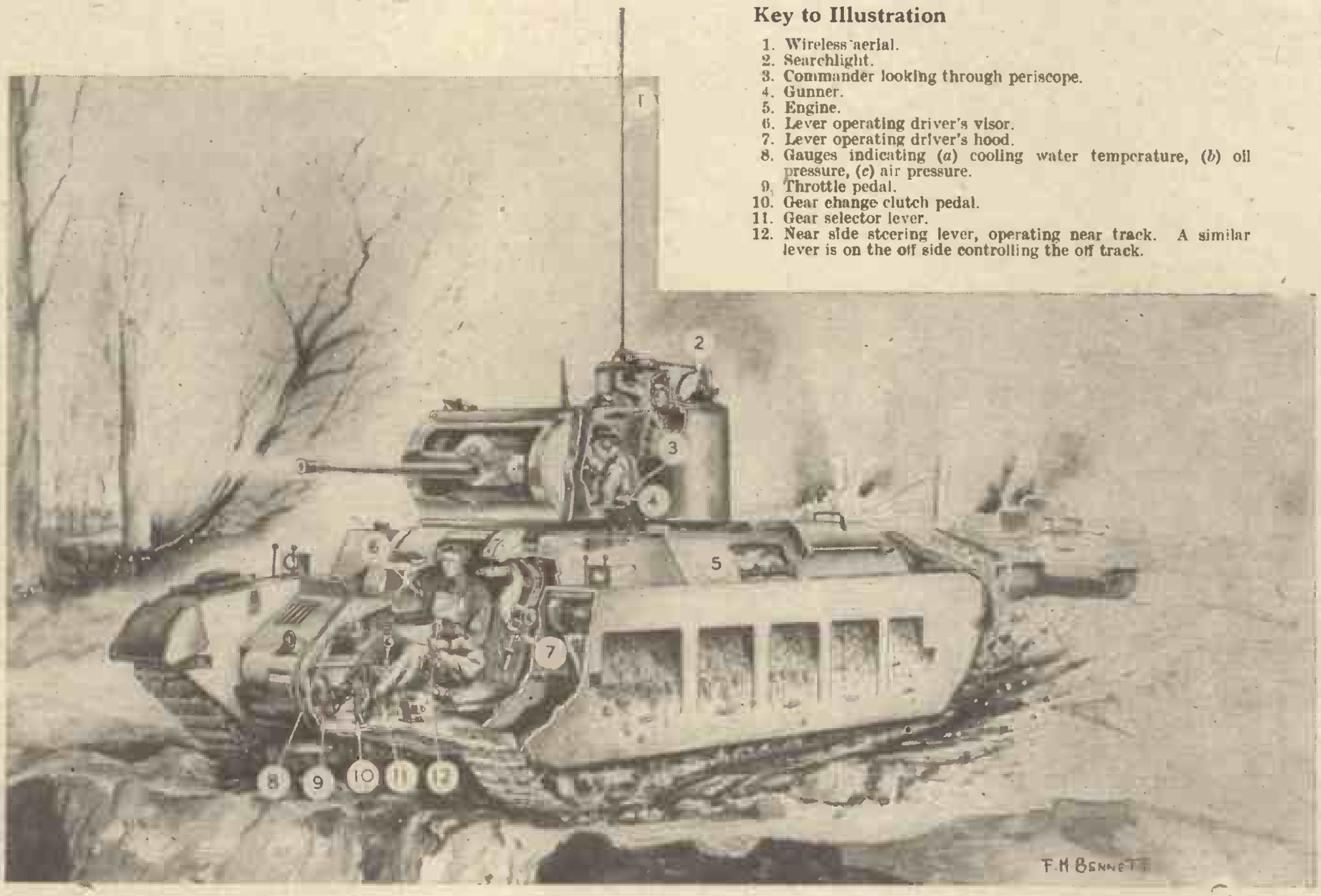
Wood Diet

ACCORDING to a Czech newspaper, Dr. Bergius, a German Nobel prize-winner in chemistry, has invented an artificial stomach capable of pre-digesting wood, and preparing it for human consumption. The learned doctor claims that hydrocarbonic produce forming the basis of compounds similar to white of egg can be obtained by this method.

The New "Matilda" Tanks

Key to Illustration

1. Wireless aerial.
2. Searchlight.
3. Commander looking through periscope.
4. Gunner.
5. Engine.
6. Lever operating driver's visor.
7. Lever operating driver's hood.
8. Gauges indicating (*a*) cooling water temperature, (*b*) oil pressure, (*c*) air pressure.
9. Throttle pedal.
10. Gear change clutch pedal.
11. Gear selector lever.
12. Near side steering lever, operating near track. A similar lever is on the off side controlling the off track.

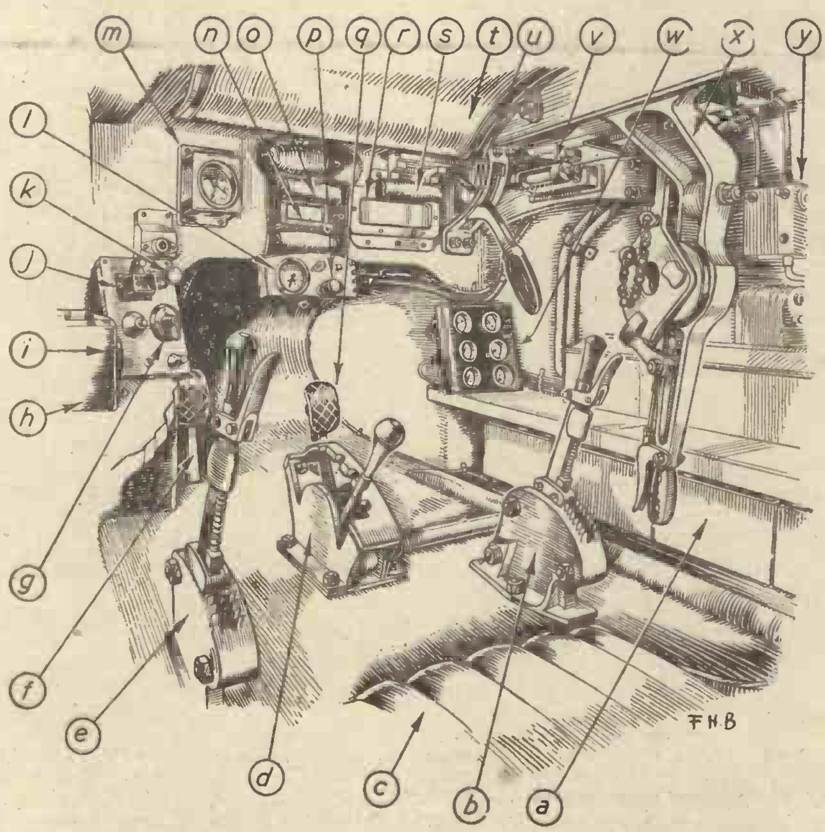


Notes

Weight 28 tons.

A small bell push at the rear of the tank is provided to warn the tank crew that they have callers.

This is the type of tank being rushed through the factories to supply our ally, Russia.



Interior of Driver's Compartment

a. Accumulators.
b. Off side steering lever.
c. Driver's seat. Adjustable for height.
d. Gear change selector.
e. Near side steering lever.
f. Gear change clutch pedal.
g. Lamp switch.
h. Switch box.
i. Ammeter.
j. Engine cut-out.
k. Engine starter button.
l. Speedometer.
m. Stop and trim time clock.
n. Periscope.
o. Periscope brow pad.
p. Electric horn button.
q. Engine throttle pedal.
r. Bullet-proof glass view panel.
s. View panel brow pad.
t. Driver's sliding hood.
u. Lever actuating visor.
v. Festoon interior light (repeated on the near side).
w. Instrument board. (Top pair) Water temperature gauges. (Middle pair) Oil pressure gauges. (Bottom pair) Air pressure gauges.
x. Lever operating driver's sliding hood. Repeated on the near side.
y. Electrical switch gear.

Running Cars on Coal Gas

Some of the Problems Connected with the Simple Conversion of Petrol Vehicles to Operate on Low-Pressure Town Gas.

By E. A. C. Chamberlain, Ph.D., D.I.C.

(Continued from page 8, October issue)

A motor van fitted with a Walsh Collapsible Crate for holding the gas bag.

It has not been possible to obtain any figures of direct conduction and radiation losses from an engine operating on gas or petrol, but the following determination of jacket losses shows that there is a greater heat loss to the walls when operating on gas than on petrol.

Summing up the foregoing considerations, it is possible to express the percentage power loss on simple conversion of a petrol engine to gas in the form

Loss % = 100 (1—f× volumetric efficiency ratio × F)

products of combustion and specific volume change. In other words:—

Gas

R.P.M.	B.H.P.	Gas rate cub. ft. /hr.	Heat input B.Th.U. /hr.	Temp. rise in cooling water °F.	Heat content of cooling water B.Th.U. /hr.	Jacket loss %	Power development % heat input
1,000	13.6	372	185,500	71	80,250	43.2	18.7
1,500	19.6	530	264,000	86	100,000	37.9	18.9

Petrol

R.P.M.	B.H.P.	Petrol consumption gals./hr.	Heat input B.Th.U. /hr.	Temp. rise in cooling water ° F.	Heat content of cooling water B.Th.U. /hr.	Jacket loss %	Power development % heat input.
1,000	13.6	1.3	195,000	66.5	72,500	37.2	17.8
1,500	19.6	1.8	270,000	86 0	93,800	34.5	18.5

where f = a factor involving calorific value of the fuel air mixtures, specific heat of the

f = the ratio of pressures developed by explosion of equal volumes of the two fuel/air mixtures at constant volume.

F = an indeterminate factor involving flame characteristics convection and radiation losses, greater than unity.

Power loss = 100 (1—.875 × 0.93 × F) = 100 (1—0.814 F).

It is therefore to be expected that under the conditions of simple conversion the power loss will not be less than 100 (1—0.814) per cent.

Power loss = 18.6 per cent. of the power on petrol.

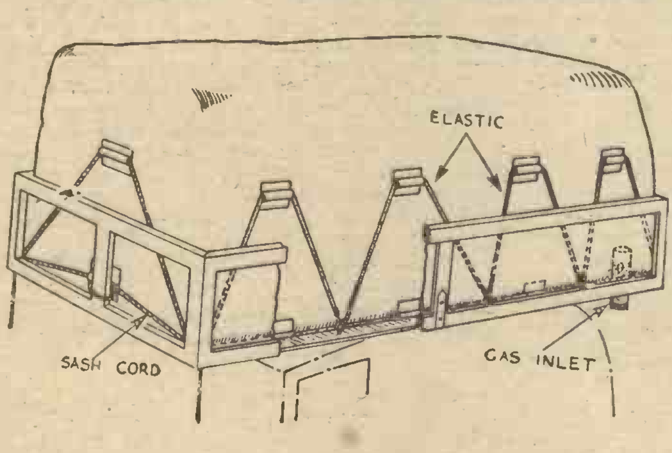


Fig. 5. Crate, showing method of fixing gas bag.

Experimental Determinations of Power on Gas and Petrol

Burstall gives a comparison of petrol and gas on a single-cylinder test engine (Cambridge E.35) at 1,500 r.p.m. at a compressio ration of 5: 1. I.M.E.P. on petrol 141, on gas 126 lb. per sq. in., corresponding to a power loss of 10.7 per cent. This figure must be regarded as ideal, since the engine was specially tuned to obtain maximum power on both fuels.

Walter quotes the following results for the simple conversion of a 7-h.p. 4-cylinder engine:—

Fuel	Max. B.H.P.	Fuel consumption per B.H.P./hr.	Brake thermal efficiency %
On petrol	11.2	—	22.6
On gas	7.4	27 cub. ft.	19.6

Loss of power on gas 34 per cent.

The same author states that on engines with the C.R. increased to 6.5: 1 it is possible to obtain with town gas 85 per cent. of the power on petrol, and 90 per cent. if the hot spot in the induction system is removed.

Rixman did complete tests with gas and petrol on two engines—(1) a slow-running 6-cylinder engine of 120 mm. bore × 160 mm. stroke, normal speed 1,250 r.p.m.; (2) a high-speed 6-cylinder engine, 79 4 mm. bore and 117.5 mm. stroke, maximum speed 3,200 r.p.m. Engine No. 2 had marked preheating of the induction system. His results are given as follows:—

Engine 1.

Speed	Loss of power per cent.
700	20
900	21.5
1,100	19.5
1,300	14
1,500	9 5

Engine 2

Speed	Loss of power per cent.
1,200	21
1,600	19
2,000	22
2,400	24
2,800	25

Our own test results may be summarised as follows:—

Engine	R.P.M.	Gas	Petrol	Per cent. power loss on gas
Commer 14/4	2,500	20.1	30.0	33.0
Austin 16/6	2,500	30.2	39.4	23.4
M.G. Sports	4,500	30.2	42.0	28.0

These results were obtained on unmodified engines.

As would be expected, these results indicate that the loss of power on typical small high-speed engines is greater than on the larger cylinder type of slow-running engine. It is therefore possible to anticipate that the power losses on vehicles converted to town gas will be:—

(1) Lorries with slow-running engines, 15 to 20 per cent.

(2) Light vans and private cars, 20 to 30 per cent.

Thermal Efficiency of the Engine

Heat that is not converted into work is left to raise the temperature of the cooling water and of the exhaust gas, so that the higher the efficiency, the lower the waste heat must be. This effect is bigger than is at first evident; for consider two engines, one giving 18 per cent. efficiency, and the other 25 per cent. At the same heat input the waste heats are in the ratio of $82/75=1.1$. If, however, a comparison is made on the basis of equal b.h.p. output, the waste heat ratio is

$$82/75\times25/18=1.52$$

So that the less efficient engine when working at the same power output has 52 per cent. more waste heat to dissipate.

The conversion of a petrol engine does not necessarily reduce the thermal efficiency; indeed, under the right conditions slightly higher efficiencies than with petrol can be obtained. With simple conversions these conditions are not attained. As a result it appears that the efficiencies of gas conversions are often slightly lower than on petrol. Dynamometer tests show that between 25 to 30 cub. ft. per b.h.p. may be expected for a normal conversion. Typical results obtained are as follow:—

14/4 Commer. Carburettor G.L.C. No. 1

R.P.M.	Cub. ft./B.H.P./hr.	Efficiency per cent.
1,500	30.8	16.6
2,000	27.4	18.6
2,500	29.0	17.6
3,000	28.6	17.9

16/6 Austin. Carburettor G.L.C. No. 2

R.P.M.	Cub. ft./B.H.P./hr.	Efficiency per cent.
1,500	27.4	18.6
2,000	28.0	18.2
2,250	25.0	20.4
2,500	27.6	18.5

C. M. Walter and J. S. Clarke do not give actual efficiency figures in this form except for an engine with the compression ratio increased to 5.6: 1: but from curves drawn from the engine (Austin 20/6 in its original form with a compression ratio of 46: 1 it appears that the best efficiency on gas was 20.5 per cent., equivalent to 24.8 cub. ft./b.h.p./hr. with a calorific value of 500 B.Th.U./cub. ft.

For the modern petrol engine the corresponding consumption may be taken as 0.6 pint/b.h.p./hr. which corresponds to an efficiency of 22.6 per cent. While these figures may be taken as an average on grade 1 petrol, our own results on the Austin 16/6 running on Pool petrol indicate a consumption of 0.65 to 0.7 pint per b.h.p./hr., giving efficiencies between 20.9 per cent. and 19.4 per cent.

R.P.M.	B.H.P.	Cub. ft./B.H.P.	Ignition timing
1,500	19.5	26.35	1° after T.D.C.
1,500	19.5	26.75	6° before T.D.C.
1,500	19.15	27.25	11° " "
1,500	18.35	29.40	16° " "
1,500	17.78	31.2	21° " "
1,500	16.72	34.7	26° " "
1,500	14.68	38.3	36° " "
1,500	12.50	44.8	46° " "

The Influence of Ignition Timing

It has been found on road tests with vehicles fitted with manual ignition control (Ford 24.9-h.p. van and a Morris Commercial 14-h.p. van) that the optimum ignition setting on gas was only slightly in advance of that for petrol, whereas it is generally considered that a large ignition advance is desirable. The following test on the Austin 16/6 gave the results shown in the table.

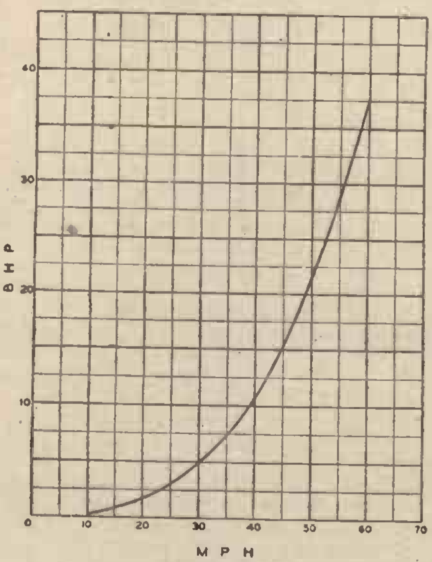


Fig. 6. Curve showing horse power required to overcome wind resistance of a gas bag 21 sq. feet frontal area, at speeds up to 60 m.p.h.

Following this test, attempts were made to recover part of the power loss at the advanced ignition settings by readjusting the air gas ratio delivered by the carburettor, but no improvement could be obtained.

It appears, therefore, that though it is possible on gas to obtain higher thermal efficiencies by working with weak mixtures and a large ignition advance, this result can only be obtained at the expense of power output which cannot be afforded in the general conversion.

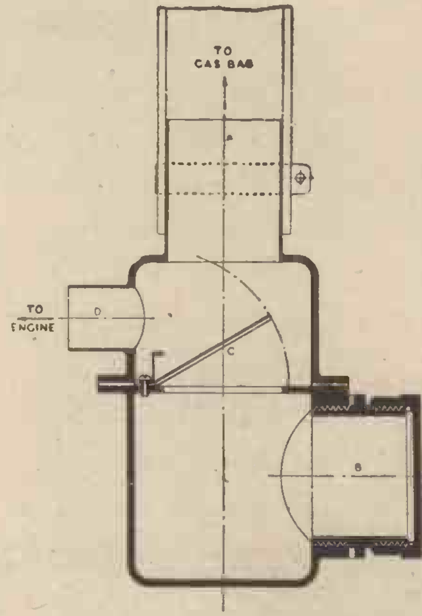


Fig. 7. I.G.C.C. filling valve

Sparking Plugs

Owing to the fact that an engine tends to run hotter on gas than on petrol, it is sometimes found that when converted to gas pre-ignition occurs, due to plugs overheating. This is by no means general, and usually any trouble can be cured by setting plug gaps to 15/1,000 in. and advancing the ignition slightly. Small engines up to 12 h.p. on certain makes of vehicle are sometimes difficult to cure by this means, and plugs with a higher heat dissipation factor are required. The following list gives an indication of the plugs recommended:—

Maker	14 mm.	
	Standard	Gas
K.L.G.	F 50	F 70 X
Lodge	C 14	H.D. 14 H.B. 14 (Sintox)
Champion	L 10	L 10 S, LA 10

This list covers ½-in. reach plugs only, and makers' lists should be consulted for more complete information of other plugs.

(To be concluded.)

The American long range stratosphere bomber, "Flying Fortress," skirts a billowy cloud at 13,000 feet.

War in the Stratosphere

How the Problems Involved Have Been Solved

A NEW phase in aerial warfare was introduced when the American-built Flying Fortresses went into action for the first time over Brest. The great height at which they fly makes ordinary methods of detection difficult, or even useless. A stick of bombs bursting in the target area is the first warning of the approach of this type of bomber. It is then too late for fighters to go up, even if they were able to reach this great altitude, as by the time they had reached it, the bomber would be several miles away.

Many problems have had to be overcome before these Flying Fortresses could be built. Provision had to be made to protect the crew against reduced pressure and rarified atmosphere. Air-screws will not have the same power owing to the reduced density, and thus do not carry the plane forward as far for each revolution as they would at sea level. The absence of moisture at these great altitudes eliminates the danger of icing, but a temperature of sixty-seven degrees below zero will freeze up oil. Engines and guns that are water-cooled become difficult to operate, and the low density hampers air-cooled engines.

Protection of Crew

In considering the protection of the crew the question arises as to whether this is to be achieved by pressure cabins or special types of suit for each member of the crew. The pressure cabin is a specially designed fuselage which is strengthened to maintain an even pressure inside. Air is sucked into the cabin, under pressure, from the outside, and used air escapes at the tail. In such a cabin the crew can move about without discomfort. This is preferable to a pressure suit, which is cumbersome and hampers free movement. One of the dangers in a pressure cabin lies in the fact that a single bullet penetrating both the fuselage and inner cabin would be sufficient to explode the entire aircraft.

The choice of crews requires considerable care, and as much research as in the construction of the aircraft itself. The effect on their health is constantly under review. Before crews go up in the Fortresses they are put into a pressure chamber which reproduces the atmosphere at 30,000 feet or more. They learn how to become "oxygen conscious," and to understand what effect the lack of oxygen has on a man. Among the strange effects produced are a warping of the judgment, a spurious self-confidence, a slowing down of the brain, blurring of vision, and weakness in arms, legs, hands and feet. New problems arise should the crew have to bale out. In order to deal with this, they are given a course of special parachute drill in which they are trained to use their oxygen until the last moment. The breath must be held until the last moment and the ripcord must be pulled promptly. Any delay may result in unconsciousness, making this impossible. Portable oxygen bottles are now removing much of this difficulty.

Engine Performance

Engine modifications which have been made to secure maximum performance at these great altitudes are still secret, but it is known that the Flying Fortresses have the remarkable speed of 305 m.p.h. at 25,000 feet. This is made possible by superchargers driven by the flow of exhaust gases and not by the engines. By this means none of the power is taken out of the engines. Another problem was to make bearings which could stand up to the intense heat, and in this connection the Americans have found an alloy which is suitable. The Fortresses are powered by four 1,200 h.p. Wright Cyclone radial engines, and have a range of 2,450 miles, with a cruising speed of 220 m.p.h.

Armament

Flying Fortresses are equipped with seven guns, one firing forward, two from an astral hatch, one from each beam, and two from a hatch in the floor of the fuselage. Six of them are Browning .500 guns, while the seventh, firing forward, is a Browning .303. The bombs, of which a load of about four tons can be carried, are stowed vertically. In the windowed nose of the aircraft is the bomb aimer's cabin, which is below the pilot's cockpit and is reached through a floor hatch. He is rather better off in the matter of comfort than the gunners, since his cabin is sealed with a thick felt lining which covers the walls. He also wears an electrically heated suit. The secret Sperry gyroscopically-controlled bomb sight is used which, it is claimed, is extremely accurate.

The Pilot's Cabin

Two pilots can sit side by side in the pilots' cabin where there are 130 controls, instruments, and gauges. One man can handle the aircraft at ordinary heights, but two are usually at the controls at the take-off and at the maximum altitude. Inflation of the dinghies is controlled from the pilots' cabin, and almost everything is electrically operated. The radio operator's cabin is forward.

Dimensions

The wing span of the Fortress is 103 ft. 9 ins., its length is 68 ft., and height 15 ft. 6 ins. Its great size makes an ordinary medium bomber look like a very small aeroplane.

Future Developments

Already the first Fortresses have been improved upon, and later models embodying the latest refinements are well on the way to completion. The battle for height goes on unabated, and in the future the air battle zone may well be at altitudes from 50,000 to 60,000 feet. In 1937, Flight-Lieutenant Adam of the R.A.F., reached a height of 53,937 feet, the highest then reached by a heavier-than-air machine. The United States explorers, Anderson and Stevens, reached 72,395 feet in a balloon in 1935, and Piccard and Cosyns, 54,789 feet in 1932. The stratosphere data obtained by these pioneers laid the foundation for the modern stratosphere bomber.

From the stratosphere bomber the next step is likely to be the stratosphere fighter, in the designing of which, many fresh problems will need to be solved. Pressure cabins for single-seat fighters seem to be out of the question, mainly because they would be likely to impair performance and manoeuvrability. Increased power and speed of climb will be necessary. It was demonstrated by Swain and the late Adam, that one man could successfully pilot a plane in a stratosphere suit. Their reports indicated, however, that these suits were not sufficiently trustworthy for every ascent. Another fact to be considered is that such suits must be easy to put on. Any delay in this respect would defeat the object of the stratosphere fighter.

THE MONTH IN THE WORLD OF

Science and Invention

Hairbreadth Control

IT is often necessary to fit cut-outs in a mechanical or electrical circuit, either for protection or for recording purposes. A unit which magnifies the movement of a diaphragm over a thousand times has been devised by the Westinghouse Research Laboratory of America. It is claimed that it can operate in circuits where the current involved is very small.

An Artificial Eye

A NEW artificial eye, made of resin, has been invented by Dr. Dimitry, of Louisiana State University. He claims that it can be moved by the eye muscles just like a real eye.

A New Land-water Tank

A NEW type of amphibian tank, capable of travelling 60 miles an hour on land and 15 miles an hour in water, is being tested in New Orleans.

Marconi Mausoleum

THE remains of Marconi, the wireless pioneer, who died in 1937, have been placed in a sarcophagus in a mausoleum erected at Pontecchio. It was at his father's country house in Pontecchio that Marconi made his first wireless experiemnts.

Cure for Stomach-ache

A NEW remedy for spasmodic stomach-ache, obtained from the purple sheen of coal tar, was announced at the American Chemical Society's annual meeting in Atlantic City.

Eye Jerks

TWO American research workers have made the discovery that, when we read, our eyes perform a sort of physical jerks all the time at an astonishing speed. They have also revealed that these physical jerks are accompanied by electricity. Apparently, when we read a line of type of three and a half inches long, the eye does it in six stages, varying a little from person to person. There is a tiny pause between each stage, which lasts only about one-hundredth of a second for the meaning of the printed word to be registered on the brain.

A view of the General Electric Co.'s new fluorescent plant at Jackson, Missouri. This plant, said to be the largest of its type in world, can turn out from 10,000 to 20,000 lamps per shift.

New U.S. Cargo Ship

IT was announced recently by the U.S. Navy that it has succeeded in designing a cargo ship of a radically new character, which could be produced by hundreds in a much shorter time than other types. It can be built in inland yards and taken to the sea by river or canal, it is light in weight, simple in construction and relatively cheap to build and maintain. According to the Navy the first of these ships, which is to be called the *Sea Otter*, will carry a net 1,500 tons cargo. When loaded, it displaces 1,900 tons, and is only 270 ft. long. The ship is powered by 16 six-cylinder petrol engines, developing altogether 1,700 h.p. and a unique feature is the use of a 6 ft. propeller sunk into the water amidships instead of at the stern.

Riveting Machine

A MACHINE has recently been produced which pierces and sets rivets in two strokes. A piercing die for the work and a ram for the riveting are incorporated in a reversing head, which turns over at each operation. A spotlight on the machine locates the position of the rivet before the ram comes into operation. The whole job is about the size of a medium high-speed drilling machine, and stands about six feet high.

New Comets

THE Soviet astronomer, Professor Neujmin, has discovered two new periodic comets, according to a report from Moscow. He has already discovered nine other comets.

Porous Castings

AN ingenious method of rendering castings, which have been rejected on porosity, suitable for pumps, is announced by Durez Plastics and Chemical Inc. It is said that the Navy department have approved the method for certain classes of pumps, which consists of forcing plastic resin into the pores under pressure of 45-100 lb. sq. in. An alternative is to seal up the outlet of the casting. The resin is then hardened by baking at 250-275 deg. F. for several hours, or heated in a pressure tank with steam at 20 lb. sq. in. for two hours, followed by a further two hours at 100 lb. sq. in. steam pressure.

An Electric Tooth Brush

DR. P. O. ROSENTHAL, of Minneapolis, has, after four years' research, perfected an electric tooth brush, which he believes will abolish hand brushing. It appears to be an ordinary brush set in a handle resembling an electric shaver. A motor operates the brush in the rotary motion approved by dentists. The device can be plugged into any light or power socket. It gives the gums a better massage, says the inventor.

Power of the Sun

RESEARCH experts at Massachusetts Institute of Technology are attempting to accomplish something that scientists have tried to do for years. They are working day and night to evolve a method of shackling the rays of the sun. They believe they can make the sun's heat operate on some suitable chemical material so as to let loose undreamed-of supplies of heat, light and power for the world's machines. The chairman of the Fuel Research Board, Sir Harold Hartley, says: "Their ultimate object is the utilisation of the sun's radiation by some photo-chemical or photo-electric device—such as made the talkies possible—to take the place of oil and coal.

"The use of electricity as a motive power and wireless had both been possibilities for centuries—yet their real use was revealed to the world as a complete surprise. So it is likely to be with the harnessing of the sun's rays to the mechanical needs of humanity."

Rubber Road Springs

VEHICLES fitted with rubber instead of helical or leaf pattern steel springs have given promising results during recent experiments. Both front and rear independent wheel springing systems, using relatively large-dished cylindrical rubber blocks with conical steel side plates, have been investigated. The torsional effect of the rubber blocks resists the springing action of the car in a somewhat similar manner to the torsion method of springing used on Citroen cars. Certain difficulties were experienced with the steering and front end stability during the earlier stages of the road tests, which covered a distance of 60,000 miles. Certain components were redesigned to overcome these, notably, the pin ball joint. The springing method has been shown, under further tests, to bed satisfactorily under severe conditions of service.

New London Beacons

TWO new-type pedestrian crossing beacons have been set up experimentally in London, at the request of the War Transport Ministry. They comprise two flat metal discs set at right angles on top of the existing posts. They are the same colour as the globes and have been revised because last winter's raids caused havoc among the glass beacons. If they are officially adopted, the new beacons will replace existing ones as replacements become necessary.

New Type of Bridge

A NEW type of bridge is under construction in Sussex. This is the first time the 'Derrick and Preventor" method of launching has been carried out. Two double truss girders, each weighing 27 tons, and 140 ft. in length form the main part of the bridge. A derrick is erected to pull by winch, the girders across a river. A cable and winch is secured to the opposite end to prevent the girder toppling when past the point of balance.

The Shasta Dam

THE Shasta Dam in America is now one-sixth completed and it already contains more concrete than any other dam in California. The six-millionth yard of concrete is expected to be placed in position in 1943 or 1944 when the dam will go into service to aid inland navigation, help control floods, and furnish water and power to agriculture, industries, and cities.

Rubber and Glass Tyres

THE Goodrich Tyre Co. of America have recently produced a new kind of automobile tyre employing synthetic rubber and glass fibres. The wearing and safety qualities of the present tyres, it is stated, are capable of being excelled, and satisfactory results have been obtained at sustained speeds of 75 miles an hour. Experiments are being carried out with steel, glass, flax and improved varieties of cotton and rayon for making tyre cords.

Non-Corrosive Rivets

THE corrosion resistance of the rivets employed in the assembling of metal wing lattices, seaplane hull lattices, float lattices, etc., is of primary importance. Most of the large aircraft builders are using Monel metal rivets, the majority of which are made with cold upset heads from ordinary soft annealed Monel metal wire. Tubular rivets are also being produced, some from solid drawn tubing and others by punching from cold drawn rod.

Giant Windmill Unit

THE new installation which is being erected at Grandpa's Knob, Rutland, Vt, U.S.A., is claimed to be the largest windmill electric plant ever attempted. Designed to generate 1,000 kilowatts, it has a built-up steel tower, 110 ft. high, with a 36 ft. square base which is securely anchored to the mountain top at a height of 2,000 ft. above sea level. The windmill blades, which are of stainless steel and weigh 15,300 lb. each, are 65 ft. long and over 11 ft. wide. The windmill shaft rotates at 28.7 r.p.m., corresponding to a blade tip speed of 15,785 ft. per minute. The pitch can be altered automatically with the aid of a governor device. For experimental data purposes a change of pitch angle of 99 degrees has been provided, but the normal change is 30 degrees. The diameter of the windmill shaft is 2 ft. and it is supported on roller bearings 12 ft. apart. It is stated that this shaft is coupled to a double helical gear unit that increases its speed to 600 r.p.m. The generator is rated 1,000 kw. at 80 per cent. power factor, 2,300 volts, 60 cycles, three-phase.

Huge Diesel Locomotive

THERE has recently been put into service in America a giant new Diesel locomotive capable of drawing a freight train of six special cars and 58 loaded frieght cars. On its maiden trip, the locomotive, which is rated at 5,400 h.p., covered 2,000 miles in 62 hours running time. Nine locomotives are required for the fastest steam locomotive freight train. A second locomotive replaces the first after each section of 200 miles has been covered, and this continues over the whole 2,000 miles. The entire run was covered by the Diesel locomotive alone, with only three stops for fuel. According to reports, the locomotive has four 1,350 h.p. 16-cylinder high speed Diesel engines, each of which drives an electric generator which in turn supplies current to two driving motors. In the complete locomotive, which weighs 415 tons, there are 32 driving wheels, and the engines operate on the two-cycle principle.

Moving a Lighthouse

AN extraordinary engineering feat took place one hundred years ago when Sunderland lighthouse was moved from its original site without being taken down. When the North pier was extended, it was decided to take the lighthouse down and re-erect it at the extreme end. John Murray, the engineer, proposed that it should be moved entire, and the masonry at the base, 15 feet in diameter, was cut away. Timbers were inserted through the building and extended seven feet beyond it. Another tier of timbers was inserted above and at right angles to them to form a base of 29 feet square. This was supported on bearers with 250 wheels to traverse a specially laid railway. The lighthouse had to be drawn 30 feet to the north and 420 feet to the east. It is 78 feet high and weighs 300 tons.

The Army's handiest bridge can be carried by two men, and consists of two tubular girders. In the illustration a soldier is seen carrying one of the sections, and crossing a stream by the other section.

Vitamin Sandwich

A VITAMIN B sandwich, composed of peanut butter and 20 per cent. dried brewers' yeast, which is also rich in protein and fat, has been devised by Dr. Tom B. Spies of Texas University.

Canada's Biggest Ship

THE 9,300-ton Fort Ville Mario which was recently launched in Montreal by Mrs. C. D. Howe, wife of the Munitions Minister, is the largest ship ever built in Canada. This is the first of Canada's new war-time fleet which is to consist of more than 100 vessels.

Making Time Bombs Harmless

DR. NEVIL HOPKINS, a New York research engineer, has invented a portable device for rendering time-bombs harmless without exposing men to danger. The inventor was an adviser on ordnance questions during the last war and is an expert on explosives. He refused to reveal details but said a demonstration had proved very satisfactory.

Powdered Metal

A NEW method of making a cheap alloy powdered from scrap metal has been described by Dr John Wulff of the Massachusetts Institute of Technology.

He said the method involved using scrap metal that could not be employed efficiently for melting, and reducing it to powdered form by gravity and corrosion methods.

H. Grindell-Matthews

THE recent death, at the age of 61, of H. Grindell-Matthews calls to mind a picturesque character in the world of invention. He worked on rather fantastic ideas, such as a death-ray that would stop a 'plane in mid-air, and put its engines out of action, and a six-miles-a-second rocket to reach the moon.

PHOTOGRAPHY

Making Enlargements

By JOHN J. CURTIS, A.R.P.S.

EVERY branch of photography has its own particular fascination, and provides a definite interest to the amateur, but I think every advanced worker will agree with me that among the many processes, from the selection of subject and exposing of the film to the finished picture, there is not one that will give so much thrill as the making of the first enlargement from one of your own negatives.

When amateurs arrive at the "enlarging" stage, it is a sure sign that they have reached the period when they change from "snapshotting" to serious work. Certain it is that the work becomes much better in quality right from the time of exposing to the finished print, because from the outset the thought is always present that the negative might make a first-class enlargment suitable for exhibiting, and for this reason more care is taken in the selection of the subject and the processing, with the result, which is very important, there are fewer failures in each spool of film.

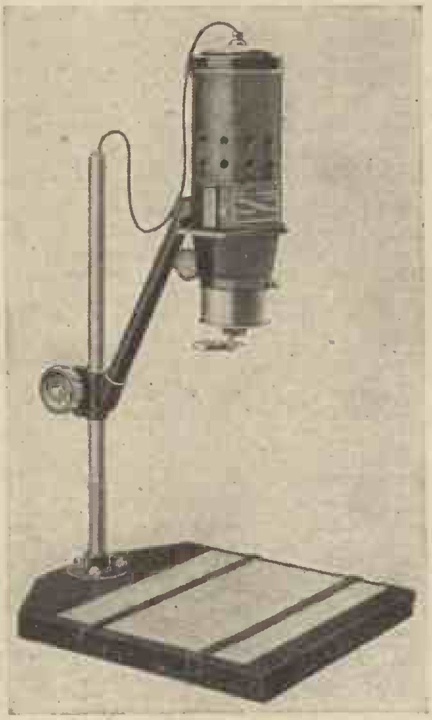
So far we have only dealt with the making of a contact print, the same size as the negative, and those readers who have made some of these will possibly have wished that they could see those same prints magnified. How very much nicer that andscape would be if it could be printed on a 12 by 10 piece of paper instead of a piece 2½ by 3¼, and then mounted on a white card with a fair margin round it; or it may be that a small part of that print would look better if it could be made bigger, and all the other parts were not there. Well, that is just what you could do if you had an enlarging camera, or as it is usually termed, an enlarger.

I intend to give a description of such a piece of apparatus in a future article when I will endeavour to show you how to make one, but some of the necessary parts are difficult to obtain in these days. It is possible. however, to buy an enlarger from your dealer, or to join a local camera club and start this interesting stage by using the one provided for the use of members, or perhaps if you have two or more friends keen on photography you could pool your funds and get an enlarger for the use of your circle, sharing the cost of paper and chemicals. This last suggestion is one that has been adopted by a good number of schools, boys' clubs, and similar organisations, and will be found to have advantages as the members in their work help each other.

We will now assume that you have an enlarger, either a vertical or horizontal type, and that you are anxious to get the best out of it. Besides the apparatus which you have bought for the ordinary printing, such as measures, darkroom lamp and chemicals, you will have to get at least two dishes, the size of which must be governed by the size of the paper you intend to use for the printing. Also, it is advisable to get deep porcelain dishes as these can be kept clean easily, and this is very important.

Cleanliness Essential

A large number of prints pass through my hands every year, and it is surprising how many otherwise good results are spoiled through the lack of care and clean working. Carelessness in the preparing of chemical solutions; laying paper down on wet benches, or handling it with fingers that have not been washed after making the fixing bath, may cause bad stains. Specks of dust on the negative should be removed before placing it in the carrier in the enlarger, and the same applies to any finger markings on the negative. The reason for this extra care is that whatever blemishes there are on the negative will certainly be enlarged on the print, and it is easier to remove them in the first instance.



An Ensign "Magnaprint" Enlarger.

All chemical solutions must be prepared beforehand and, if convenient, in another room, especially if you weigh and mix your own chemicals, for some of them are in the form of a fine powder, and it is possible for small particles to float about and finally settle on the surface of the paper while you are handling it, or placing it on the easel.

Dark-room

The room in which you intend to do the work of enlarging must be completely light proof, no light must be allowed to filter in through the door or windows, and, further, the dark-room light, the one with the orange and ruby glasses, must be safe; before doing any work it is as well to test this in the following manner. Exclude all white light, take a piece of bromide paper from the packet, and cover half of it with a piece of cardboard and place it under the dark-room lamp at about the same distance as you intend to have your developing dish; now switch on the light in the lamp with the orange glass in position, leave the paper exposed for about ten minutes to this orange light, and then develop it for about two minutes in the developer; if there is no difference in the two halves, then the lamp is perfectly safe.

Selection of Negatives

What is the best type of negative for enlarging? I pointed out in last month's article that the perfect negative was shown to be the one with a long line of gradation, or a whole range of halftones; such a negative will give an excellent print by any printing process by contact or enlarging. You will also recollect that a strong contrasty film, one showing very little difference between the blacks and whites might be all right for printing on certain grades of gaslight papers, but the print would in the majority of instances be lacking in pictorial qualities; with these reminders, you will be able to satisfactorily solve the question, "What is the best type of negative?"

It will help you in choosing your negatives for enlargement if you carefully examine your collection of prints and select a few that show a good assortment of greys, with occasional black and white. Now, if you turn to the negatives of these prints you may be inclined to think that they are not first-class ones, they may appear to be a trifle thin, and there is nothing about them to suggest the possibilities of a picture; but wait a minute, just put one of them into the enlarger and focus on to a sheet of white paper on the easel; now what do you think about it? Yes, it may look rather flat and that piece on the side is really not good, and there is a lot of foreground.

Get a couple of pieces of black paper—collected from the previous packets of bromide and gaslight papers—and pin one down the side where the ugly wall is, and then place the other piece over part of the foreground. Now increase the size of that section of the negative now showing to the size of the paper it is intended to use, cover up the side and foreground as before. It is beginning to look like a picture now, and probably you will think it is worth while to expose a piece of bromide just to see what it looks like when finished.

From the foregoing example it must not be inferred that you must have a thin negative; it is easier to enlarge from such than from a dense one, but if the latter possesses those other qualifications—gradation, details and absence of hard contrasts—then it will give perfectly satisfactory enlargements but, obviously, it will take longer for the exposure, and rather more care will be required in the manipulation.

We now come to a point where a little more help can be given; it concerns the initial stage of the manipulating. An enlarger must have some sort of easel, and I have found those ruled with a series of rectangles—the same sizes as the standard sizes of papers—are the easiest to work with. It is also possible to have one with a special adaptation for holding the paper in position such as the Ensign Magnaprint, it is also possible to obtain an adaptor for giving perfect white margins of varying widths.

Focussing

Focussing by means of an enlarger is at first a little trying to the amateur, especially if his or her sight is not of the best, but even this can be got over quite easily. Reserve one section of your next spool for exposing on a sheet of white paper, quite plain; when this has been developed it will be quite black, and after it is fixed and dried, take a sharp knife or a needle, and cut some thin straight lines in the emulsion. Also, if possible, add to the lines with a series of concentric circles cut with compasses. Place this film in the carrier of the enlarger, and focus till the lines are dead sharp, then remove the film and replace with the one you are to enlarge, and you will find that your picture is truly and sharply focussed.

Selection of Paper

The selection of a suitable paper for different negatives requires experience, but a few experiments made with one good negative, typical of the majority in your collection, will give a whole store of knowledge on which to act. It is certainly very fortunate for anyone to have a selection of the different grades and surfaces of a particular make, but this means a fair expenditure. For the average type of negative and subject the most useful paper is a normal grade and a semi-matt surface, and if you stick to a well-known make you are not likely to be far off the best.

Now, a few words about the developer. It is generally acknowledged that the best for enlargements is Amidol. One word of warning is necessary, however—do not attempt to keep a solution of Amidol, for it will not retain its activity more than about three days.

You should be speedy in passing the print from the developer to the fixing bath, and be sure to use only acid fixing; it clears the print and often prevents stain. I would also strongly recommend the use of a stop bath as a preventative of stains; it is used in between developing and fixing, and is made by dissolving one ounce of potass. metabisulphite in 20 ounces of water.

Perpetual Motion

Some Schemes which have been Introduced from time to time are Discussed

FOR many weary years the Patent Office has struggled with the perpetual motion crank, and although nowadays they have, in deference to commonsense, insisted upon some other title, there are many inventors who not only have hopes, but succeed in rendering them capable of financial support.

I think perpetual motion deserves some examination in so far as its meaning is concerned. Without attempting any hair-splitting expressions in the realms of conservation of energy, perpetual motion means power without expense. Some designers have been very skilful when describing their work for they will admit that to obtain enough energy to run the District Railway it is necessary to replace a pocket flash-lamp battery once a year, and others talk of power from the tides, or from the heat of the earth, as if this was perpetual.

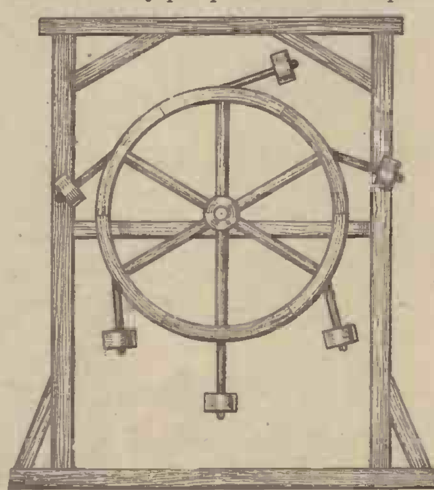
Wheels and Cranks

In the old days of the perpetual prime mover, we were confronted by a collection of wheels or cranks which looked like a cross between a tide prediction machine and a Corliss engine. Separated into its simplest parts, the machine usually comprised, as they say in the Patent Office specifications, a wheel surrounded by weights which were drawn inwards during part of each revolution so that they had less "effect" than other weights which were near the periphery. Occasionally, as has been bitterly remarked, the wheel was *also* turned by a "crank."

What does not appear to be clear is that useful mechanical energy has never yet been obtained without the expenditure of a far greater amount of energy, enough in fact to allow for loss by friction, heat, and other difficulties with which all engineers suffer in this world. But I must admit that friction is not always bad, for it might be very difficult to run trains or motor-cars without its aid, not to mention the act of walking with which we are becoming, unhappily, familiar.

Let us consider some other perpetual motion schemes which are less simple, and of these I would give pride of place to the gentleman who uses a dynamo for the electrolysis of water, and then explodes the oxygen and hydrogen in an internal combustion engine which drives the dynamo and lights a whole street. He forgets that the dissociation of water is a "wasteful" process, just as he refuses to consider the truth that an internal combustion which gives back 30 per cent. of the available fuel energy is highly satisfactory for the moment.

I have even seen designs for ships driven by water turbines which were actuated by water rushing in from a hole in the side, a small auxiliary pump was fitted to replace the water into the sea, and when the inventor told me the heavier the ship, the faster it would go, he was terribly annoyed when I said—"Yes, yes—along or down?"



The overbalanced wheel of Vilard de Honnecourt (13th century)—the first of a long line of perpetual motion inventions.

Power from Earth's Heat

There are, of course, a number of inventions which, while not attempting to get power for nothing, try to take the initial energy from an apparently inexhaustible source. In this category are several interesting ideas, notably perhaps, the use of the internal heat of the earth.

By the way, it is a steadying thought to those who believe that science has advanced too fast, for we are still living on the thin crust of a pudding which is so young that it has not yet had time to cool. In the centre, bearing up the outside like a floating plank of wood, is a mass of hot rock. If into this rock water could be allowed to flow, the steam would be able to give us a huge supply of power, and it might take a very long time to cool all the "fuel."

Unfortunately, it is practical difficulties which win the day. It would be necessary to dig for several miles into the earth, and to obtain the necessary area for heating some blasting would then have to be conducted. How could man work in such an atmosphere? And if for some colossal price the result could be achieved, think for a moment of the cost of the steam. There are many examples to-day of enterprises which could succeed but for economic difficulties.

Another plan was once devised for using the differences in temperature of the sea at various levels, and in this scheme a number of thermo-couples were employed, the junction parts being kept at different temperatures by the sea itself.

Atmospheric Electricity

There are two more well-known plans in this "power" category. One is the collection of atmospheric electricity which has an unpleasant habit of arriving at enormous voltage so that transforming and storing wastes it all en route. And the other is the idea of building a huge area of photo-electric cells. This, unfortunately, fails from lack of bright light, resistance, size, expense, and all the other troubles which even apply to such simple things as boilers heated direct by the sun. *Convenient* power is wanted, not just power.

There is, of course, one inexhaustible source of power which has been applied to a self-winding clock device by using the constantly changing pressure of the atmosphere. Instead of a needle moving about a scale, a simple ratchet device keeps a clock spring always wound in a manner not unlike the self-winding watches which one used to see on motor-cars, or upon the wrists of rich friends.

One day I hope to tell you of some of the queer inventions I have seen from time to time, but at the moment I shall content myself, if not you, by describing a "genuine" perpetual motion machine, and leaving you to find out its fault.

Imagine, please, a small wheel operated by water which is drawn up a capillary tube by the end being dipped into a container and then allowed to run down the other side by siphoning, falling as it goes upon a miniature water wheel, and driving it for ever and ever. "Nonsense," you will say. Well, I am waiting to hear. For no one is more easy of conviction than myself, or any other reasonably sensible man who has found that never to make mistakes is to make nothing at all.

The Handley Page "Halifax," one of the new four-engine bombers of the R.A.F. Bomber Command

The World of Aviation

New Aero Engines; Improved Bomb Sight; New "Halifax" Four-Engine Bomber; The Mark II Hurricane and New American Aircraft

New Flying Fortresses

FLYING tests have recently been carried out at Seattle of a new model of the Flying Fortress, known as B-17E. This latest type weighs 30 tons when fully loaded, and is six tons heavier than the B-17D now used by the R.A.F. As a result of fighting experience, many new features have been incorporated, including gun turrets on the top and bottom of the fuselage, and a tail gun turret.

New Aero Engines

ACCORDING to a recent press report, a new aero engine has been under secret development in New Jersey. It is designed to produce as much horse-power per pound weight as the lightest engines now in use, and it may be used for heavy bombers. In order to determine the amount of power exercised under service conditions, a test flight with a preliminary two-cylinder design is to be made shortly.

The Ford Company have also produced a new supercharged aero engine of the 12-cylinder V type, liquid cooled, capable of 1,800 h.p. at take-off, and 1,500 at 32,500 ft. It is a development of the regular V-eight car engine, in which the conventional carburetter is eliminated by means of a system of direct-injection of solid fuel.

Germany also report new high-powered aero engines which run on heavy oil. The Junkers Company is manufacturing them, and it is stated that one type develops 2,000 h.p., and has 24 cylinders arranged in X form. It is claimed that, considering its great power, it is of compact dimensions. Another type has 6 cylinders and develops about 1,000 h.p.

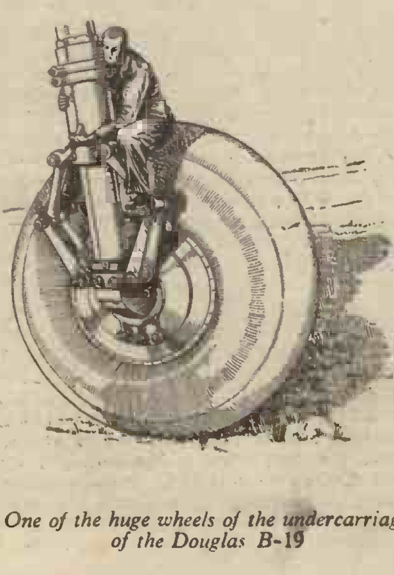
A New Bomb Sight

CAPTAIN BERGER JOHNSON has invented a new automatic bomb sight which weighs less than 20-lb. It is expected to do away with much inaccurate bombing, and plans have been submitted to the British and United States Governments. Captain Johnson is engaged in Montreal in work with the British Commission for aircraft production. His invention would automatically release a salvo of bombs even if the pilot were flying blind.

The bomb sight also combines a wind-speed and velocity indicator, ground speed indicator, drift indicator, altimeter, visible strip chart position marker, artificial horizon, turn and bank indicator and camera. The pilot can act as his own bomb-aimer by watching a foot square panel and pressing a button when the target is properly sighted. The inventor has been working on the sight for nine years. It is claimed that it will make bombing from four miles up as accurate as tree-top bombing.

Wooden 'planes

THE next step in Canada's aircraft production programme may be all-wood and fabric aeroplanes. An Anson with all-wood fuselage showed a gain of ten miles over the metal fuselaged Ansons now in use, during recent tests carried out in Ottawa.



One of the huge wheels of the undercarriage of the Douglas B-19

Aircraft Wheels

MODERN aircraft manufacture is no longer a "light" industry, for bombers in the 50-ton class are getting common. Wheel suspensions are an example, and the sketch on this page, which is a scale drawing, conveys an idea of the size of the Douglas B-19. The mechanic is sitting astride the tyre, which absorbed about 1,000 lb. of rubber and other materials. Equally imposing are the quantities of steel, in alloy form, which go into such an aircraft.

Halifax Bombers

DETAILS recently released by the Air Ministry show that the Handley Page Halifax bomber has a wing span of 99 ft., is 70 ft. long, and 22 ft. in height. It has three-bladed airscrews and is powered by four Rolls-Royce Merlin 12-cylinder liquid-cooled engines. The position of the bomb-aimer is under the forward turret, and heavy defensive armament is carried. The flaps are slotted for improved take-off and de-icing equipment is fitted to the tail unit. Airscrew de-icing is also provided and one of the features is a cabin-heating system.

New American Fighter

THE recent opening of the Curtiss-Wright Corporation's new £4,500,000 factory at Buffalo, New York, inaugurated production of the new American fighter plane for Britain. This machine is an export version of the Curtiss Hawk P-40D, recently developed for the U.S. Army air forces, and has been named the Curtiss Kittyhawk. Details of its performance are secret, but it is known to be faster and more manoeuvrable than the Tomahawk, which is the British name for the original Curtiss P-40. It has a high degree of streamlining, and is said to have 25 per cent. more fire-power than earlier designs. The machine is powered by an Allison liquid-cooled engine which is stated to develop 100 h.p. more than the Allison engine used in the Tomahawk.

The New Hurricane

THE official description of the Mark 2 Hurricane which has just been released, proves it to be the most formidable fighter aircraft in the world. This four-cannon single-seat machine which has a new-series Rolls-Royce Merlin engine with two-speed supercharger, forms part of the R.A.F.'s improved equipment. The fighting ability of the pilot is extended in three directions: performance at height, fire power, and effective range. It is capable of engaging high-flying enemy fighters, and its raking fire power makes it suitable for attacking dispersed aircraft on aerodromes, armoured vehicles and small ships. The machine is also capable of engaging enemy bombers at very long range. There are two versions of the Mark 2 Hurricane, one having four cannons, and the other twelve machine guns. The earlier Hurricanes, of course, carried eight machine guns. The 20 mm. cannons with which it is fitted are capable of firing a shell of nearly 1 in., which can be either explosive, armour piercing or tracer. The R.A.F. have two other fighters carrying four forward firing cannon: the Westland Whirlwind and the Bristol Beaufighter, but both of these are twin-engined aircraft.

The fire power of the new Hurricane is vastly superior to that of the latest German single-seat fighter—the new Messerschmitt 109F 1-2, which has only one 15 mm. Mauser cannon. Although this weapon has a high muzzle velocity, it fires a smaller shell than the Hurricane's 20 mm. cannon, and consequently does not "pack" such a powerful explosive charge.

New U.S. Dive Bomber

IT was stated recently that Mr. Knudsen, Director-General of Defence, had examined a new type of long-range dive-bomber at the Brewster factory. It is said to be 100 m.p.h. faster than the German Stuka, and is manned by a pilot and gunner, carries a bomb load of 1,000 lb. entirely enclosed within the fuselage, a feature reputed to increase speed, and is powered by a 1,700 h.p. Wright Cyclone engine.

The New Messerschmitt 109

SINCE the Spitfires and Hurricanes of the R.A.F. began shooting down specimens of the new mark of Messerschmitt single-seat fighter, the Me. 109F, there has been a good deal of speculation about the purpose for which it is designed, and the real capabilities of the type. The full extent of the changes discovered in those brought down remains the secret of the R.A.F. It is sometimes an advantage not to inform the enemy just how much is known about his new weapon. But certain details may be revealed.

Four of the obvious differences between this new Me. and its predecessors are the more powerful engine, changed armament, re-designed wings with rounded wing tips, and new tail plane now devoid of bracing struts. There are other changes, too, such as making the tail wheel retractable and giving a general cleaning up to the silhouette, which clearly aim at greater speed. It is obvious that these various improvements, both in the engine and the airframe, will result in a higher ceiling and better performance at height.

An interesting feature of the new Me. is the way the armament is now distributed. The wing guns have been dropped, and all it has is one cannon of 15 mm. firing through the airscrew hub, and two small bore machine guns mounted on the fuselage. This central grouping of the armament weight may result in better power of manoeuvre, never a strong point in the Me. 109.

So far the Me. 109F has not been met with in force. When it is, perhaps accompanied by new or improved bombers, new problems will be set to Britain's air defenders. But as in the past, the R.A.F. will be ready.

Tempo of Aircraft Production

IN considering the purpose of aircraft developments it is useful to set them against the background of modern aircraft manufacturing tendencies. This war differs from previous wars in being so much more a battle of rival industrial capacities. The full utilisation of machine tools, skilled and unskilled labour, and of intensive production methods aimed at rapid and overwhelming output have a new, perhaps decisive significance. Above all, the tempo of production must not fall. To turn over plants to the production of a completely new type of aircraft is a serious matter, and must inevitably result in a temporary drop in output. Furthermore, it takes time—longer to-day under mass production methods, than in the individual production days of the last war. To fill in the gap whilst basically new types of aircraft, dictated by the general advances in aeronautical knowledge, are being laid down there is a tendency to effect less drastic alterations to existing types so as to keep them abreast of new requirements.

The Hurricane II, with improved armament consisting of 20 mm. cannon the combined fire of which is 2,400 shells per minute

South Africans Rebuild a Savoia

A SAVOIA 81 has arrived at Nairobi after a perfect flight from Addis Ababa. A large white "V" had been painted on the fuselage.

The Italians had left the bomber behind at Addis Ababa aerodrome as a useless wreck. It had been badly damaged by South African aircraft in their raids on the Abyssinian capital. The South Africans found it on their entry hidden under camouflage nets. It was wingless, and its petrol tanks and tail had been holed. Nails had been hammered into the engines by the Italians.

South African Air Force engineers and the ground staff at Addis Ababa aerodrome set to work, and in three weeks had rebuilt the Savoia and rendered it serviceable. With the aid of Italian handbooks, ground engineers reassembled the machine from parts left behind by the Italians. "A few of us knew Italian slightly and could follow the instructions, but when it came to technical terms we had to use our own judgment," said a Flight Sergeant. "It was a case of trial and error."

Several other Italian aircraft have arrived at Nairobi recently *en route* for South Africa, where they are to be used for exhibition purposes.

German Boast Repaid

A STORY of how an unarmed British fighter forced a Messerschmitt down on British soil is recalled by a recent award of the D.S.O. to the leader of a famous Yorkshire Auxiliary Air Force Squadron.

The Squadron Leader was at Augsburg for the Winter Sports in the spring of 1939. There he met and was entertained by members of the German Richthofen Squadron. One of the Nazis indulged in a characteristic German boast:—"You think your Hurricanes are good, don't you? Well, wait till you meet our Messerschmitts!"

Eighteen months later, in the Battle of Britain, the British Squadron Leader had the satisfaction of bringing down one of his former hosts without firing a shot. He had run out of ammunition when he encountered an Me. 109, damaged and endeavouring to escape across the Channel. He closed in on it, cut off its retreat, and signalled to the Nazi to land immediately. The Nazi obeyed, and force-landed in a field with his wheels up. When the two met later, the British Squadron Leader recognised the Messerschmitt pilot—and reminded him of that Augsburg dinner!

A NEW SERIES

The Story of Chemical Discovery

No. 9. Baron Berzelius, and The Introduction of Chemical Analysis.

THE art of chemical analysis rests upon no single discovery, or even upon any one group of discoveries. The exacting day-by-day work of the modern analyst is based upon a system which has patiently been reared and perfected by the aid of a multiplicity of chemical discoveries.

The analyst of to-day who tells you that an apparently innocuous white powder is a mixture of chalk, arsenic and starch, deadly in its properties, yet looking merely like a mass of whiting or a quantity of flour, bases his information upon a dozen or more separate chemical discoveries which, in the course of time, have been carefully correlated and systematised so that they fit together like the pieces of a jig-saw puzzle into a definite and reasoned system which guides the chemical analyser to the infallible detection of these substances in a mixture.

Early Days

In the earliest days of chemistry, analysis was unknown. True it was that certain skilled dispensers of drugs by dint of their long experience in the handling of such commodities, could feel pretty certain in differentiating between, say, Epsom salts and carbonate of soda, or between sulphate of zinc and sal ammoniac. But in those early days there was no certain system whereby the several ingredients of a mixture might each be picked out, identified and estimated as regards the amount or proportion in which they existed in the mixture. Such a feat was only made possible as a result of a myriad of separate chemical discoveries concerning the characteristics and properties of individual chemical substances.

One of the most noted of the several individuals who, in the earlier days of scientific chemistry, took in hand this description and registration of the properties of chemical compounds so as to build up a comprehensive analytical scheme, was the famous chemist, Baron Berzelius. Johann Jacob Berzelius (born 1779) was a Swede, who, for a short period of his earlier days, practised as a doctor in Stockholm. He soon found, however, that chemistry had a greater attraction for him than medicine, with the result that he gave up a fairly lucrative career to undertake chemical research in a number of subjects which held out a special interest to him.

Within a few years, the fame of Jacob Berzelius had extended around all the chemical Schools and Institutes in Europe. At the age of thirty-one, Berzelius was elected President of the Stockholm Academy of Sciences. A few years later he was elected a Fellow of the British Royal Society and was awarded the "Copley" gold medal of that Society for his discoveries in chemistry, whilst subsequently, the King of Sweden, in reward for the fame which he had brought upon his country, raised him to the rank of Baron, an honour which was then reserved only for the very few.

Johann Jacob Berzelius

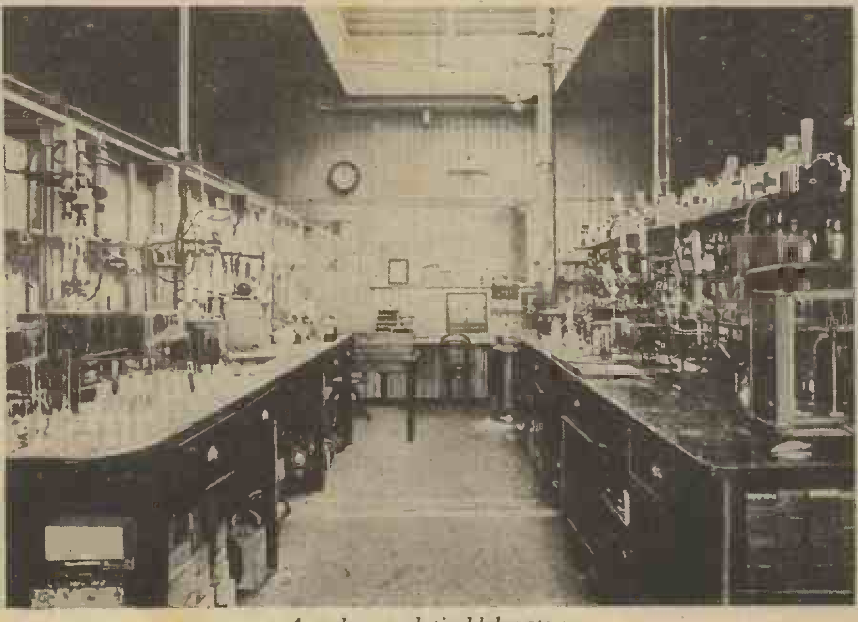
Berzelius's discoveries in chemistry are so numerous that only a small number of them can be described here. No chemical investigator has brought to light so many facts as did Berzelius, the Swede. Like our own Michael Faraday, he was always at work in his laboratory, and always he worked with the greatest of care. Berzelius seldom, if ever, made a mistake or an inaccurate observation. Yet, the laboratory facilities which he was able to command were meagre in the extreme, and would cause disappointment to even a first-year student of chemistry in our own days.

Wohler, a renowned chemical worker with whom we shall deal in a future article, visited the great Berzelius in 1823 and became one of his students.

Simple Laboratory

"Berzelius's laboratory," writes Wohler, "consisted of two ordinary apartments with the simplest of fittings. There was neither oven nor fume-chamber, neither was there water or gas supply. In one room stood two ordinary work tables. At one of these Berzelius had his working place. On the walls were several cupboards containing chemical reagents, which, however, were not provided very liberally, for when, on one occasion, I wanted prussiate of potash for my experiments, I had to get it from Lubeck. In the middle of the room stood the mercury trough and a glass-blower's table. The washing-place consisted of a stone cistern having a tap with a pot under it. In the kitchen, where the food was prepared by the severe old Anna, cook and factotum of the master who was still a bachelor, stood a small furnace and the ever-heated sandbath."

It was among such scenes that chemical analysis took its first systematic rootings, for here the quantitative method in chemistry, founded, in the first place, by the ill-fated Lavoisier, was continued and extended by Berzelius and, through his pupils the new technique was carried to the great chemical centres and schools of Europe.



A modern analytical laboratory

Discovery of Selenium

Berzelius's chief aim in chemistry was the determination of the atomic weights of the elements, and the composition of inorganic and organic compounds. In the course of these activities he discovered five new elements — cerium (1803), selenium (1817), thorium (1828) zirconium (1824), and, titanium (1825). Little did he think that all these elements would ultimately be found to have commercial uses, for in Berzelius's time, these new elements were exceedingly rare, so much so that they could only be isolated in relatively minute amounts.

Although Berzelius discovered the so-called "moon element," selenium, he was, of course, totally unaware of its curious light-sensitive properties which have conferred upon it so much popular and technical interest in our own days.

Berzelius, too, was the first man to extract the element silicon from sand. Furthermore, he demonstrated that silica or sand had acidic properties, and that most of the "stony" minerals and rocks are, in reality, nothing more than complex combinations of the acidic sand or silica with various alkaline bases.

Here, of course, Berzelius shone as a chemical mineralogist. He obtained thousands of mineral specimens from all over Europe. These he patiently subjected to careful chemical analysis by methods which were peculiarly his own, and which he had evolved for the purpose. In every case, a "stony" mineral was always found to contain silica (which is, of course, silicon dioxide, SiO_2) coupled with other compounds. Gradually, Berzelius built up a technique of breaking down even the most complex of minerals and of qualitatively and quantitatively ascertaining their constituents. The task was an exceedingly intricate one at first, for many unknown technical difficulties were encountered during the course of the work. Although Berzelius left a portion of this vast task uncompleted, the methods of analysis which he evolved were sound enough, and other workers, following in his footsteps, have made it possible for every known natural mineral to be analysed and classified according to its chemical constitution.

Berzelius, Davy and Dalton were contemporaries who were well known to one another. The work of Dalton, of Manchester, on atoms and their combining powers greatly attracted the Swedish chemist, and it is true to say that much of the eventual success of Dalton's theory of atoms was due to the tremendous practical emphasis which Berzelius's work lent to the Daltonian system.

Atoms and Molecules

In the light of John Dalton's theory of atoms, Berzelius, as far back as 1807, began to analyse a long series of chemical salts. Gradually, he accumulated experimental data by means of which the atomic or relative weights of the atoms might be calculated. Here Berzelius confirmed practically the work of Dalton. He demonstrated that every atom has a distinct weight, and that one atom of an element combines with one, two, three or more atoms of another element to form a definite chemical compound.

Berzelius, in this direction, went a little further than Dalton had done. He suggested that the atoms of elements could combine or link up with themselves to form atomic clusters, or, as we nowadays call them, "molecules." Thus, for example, in a mass of copper, the copper atoms never, at ordinary temperatures, exist singly, side by side. They are invariably loosely linked up with one another, forming atomic nuclei which we call "molecules."

Berzelius showed that the weights of the volumes of two elementary gases which combined together were, in reality, the weights of the atoms of those elements.

Let us make this point clearer. Suppose we have one volume of hydrogen, the weight of which we may call 1. If we proceeded experimentally, we should find that two similar volumes of hydrogen (weighing 2) would combine with one volume of oxygen (weighing 16) to form two volumes of water vapour.

Berzelius performed this experiment very carefully. He reasoned that the molecule of water consists of two atoms of hydrogen combined with one atom of oxygen, and that the oxygen atom is 16 times heavier than the hydrogen atom.

Similarly, Berzelius found that three volumes of hydrogen (weighing 3) will combine with one volume of nitrogen (weighing 14) to form two volumes of ammonia. Applying the same reasoning, Berzelius demonstrated that the molecule of ammonia consists of three atoms of hydrogen combined with one atom of nitrogen and that the nitrogen atom is 14 times heavier than the hydrogen atom.

A tube of liquid chlorine, an element closely investigated by Berzelius

Atomic Weights

In this manner, starting from very simple chemical reactions such as the above, Berzelius was able to work out the actual weights of the chemical elements relative to the weight of hydrogen. These "Atomic Weights," as they are called, were, after the death of Berzelius, worked out again with enormous care by a number of different highly skilled investigators. Nowadays, they are all known with an exceedingly great exactitude. Such knowledge of the relative weights of the elements has been of tremendous importance in the development of theoretical and practical chemistry throughout the last century, for it is upon an accurate knowledge of these relative weights of elements that quantitative chemical analysis (i.e. the determination of the actual proportions or quantities of substances present in mixtures) has been made possible.

Berzelius was one of the earliest workers to conceive the idea of electrical action underlying chemical affinity. For a long time experimenters had asked themselves why certain elements showed great combining affinities, whilst others were seemingly sluggish or inert in their actions. They also wanted to know why certain chemical combinations proceed at elevated temperatures, and not at all at lower temperatures. For example, carbon, when cold, does not combine with oxygen, but when raised to red-heat this material readily combines with oxygen, forming the gas carbon dioxide, CO_2.

Electro-Chemical Theory

Berzelius's answer to such problems is represented by his famous Electro-Chemical Theory which he first advanced in 1812. According to this theory, chemical combination is inherently an electrical phenomenon, and is due to the attraction exerted by the electricity of atoms on other electrical atomic charges of opposite polarity.

Each atom, postulated Berzelius, possessed two kinds of electricity, one being in excess of the other. Hence, every atom has either a negative or a positive polarity, which polarity, asserted Berzelius, is increased by heat.

Chemical combination, therefore, according to this theory, consists in the attraction of atoms of different polarities, and the polarity of the resultant compound depends upon the polarity which predominates in the original combining atoms.

We now know that Berzelius's Electro-Chemical Theory is untrue, and that atoms are, at least outwardly, neutral bodies. Yet this famous theory which held sway for many years undoubtedly gave an impetus to chemical discovery, since it provided experimenters with a working hypothesis upon which to base and plan their investigations.

Dualistic Theory

Out of this theory, too, Berzelius developed his equally famous "Dualistic Theory," which stated that every chemical compound consists of two essentially distinct parts, these parts being electrically different. Without such a difference, asserted the Dualistic theory, no chemical compound could be formed.

The Dualistic theory of Berzelius, whilst untrue, persisted for a number of years.

It is from his practical work in the realms of chemical analysis, and the discovery of new elements and compounds that Berzelius's name has persisted, and is likely to do so. Berzelius, in many respects, was a sort of Dalton and Faraday rolled into one. As a theoretical and a practical investigator he was equally brilliant. It has been said, with all truth, that he revised the whole of the chemical science and knowledge of his time, and that he placed it on a superior footing. The symbols for the various elements which we nowadays make so much use of in chemistry were originated by Berzelius. He was the first to put forward workable Tables of Atomic Weights, whilst, in the domain of everyday chemical practice, he introduced for the first time, laboratory apparatus which is now familiar to even the most elementary of chemical students. Among such equipment may be mentioned water-baths, rubber tubing, constant-weight filter-papers, blowpipe reagents, borax beads and improved analytical balances.

Pieces of pure selenium, the strange photo-sensitive element discovered by Berzelius

MASTERS OF MECHANICS

No. 70. The Ill-fated John Lombe. A Curious Chapter in the History of Silk Manufacture in England.

SILK-PRODUCTION is one of the world's oldest mechanical industries. From the earliest times of recorded history, the Chinese have fostered the art of silk spinning, and for centuries that wise and ancient people maintained the manufacture of silk a close secret from the rest of the world. Ultimately, however, the secret leaked out. Some say that in the sixth century A.D. a couple of monks brought with them from China a number of silkworms' eggs which they concealed in a piece of hollow cane. Whether this account be true or otherwise, there is no doubting the fact that about this time, silk manufacture was surreptitiously introduced into Turkey, thus destroying the total monopoly which the Chinese had enjoyed from very early ages.

From Turkey, the manufacture of silk spread slowly yet none the less surely into Greece, and from Greece it went to Italy and then to Spain. Each country, as it came into possession of the secret of silk production and manufacture, did its best, by dint of dire threats and penalties, to prevent its neighbouring nation from gaining a knowledge of the profitable secret and, for a time, this conspiracy went on successfully. France and England, for instance, in the latter part of the sixteenth century were behind most of the European nations in their knowledge of silk manufacture.

By devious means, the manufacture of silk spread into Southern France and, after the turn of the seventeenth century, some attempt was made to introduce silk-making into England. It is on record that James I of England (1566-1625) endeavoured to establish silk manufacture in Britain. He tried to encourage people to plant mulberry trees upon which the silkworms feed. The trees were planted in response to this royal appeal, but the leaves did not ripen in time to provide food for the silk-producing caterpillars. A similar attempt was made to introduce silk making into Ireland, but in that country climatic conditions were even more unfavourable than they were in England, and the project failed dismally.

The influx of Continental artisans who arrived in England periodically as the result of religious and political persecutions on the Continent, caused our country to gain many individuals who had a knowledge of silk manufacture. With the aid of these refugees, silk weaving was gradually set up in Britain—but not silk spinning or silk "throwing," as it was called. All the "thrown" or spun silk which was used in Britain had to be imported from the Continent, notably from the Savoy regions of Italy.

Italian Organzine

The Italian manufacturers were exceedingly skilled in the spinning or "throwing" of silk. Their silken thread, which was termed "organzine," was the finest in the world. This material was made in a number of Italian factories under the control of the then King of Sardinia, which worthy derived so much profit out of the industry that, in his wisdom, he decreed that the technique of silk-throwing should ever remain the secret of the Italian people. Exceedingly severe laws were enacted whereby the mystery of Italian silk production was to be perpetuated. Any attempt even to discover the secret by an unauthorised person was visited by death and the subsequent forfeiture of all the legal possessions which the unfortunate culprit had possessed.

For a time, the Italian silk laws had their desired effect. Italy retained almost exclusively its silk production and that nation waxed rich upon the silk exports which it sent to Britain and to other countries.

John Lombe

John Lombe

To a greater or less extent, this condition of affairs was prevailing when John Lombe was born at Norwich about the year 1693. Lombe's family was descended from Flemish settlers who had come to England about a century previously. His father, John Lombe, was a worsted weaver, who married twice, whilst his more successful half-brother, Thomas Lombe, went to London, was apprenticed to a mercer of that city, and ultimately succeeded so well in life that he ended up with a knighthood.

Of John Lombe's earliest days we know little. In 1702, when he was about ten years of age, we find him working as a mechanic in Derby. Evidently, however, his mechanical inclinations were well defined even at this early age, and, for a number of years, he worked as apprentice to a mill-owner named Crotchet (or Crockett), who was endeavouring to start a small silk mill in Derby.

Crotchet was an enthusiastic man, and an individual of some mechanical pretensions. He seems to have erected some kind of a silk-winding engine at Derby, and to have attempted to operate it commercially. But his knowledge of the technique of silk production was very limited, so much so that ultimately the Crotchet establishment failed.

The failure of Crotchet meant for John Lombe the loss of his job. It was suggested that Lombe, being a clever draughtsman after his years with Crotchet, should seek a similar position with another enterprising manufacturer. The young man, however, seeing that there existed great possibilities in silk manufacture, rejected all such suggestions. Instead, he decided upon making a journey to the silk-producing districts of Italy, to live there and, after gaining a knowledge of the Italian methods of silk making, to return to England in order to establish the manufacture of silk in his own country.

Journey to Italy

Accordingly, in 1715, he journeyed to Italy and, after settling there for a little time, disguised himself as an Italian labourer, and eventually bribed a couple of workmen to allow him admittance to one of the Italian silk-throwing factories. Not once, but several times, did John Lombe thus gain access to the secret silk factories of the Italians. His visits were but short ones, but each time he made the most of his opportunity, committing to memory every detail of the silk-throwing machines, noting the principles of their operation and the mode of their construction.

Each night during this critical period of his residence in Italy, Lombe noted down on paper everything he had seen during the day. Before long, he had a complete sketch and a set of competent working drawings of a typical Italian silk-throwing engine.

All went well until Lombe began to prepare for his departure from Italy. Then the news leaked out that he had been spying upon the silk "engines." A tremendous hue and cry was set up, and it was not without some difficulty that the Englishman managed to make his way to a British ship in which he escaped to England.

Two or three Italians came with Lombe to our shores, since, now that the plot had been discovered, it spelled certain death for those individuals to remain in their native land.

Lombe's Patent

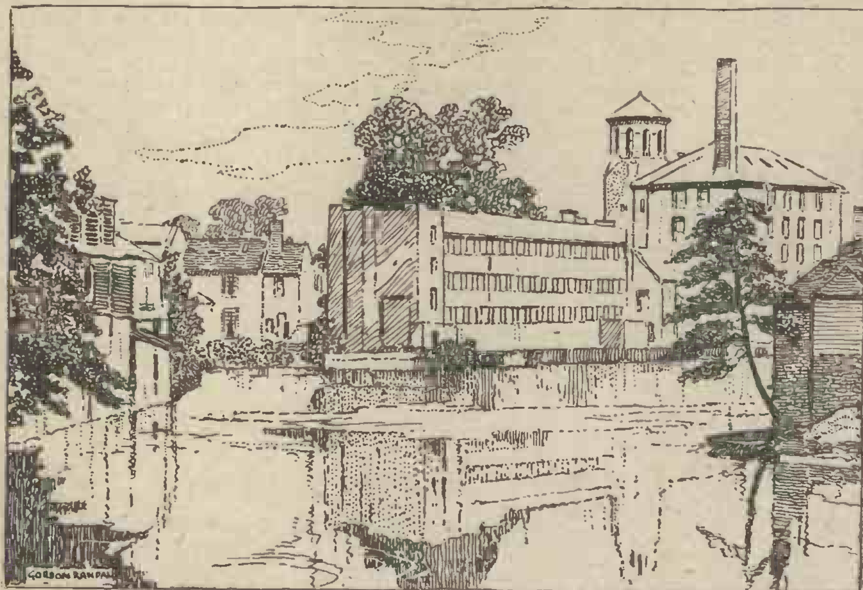
Arrived in England, John Lombe lost little time in making a start with silk manufacture in this country. He seems to have effected some improvement on the original Italian silk "engines," whereby the machines were considerably speeded up. He arrived in London in 1716 and immediately conferred with his half-brother, Thomas Lombe, who was greatly interested in the enterprise. Between them, the Lombes drafted a patent specification for the "organzining" of raw silk, i.e., for the "throwing" or spinning of the material so as to convert it into the Italian product known as "organzine." The patent was then applied for and was subsequently granted.

Thomas Lombe was sufficiently wealthy to be able to finance his younger half-brother, John, in his project. The latter returned to Derby with the intention of setting up silk manufacture there for the reasons that the town contained plenty of willing workers and also that the projected factory which Lombe planned for Derby would be able to take its power from the River Derwent.

After his return to Derby, John Lombe, in conjunction with his brother, Thomas, arranged with the Corporation of that town for a lease of an island plot of land in the River Derwent at a rental of £8 annually. The island was singularly well situated for water power. It was 500 feet long and 52 feet wide. On it, John Lombe erected his silk mill. It was built entirely at the expense of Thomas Lombe, the successful London merchant, and it took three years to complete.

England's First Silk Mill

Lombe's factory at Derby is noteworthy as constituting one of the first, if not *the* first, large industrial works to be set up in our country. It was erected upon huge oaken piles which were driven into the marshy island in the River Derwent. The building, when completed, was five stories high, contained eight large workrooms, and had no fewer than 468 windows. It cost £30,000, and, when in full operation, gave employment to a large number of Derby people.



England's first silk mill at Derby, established by John and Thomas Lombe.

This achievement on the part of John Lombe is a very remarkable one, particularly when we consider the crude conditions under which he worked. Apart from superintending the erection of this giant factory, John Lombe set up silk-winding machines in various hired buildings in Derby, and even in the Town Hall of that now noted industrial centre. The proceeds of these activities helped to pay for the cost of the silk-throwing engines which Lombe built for operation in his island factory at Derby.

The construction of these machines—Lombe's modification of the Italian model—occupied a great deal of his time, but, in this direction, the Italians whom Lombe had brought over to England helped him a good deal. The machines were, of course, water-driven, that is to say, impelled by the power derived from a wooden water-wheel permanently fixed in the river.

If we are to rely upon the early records of the Lombes' enterprise, it was, indeed, a remarkable and a courageous one for its time. According to such accounts, there were eight silk "engines" which gave motion to upwards of 25,000 separate silk bobbins. There were four silk-twisting mills, each mill having 389 spindles impelled by it. The whole of the machinery was put in motion by a single water wheel some twenty-three feet in diameter, which was situated on the west side of the building. All the operations from winding the raw silk on to reels to "organzizing" or "throwing" (spinning) it for the weavers were performed in the factory.

The Lombe factory in Derby began as a miracle of industry, and went on very prosperously. Sufficient thrown silk was quickly being produced to supply the whole of the English trade. Moreover, this silk was at least the equal in texture of the best of the Italian silks. Another effect of the working of the Derby silk mill was to quickly bring down the price of thrown silk. The cost of the material sank far below that of the Italian article, so much so that the Sardinian monarch, who had heard of Lombe's success, prohibited the export of any raw silk to England. Supplies of the material, however, were readily available from other sources and, for this reason, the trade of the Lombes remained unaffected.

John Lombe's Early Death

John Lombe had been engaged in his lucrative trade for only a matter of four years when he met his death at the lamentably early age of 29 years. The story of his death is a strange one. It appears that a coterie of Italian manufacturers, maddened by Lombe's continual success, determined to bring about his destruction. They took into their conspiracy an Italian woman who came over to England in the guise of a traveller. This woman, the story goes on, made her way to Derby and gained the friendship of one of the Italian workmen whom Lombe employed in his factory. This individual is credited with having administered a slow poison to Lombe, although by what means is quite unknown. The story ends by asserting that John Lombe died an exhausted man after undergoing a protracted period of terrible agony. Ultimately, the workman in question escaped to his own country and, suspicion having been aroused, the Italian woman was officially interrogated, but no information was obtained from her.

The above story has been disputed, but the evidence for it outweighs that which would tend to disprove it. Certain it is that John Lombe died at the relatively tender age of 29 years. His burial took place with much ceremony in All Saints' Church, Derby, in the March of 1722.

To his half-brother, Thomas Lombe, of London, passed the ownership of the silk-machinery patent, and he lived long enough to reap the benefits of John's acumen and industry. The patent expired in 1732, and Thomas Lombe petitioned Parliament for its extension. This application, incidentally, made history, since it constituted the first application to be made for the extension of a 14-years patent.

Models of Silk Spinning Machines

Thomas Lombe's application for an extension of the patent was opposed by a number of cotton and worsted spinners. The Parliamentary Bill to renew the patent was defeated, but Thomas Lombe was given "compensation" to the tune of £14,000, on the condition that he had models of his brother John's machinery made carefully to scale, and that they should be deposited in the Tower of London. These models were faithfully made and deposited in the Tower as required. There they remained for many years, but, eventually, they were lost.

Thomas Lombe was made Sheriff of the City of London in 1727, and in the same year he was knighted by George II. He died on 3rd January, 1739, leaving to his widow a fortune of approximately £120,000.

Sequel to "The Battle of Britain"

AN appropriate sequel to "The Battle of Britain" would be a book of photographs showing the results of the bombing of Britain's towns and cities—the story in pictures of the courage and endurance of the civil population and the A.R.P. services. Such a work is now available under the title of "Britain Under Fire."

Divided into two sections—London and Provincial Towns and Cities—it records in graphic photographs the damage suffered by famous buildings, churches, hospitals, schools and residential property. In many cases, contrasting pre-war pictures are given, illustrating the beauty of these buildings.

There are nearly 200 photographs in all, and a preface—illustrated by photographs taken quite recently—tells how Britain is meeting the Nazi aerial warfare.

The publication of "Britain Under Fire" is a striking condemnation of the Nazi policy of indiscriminate bombing. In a special preface to the work, J. B. Priestley describes the book as "a record of civilised savagery," and "a two-fold story of a great crime and of a still greater people."

The book costs 6/- of booksellers, or 6/7 by post from the publishers, Country Life, Ltd., 2-10 Tavistock Street, London, W.C.2, and is already in great demand in Britain and Overseas. It is a work which will be treasured as an historic souvenir of Britain's greatest hour—of an island people who are to-day the admiration of the Empire and all who watch the breathless struggle to uphold the democratic way of life.

Queer Observations

Brief Notes on the Hardness of Liquids

By PROFESSOR A. M. LOW

IF I felt intensely scientific to-day, I should write a long article upon the subject of research. I should explain how innumerable people all over the country spend their time weighing something to obtain data which no one ever wants to see, or plotting curves which enable a comparison to be made between the weight of newspapers and the traffic round Piccadilly Circus. There are many equally foolish examples in the realm of academic research where hard-working people obtain qualifications by demonstrating their aptitude for juggling. To me, there is something pathetic about the juggler—for he must devote the greater part of his life to practice, while the result, remarkable in itself, can never last long. But I think I am rather more human than that as the result of bombs, hard work, and light sleep—so let me tell you, instead, of a different kind of technical investigation carried out as the direct result of questions put to me by those who long to demonstrate my ignorance. A perfectly easy job—if only they would tackle it in the right way.

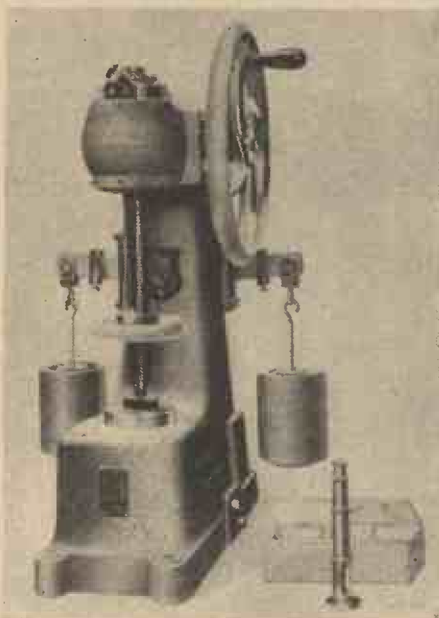
What is Hardness ?

First of all—take my correspondent who says "What is 'Hardness'"? A most useful point, for it can be defined in so many ways. In my humble opinion, it is entirely a matter of speed, and, although it can be conveniently illustrated by the Vickers test, the Brinell test—and even, perhaps, by a spectrographic examination under X-Rays—I *still* think that speed is the key to the picture. Experiments have been made to show how much a plate can be scratched; the scratch is examined carefully under microscopes, and then hardness calculated upon a scale. Others press a steel ball of definite size and condition into the substance to be examined, and they give a relative figure for hardness which depends upon the depth to which the ball penetrates. Now, free your mind of all these schemes, and remember what we used to be taught as to the difference between solids, liquids, and gases. A solid, you will remember, was something which did not adopt the shape of the containing vessel; a liquid did; and a gas used to fill any vessel into which it was put, if the circumstances were suitable.

Sealing Wax

Anyone who has turned out an old room will surely have discovered a piece of sealing wax which was left at the bottom of a vase. Examine the wax carefully, and you will find that it has taken up the shape of the containing vessel—and, therefore, may be defined as a liquid. Go to a little more trouble—and look at some high-speed photographs of water being poured from one jug into another. It takes quite a long time for the water to accustom itself to the shape of the vessel and it is of a small degree of "hardness," because its particles move together comparatively easily. I am not thinking at the moment of the atomic dance of the still smaller bits which go to make up every material—although I daresay that a few more hundred years of true research will show that the form and speed of the atomic movement are able to decide far more than the nature of material—perhaps the nature of Life itself.

But neglecting such complicated things as Electricity, Life—and Income Tax Forms, try to think back to those far-off days when you had a holiday and saw, perhaps, a speed-boat dashing across the surface of the water, making use of the partial fact that water is very "hard" at high speeds. As you will know, a man who falls overboard from one of these fast skimmers often breaks his leg—because it is like striking concrete as the pace increases.



Brinell hardness testing machine.

In an aeroplane, at a speed of 300 m.p.h., air seems very hard and tough. Try to open your mouth—and the effect is positively painful. Hold out a hand—and it is struck back as if by a giant.

So—if you will be a little more imaginative, without in any way losing your logic or accuracy, thinking in terms of Time, such as are enjoyed by a butterfly and not a tortoise—in other words, speed up your rate of observation like a cinematograph picture—when you can imagine that piece of sealing wax flowing into the jug quite easily. If you took a high-speed cinematograph film of a forest, you would be able to watch creepers dashing up trees and tearing them to pieces—simply because you have altered your apparent rate of living.

Now, come back to water again, and think of the last time you visited a Fair and saw ping-pong balls dancing on a jet of water. If air is substituted for the water, and if the pressure is high enough, heavy things like spanners or hammers will dance quite cheerfully in the air stream because, at high speed, this air is "hard." There is, indeed, no way of distinguishing between a solid and a liquid with great ease—other than by saying it would take a tremendous time for a really viscous solid to accustom itself to any particular shape, whereas others—like wax—move more quickly. So—hardness depends upon time . . . and what is that, but speed ?

Incidentally, all kinds of very quaint effects can be seen by the use of high-speed cinematography. Many years ago, I fitted up a telephone into the head of a motor car engine, and indicated the change in current upon a screen, thus pointing out what pressure changes were occurring. The latest cathode-ray instrument no doubt does this more effectually—but the principle is virtually identical.

Smashing an Electric-Light Bulb

I always take my mind back to the delightful experiment of breaking an electric light bulb with a hammer. I say "delightful," because none of us quite lose the thrill of breaking something deliberately—I suppose that is why cock-shies never lose their thrill. Observe, then, what happens as a hammer strikes the electric light bulb. First of all, the hammer pushes a small dent into the glass without breaking it at all—and then, if it is of the gas-filled variety, it is quite common for the glass to break *opposite* to the hammer owing to the current of air—sorry, gas—which is pushed across the bulb, and which presses out the opposite pane of glass, as it were, before the pressure has time to spread.

What a lesson to the designer of an internal combustion engine, who is dealing with gas travelling so fast that it acts rather like treacle. In racing engines, it pays over and over again to polish the inside of inlet pipes, just because the gas flows more regularly without bumping or shock—and in modern aeroplanes a very big change in speed can be effected by giving the outfit a coat of comparatively rough paint. Yacht designers used to know this many years ago . . . and, still farther back, pirates used to careen their ships (whatever that may mean)—but I understand it was something to do with scraping their bottoms quite heartily.

Bird in a Box

The next letter was really much more difficult, and I am so irritated by it that I think I will pass it on to you for solution. Supposing, says this infuriating person, a bird is in a small box—and that box, complete with bird, is stood upon a pair of scales. Let us assume that the scales are nicely balanced as the bird sits in its box, and that at this moment the bird begins to fly and flies round its box without touching the sides at all. What happens to the scales ? There, he says, is the bird in the box . . . yet, the bird is supported in the air and not touching the box at all. Can it be that the box will go down with a bump ?

Automatic Regeneration Control

A Method of Using an Additional Electrode in the Second Detector Valve.

WHERE a radio broadcast receiver is limited by design to three valves, exclusive of the power rectifier, in compact sets, or in battery-operated portable receivers, regeneration provides a very useful way of increasing selectivity and sensitivity. However, one of the main obstacles to using the regenerative circuit is the possibility of self-oscillation at high signal levels. A new development in regenerative circuits has reduced this obstacle to a large extent, by the use of an additional electrode in the valve used in the regenerative stage, a bias being developed by the grid current in the signal grid circuit, and being applied to the extra electrode.

Figure 1 illustrates in a schematic manner a compact superheterodyne receiver, either of the battery-operated portable type or the alternating current-operated type, employing this new development and consisting of a single converter stage 1, a second detector valve 2, and an audio power output valve which is not shown. The signal converter may consist, for example, of a pentagrid converter valve having circuits to render it operative as a combined tunable local oscillator, and tunable first detector. In the tuned output circuit 3, there is developed signal voltage of intermediate frequency.

The valve 2 can be a multi-grid valve of the 6L7 type; its circuits are shown in detail. The cathode is connected to the earth side of the power supply resistor 5. The signal grid 6 is connected to the high potential side of the resonant input circuit 7, through a resistor 8.

The latter is shunted by the usual condenser 9, and the elements 8-9 function to provide grid leak detection. The circuits 3 and 7 are magnetically coupled, the latter circuit being tuned to the operating I.F. The plate 10 is connected to the positive potential side of the supply resistor through a path comprising feedback coil 11, radio frequency choke coil 12, and audio choke coil 13, the latter element being shunted by resistor 14. The audio voltage developed in the plate circuit is fed to the following audio amplifier through condenser 15; condensers 15a by-pass the intermediate frequency currents to earth.

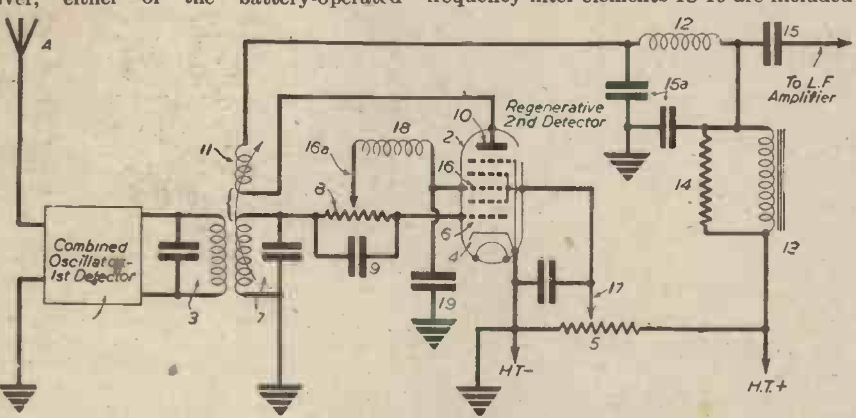


Fig. 1. A schematic diagram of the regeneration control system

Regeneration

The coil 11 is reactively coupled to circuit 7 to regenerate the latter. The arrow designates adjustability of the degree of regeneration. It will be understood that sufficient regeneration is desired to impart high selectivity, and high sensitivity to the detector. To prevent the valve from going into self-oscillation, it is only necessary to connect grid 16 to a suitable point on resistor 8. While grid 16 is shown as terminating in a slidable tap 16a, it will be generally desirable to position the latter at the grid end of resistor 8. The screen electrodes on either side of grid 16 are adjusted by lead 17 to a positive potential point on supply resistor 5, such that optimum operation is secured. Radio frequency filter elements 18-19 are included in circuit between tap 16a and grid 16.

The flow of grid current produced by the conditions causing oscillation provides a direct current voltage across resistor 8. Grid 16 is biased negatively, and acts to inhibit the sudden rise of plate current which is conducive to self-oscillation. Actual experimental operation with a receiver using this type of detector circuit demonstrates freedom from oscillation while the regeneration is at a high level.

Amplifier Circuit

In Fig. 2 there is shown the scheme applied to an amplifier, either operating I.F. or at carrier frequency, including a valve 20, which may be of the 6SA7 type. The input circuit 21 may be coupled to any desired signal circuit 22. The signal grid 23 is connected to the high potential side of circuit 21 by resistor 24 shunted by condenser 25. Resistor 24 and condenser 25 have a large time constant. The cathode 26 is connected to a tap on the input circuit coil which is above earth, and provides regenerative feedback. The plate 27 includes the output circuit 28, which is tuned to the desired signal frequency. The various positive voltages are supplied to the screen electrodes and plate from the voltage supply resistor 30. To prevent oscillation, the grid 40 is connected, through filter 50 to the grid end of resistor 24.

The signal grid 23, it will be noted, is operated at zero bias under no-signal conditions. If desired, the resonant output circuit 28 may be coupled to the following tuned network 60. Here, again, grid 40 controls the space current flow to plate 27, so that self-oscillation is prevented. Flow of grid current through resistor 24 provides bias voltage both to grid 40 and to grid 23.

This circuit was developed in the laboratories of the Radio Corporation of America.

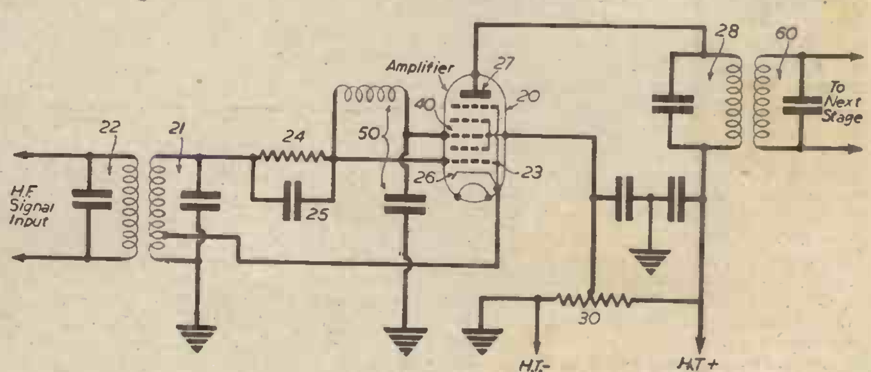


Fig. 2. The arrangement as applied to an H.F. amplifier

ITEMS OF INTEREST

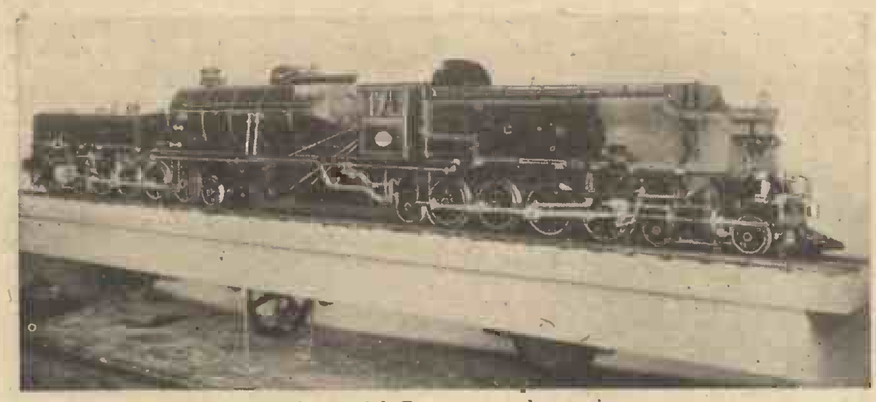
Recording Engine Sounds

IN training men for engine rooms in United States ships, recordings are now being made at sea of the characteristic sounds in internal combustion engines, effects of faulty valves, etc. These recordings can then be brought back to the classrooms on land, amplified to corresponding loudness, and played for the budding engineers, enabling them to hear actual sounds of engines running normally and engines in difficulties—while the instructors point out the significant sounds that the trained engineer strains his ear for.

Saving Life at Sea

IN addition to portable radio transmitters, electric-light buoys, attached to ships' life-rafts for use at night, and a device which flashes the S O S signal in Morse continuously for 48 hours, and if used only at night will last a week, are other devices recently introduced for saving life at sea.

THE WORLD OF MODELS—



A fine model Garratt-type locomotive

By "MOTILUS"

Craftmanship from Overseas, and Model Railway Work.

Miniature Tools

OVERSEAS news still continues to reach me, though slowly, and the latest arrival is the accompanying photograph of a miniature set of carpenters' tools, compared in size with a penny! The largest tool—the big saw—cannot be longer than three inches, and the detail is exquisite. This remarkable set is the work of Mr. George P. Gordon, a model maker, living at Funchal, on the island of Madeira, who has never left his beautiful home for the mainland. His workshop, situated in his garden, is a model of orderliness, and it contains the necessary equipment for practically every branch of model engineering. Although he has never seen a real locomotive, he proved an expert model constructor of a half-inch scale Pacific type engine for 2½ inch gauge, and other creations of his include a working steam travelling crane, a gun and gun carriage, and a weaving machine. Certainly, he has variety in modelling!

A Novel Toy Train

I wonder if any of my readers can tell me anything about this weird train model? It was "picked up," in the words of its owner, in an old curiosity shop for "a song," is a hand-made toy, and is believed to be of American origin, although the letters N. & Y.R. do not give many clues. It is evidently a very early product, because of the design and general method of construction. This is only one of the many interesting and historic models which form part of the collection of Mr. Charles Wade, of Snowshill Manor, near Broadway, but it is one which has puzzled the owner. Can any reader help me?

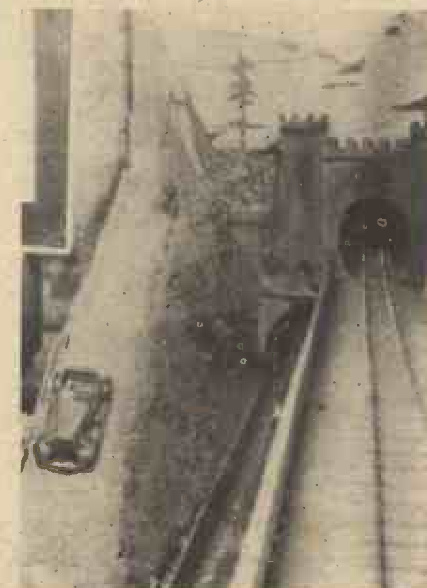
A Fine Model Garratt-Type Locomotive

The use of scale models for publicity purposes by British manufacturers will come forward again after the war is ended, and makers will be anxious to regain their previous connections and increase our exports abroad. Locomotive and ship builders have always been aware of the selling appeal of a good model of their products, and here is a model of a Garratt-type locomotive as used on the Benguela railway of West Africa.

Made in 1928-1929 by Bassett-Lowke, Ltd., to the order of Messrs. Beyer Peacock, it was built to a scale of ¾ in. to the foot, is approximately six feet in length, the gauge being 2⅞ in. (3 ft. 6 inches actual). The locomotive was built of metal throughout, and all the wheels were made to revolve by means of an electric motor and belt-driven gearing. The back plate in the cab was fitted with an exact replica of all cab fittings in miniature. The engine itself was finished in black with red panels, and the motion was nickel-plated. The whole was mounted on a ballasted base-board, with reproduction of the special type of ant-proof metal sleepers as used abroad. The tender, loaded with tree logs, showed the type of fuel used on the Benguela Railway. The model formed part of a large show-case piece 20 to 30 feet in length, made in burr walnut with base about 3 ft. 6 inches from the floor, and glass show-case on top. Within the show-case was a complete train behind the engine, showing all the types of rolling stock of the Benguela Railway, with a descriptive card in three or four languages fixed in a frame on the outside, and opposite each particular section of the train. This whole display was first shown at an exhibition on the Continent.

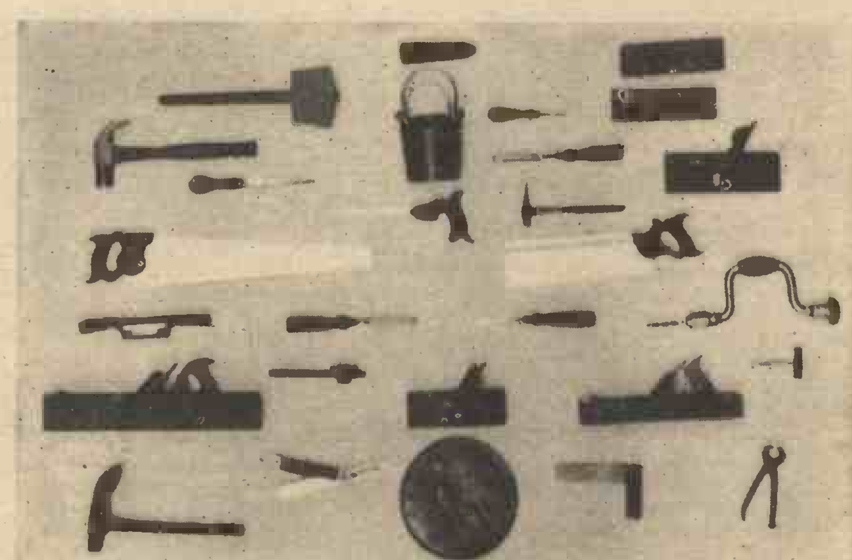
Rugby Model Railway

All about the country I am finding Model Railway Societies who are not letting war-time conditions deter them from "carrying on," and a fine case in point is the Rugby Model Railway and Engineering Society, inaugurated on January 15th, 1939, with eight members, and now over thirty strong, not counting an extra eight who are with the Forces. The club meets once or twice every week, holds a regular meeting every Friday evening, when there is either a running schedule for the trains, or a talk. They were lucky to find suitable premises in the form of a stable, which they have most successfully converted. The railway layout is upstairs, and the machines and committee room are on the ground floor.

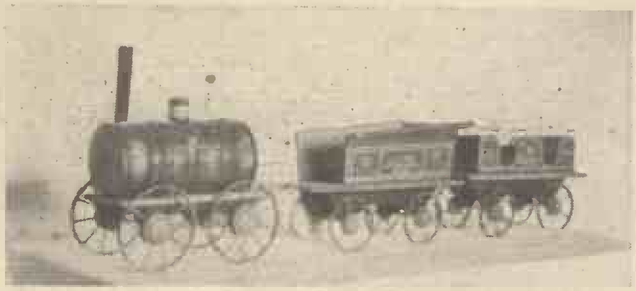


Looking up the line on the Rugby model railway.

The members use the proper telegraph code as in real railway practice, and to watch them at work on an hour's running



A miniature set of carpenters' tools, made by a model-maker in the island of Madeira



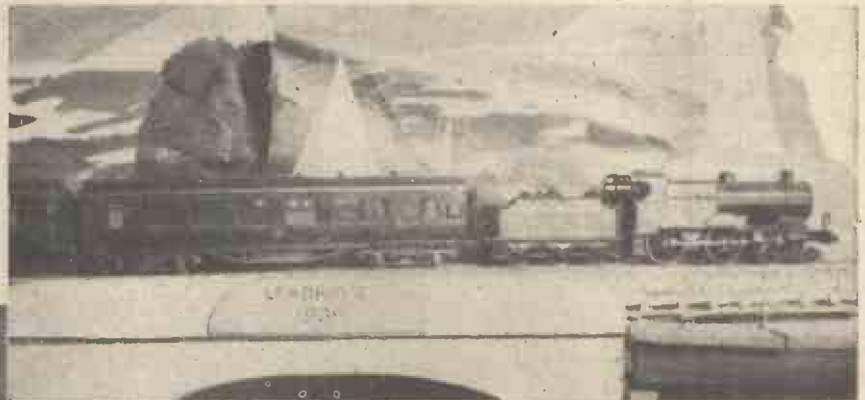
A novel toy train

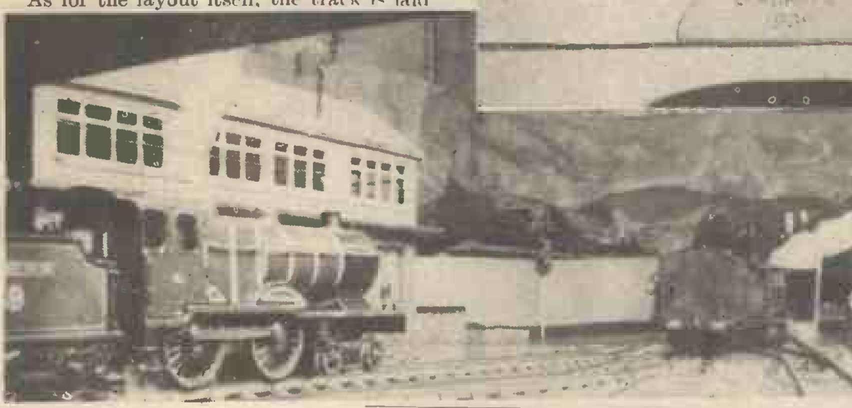
schedule is most interesting. Special members are placed in charge of the various departments. Mr. B. Gubbins, for instance, is head of the Signal and Telegraph Department. The Scenery and Civil Engineering Department is headed by Mr. Derek Favell, who has certainly made a good job of his duties. Mr. A. J. Powell, head of the Permanent Way Department had a year's work in constructing the track, which was really the layout's biggest single item. The Locomotive Department is in the charge of Mr. K. Rogers, honorary secretary of the Club, and the Carriage and Wagon Department is supervised by F. Renshaw, Junior, son of the president. The Superintendent of Operation is Mr. P. Par'sh.

As for the layout itself, the track is laid on two levels, the lower level consisting of a terminus—Leabridge—from which a train passes the signal box and the lever frame with no less than 75 levers, goes by three-colour light signals, and then enters a long tunnel 15 feet long. It emerges through a cutting and passes through to Northfield station, from whence it carries round to Stapleton and traverses a gradient of 1 in 48. From Stapleton it is on the higher level, and runs along to Merivale, the branch line station.

Very special attention has been paid to the signalling of the track, and a train records book of the runs is kept. The club owns at least 14 locomotives, including a "Flying Scotsman," L.M.S. Compound, L.M.S. 4-4-0 (Bassett-Lowke) S.R. Eton, Merchant Taylors, G.W.R. Tank, L.M.S. Tender Goods, 2-4-2 Shunting Tank, G.W.R. County of Bedford, Bramham Moor, L.M.S. 2P and S.R. 4-4-0. The layout is gauge "O" clockwork, and the track consists of Bond's rail laid on over 25,000 chairs, and 12,000 sleepers.

Mr. F. Renshaw, the president, was the "mainspring" behind the movement in forming this young and active club. He is not always there as his work takes him out of town, but whenever possible you will find him with the club, and he has a fund of railway, engineering and other stories with which to entertain members and visitors. The club keeps on the right side of its bank balance by the simple method of charging 2d. a week for members up to 18, and 4d. for over 18's. Members take every opportunity of visiting well-known model railways and exhibitions, and hope to hold one of their own at Christmas.





Two sections on the well-equipped Rugby model railway

How Lighter Flints are made

ALTHOUGH incandescent gas mantles and cigarette lighter flints bear as little resemblance to each other as cheese does to chalk, they have a common origin, and the discovery of one led to the production of the other.

To a group of lesser known metals, often referred to as the "rare earth metals," belong thorium and cerium—two elements which receive very brief mention in all but the larger works on chemistry.

Thorium is extensively used in the manufacture of gas mantles (china grass or art silk frames impregnated with a solution of thorium and cerium nitrates), owing to the coherence of its oxide, which holds together after the fabric has burnt away. Welsbach was, of course, the inventor of the incandescent mantle, and in his subsequent experiments with the rare earth metals found that mixtures of cerium and iron—technically known as ferro-cerium alloys—gave off showers of sparks capable of igniting inflammable vapour when the metal was scratched or filed.

No really satisfactory explanation of this pyrophoric property of ferro-cerium has yet been put forward. It is a property also possessed by many common metals, but in a less degree. Copper foil ignites spontaneously in chlorine gas, while finely divided lead, iron or nickel will behave similarly in atmospheric air under certain conditions.

Pyrophoric Lead

As an illustration of this it is an easy matter to prepare a small sample of pyrophoric lead. A small quantity of lead tartrate is heated to redness in a test tube, which is then heated throughout its length to expel any residual water, securely corked and allowed to cool down. The dust it contains is metallic lead in a finely divided state. This thrown into air takes fire with a shower of sparks.

Manufacture of Ferro-cerium Alloy

Oxides of cerium, lanthanum, etc., are found in many minerals—cerite, monazite, and allanite, for instance—but as large amounts of cerium earths occur as by-products in the gas mantle industry, these are employed in the production of ferro-cerium alloys.

The oxides are first extracted and then undergo an elaborate process which reduces them to the metallic state. This metal (mischmetal) is highly reactive in its molten state, combining direct with oxygen, hydrogen or nitrogen, and even with the combined oxygen in carbon dioxide or carbon monoxide. The process of reduction is, therefore, conducted in the absence of air. The rare earth oxides are converted to anhydrous chlorides and then heated strongly *in vacuo* with ammonium chloride. The molten mass is then electrolysed in a graphite crucible using an iron cathode and passing a current of 1,500 amperes.

There are numerous modifications of this process and various formulae. Some manufacturers add about 5 per cent. of copper to the mischmetal. This is claimed to yield a low melting point and smooth casting alloy. Zinc and boron cerium alloys have also been produced. The popular "Auer" pyrophoric metal contains about 35 per cent. iron and 65 per cent. cerium.

"Kunheim Alloy"

A different process of French origin yields "Kunheim" alloy, a mixture containing hydrides of cerium earth metals. Misch metal mixed with aluminium and magnesium is heated in an atmosphere of hydrogen to 500 degrees C. in an electric muffle furnace. An analysis of this shows the following composition:—

Cerium .. .	30 per cent.
Lanthanum, etc. ..	49 „
Magnesium ..	10 „
Aluminium ..	1 „
Iron	1.5 „
Hydrogen	1.3 „
Silicon	0.5 „

QUERIES and ENQUIRIES

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

Electric Motor-Boat

SOME time ago I remember reading about a method of converting an automobile self-starter motor into an outboard motor running off automobile-type batteries. As I was a keen amateur outboard motor-boat enthusiast until the petrol ban put a stop to such activities, I was hoping that you might be able to either furnish me with details as to how to convert such an electric motor, or put me in touch with a firm who could supply such details.—B. A. Sharples (Dover).

THE ordinary self-starter motor as used with cars is not suitable for continuous operation, as it would overheat after a short time in use, unless the current were restricted by a considerable amount of series resistance. The usual way is to attach the motor to the top of the rudder with the shaft vertical, terminating at the bottom of a stern tube in bevel gearing to give the change to a horizontal propeller shaft drive. We know of no published details of such conversion, as the motors are generally specially designed for the purpose, and would need to be more powerful than the starter-motor, as well as being adapted for continuous running. Possibly Messrs. Stuart Turner Ltd. of Shiplake, Henley-on-Thames, could assist you with particulars and a quotation, if not too heavily engaged with war work.

Pressure for Projectile

WILL you please inform me what pressure of compressed air is required to fire a certain missile. Particulars are as follow :—Barrel length 2 ft. 6 ins., diam of missile 4 ins., length of missile 8 ins., weight of missile 15 lbs. Range required about 30 yards? For such close range I am assuming that the barrel need not be rifled. Also, what horse power, from a petrol driven engine, is required to produce this pressure? The time desired to be taken in the production of the pressure is about 5 seconds, while the desired h.p. is about two. —R. A. Beater (Heytesbury).

ASSUMING the angle of elevation to be 20 deg., the muzzle velocity required for a range of 30 yards to a point at the same level as the muzzle is about 70 feet per second.

For a missile weighing 15 lb. this calls for a mean force of about 450 lb. acting over a length of 2 ft. 6 ins., and on a diameter of 4 ins. this means about 35 lb. per sq. in. Allowing for frictional resistance and for some drop in pressure during discharge, an initial pressure of 50 lb. per sq. in. is desirable.

The air should be compressed into a reservoir of about ½ cu. ft. capacity, and an engine developing 2 h.p. and driving an efficient compressor would just suffice to build up 50 lb. per sq. in. in such a reservoir in 5 seconds.

Transformer Winding

WILL you please state the number of turns for primary and secondary for a mains transformer to step down from 230 volts A.C. to 16 volts, and to carry about 4 amps. Also, what are the gauges for wire for both windings? Do I wind the secondary on top of the primary, and in the same direction? The core stampings measure 1⅝ in. thick when clamped tightly together.—W. E. Orr (Finsbury Park).

A TRANSFORMER core to the dimensions you give will have a cross sectional area of iron equal to 2.75 square inches, and at a frequency of 50 cycles will have a reactance factor of 2.9 turns per volt at normal flux density. For a step-down separate winding therefore the input being 230 volts and approximately 0.234 amps. with a secondary output of 16 volts 4 amperes, the windings will be 670 turns of No. 28 SWG, and 47 turns of No. 16 SWG, respectively, both double cotton covered copper. Slightly better voltage regulation is obtainable by winding on the secondary coil first and the primary over it. Each coil must be wound continuously in one direction but it is immaterial whether they are both alike in this respect, when the primary is separate from the secondary and not auto-connected.

Electric Drive for Lawn Mower

I HAVE a 12-inch lawn mower, and wish to drive the blades of this by means of an electric motor. Could you tell me what horse-power, and revolutions per minute this motor should have? Our mains are A.C. 230 volts.—J. A. Smiths (Chelmsford).

AN electric motor for driving a 12-inch lawn mower should have a rating of not less than ⅓ h.p. if it is to "drive" as well as "cut." If required to rotate the cutters only, the mower being otherwise hand propelled, an allowance of ¼ h.p. will be sufficient. The motor speed should not be less than 1400 to 1500 r.p.m., and geared down to the cylinder about 4½ or 5 to 1 ratio, so that the cutters revolve between 300 and 350 revs. per minute. A good starting torque is essential, which may be obtained by the use of a motor of the "capacitor start" type.

Power Factor

WILL you please inform me what is meant by the power factor in A.C. welding plant? How is it improved by a condenser, and what are the advantages?—R. Allen (Newmarket).

THE power in an electric circuit is measured by the watts, that is the volts multiplied by the amperes in the case of direct currents. But in alternating current work the current wave does not always coincide with the voltage wave, lagging behind it when there is self-induction in circuit, and leading in phase when the circuit contains capacity. When either of these conditions are present the product of volts and amperes may not represent the true watts, as the two waves may not reach their peak values simultaneously. The true watts will then be something less than the apparent watts as would be registered by the readings of separate ammeters and voltmeters when multiplied together, and this discrepancy between "true" and "apparent" watts is termed the Power Factor. What this really means is the percentage of useful power that can be employed out of the total power in volt-amperes supplied to the circuit. This can be ascertained by using a wattmeter instead of two separate instruments, ammeter and voltmeter, the wattmeter registering only the useful component. When the current wave is lagging in phase behind the voltage wave it can be brought into step again by the use of a condenser of suitable value.

Books on Metallurgy

AS a student of metallurgy, could you please recommend a suitable book that would help me?—H. G. Palmer (Birstall).

THE subject of modern metallurgy is a very wide one, and, in consequence, there is no one book which covers the whole ground of the science. Most of the "theoretical" books on metallurgy are very abstruse, whilst many of the "practical" books on the subject are somewhat incomplete in view of the fact that a number of metallurgical processes are still retained as trade secrets.

Without knowing the branch of metallurgy in which you are especially interested, it is exceedingly difficult for us to recommend a book which would be of service to you. Since, however, you mention chemical science, we are assuming that you will be interested in the chemical side of metallurgy, in which case any of the following works will suit your needs:—A. H. Sexton: Elementary Textbook of Metallurgy, 8s. 6d. net; J. C. Thompson: Metallurgy for Engineers, 25s. net; Jeffries and Archer: The Science of Metals, 25s. 6d. net; A. Hiorns: Principles of Metallurgy, 7s. net.

In all probability, you will be able to obtain second-hand copies of the above from Messrs. W. & G. Foyle, Ltd., Charing Cross Road, London, W.C.2.

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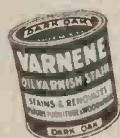

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THE Cyclist

Editor: F. J. CAMM

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Phone: Temple Bar 4363

Telegrams: Newnes, Rand, London

Comments of the Month By F. J. C

Is There a Post-war Plan?

WE ask this question because we feel that we can supply the answer—in the negative. We are merely paying lip service to that piece of topical ideology known as the Post-war Plan. We did not have a plan before the present war. Our policy was to build roads to enable motorists to travel to the seaside by the fastest but not necessarily the more pleasurable route. We had no road plan because we have not yet had a Minister of Transport with a sufficient depth of road knowledge to enable him to evolve a sane road policy, with the exception of Moore-Brabazon, who did not remain at the M.O.T. sufficiently long to enable him to put his knowledge and experience into practice. We are now experiencing difficulties as a result of this lack of policy. We have continued, as we have said in another place, upon the even tenor of our Victorian ways. We want to remain static. We regard with abhorrence and suspicion anything which tends towards progress or improvement. We want time to stand still, and that is why we have societies like those for the preservation of rural England, and the preservation of beauty spots, and the preservation of this, that and the other, whose main objective is to preserve things as they are and not as they ought to be. We blind ourselves to progress and scientific developments.

What Cyclists Should Remember

Cyclists have every reason to remember this, for when they were the fastest vehicles on the road they were opposed with extreme bitterness by those representing the horse-drawn interest. The leather industry which supplied the material for the harness, the coach builders, the breeders of horses, the ostlers, and the coachmen opposed the dawn of the cycling era. The moneyed people whose hobbies were huntin', fishin', golfin' and shootin' were able to inflict their viewpoint on the community, for some of them served as magistrates in their particular districts. Be-monocled and bland, they were able to dispense the diatom of wisdom they possessed from the haughty magisterial chair. They adjured the drivers of horse-drawn vehicles to throw their whips into the wheels of speeding cyclists. Like the motorist of to-day, cyclists were persecuted by the police. They were guilty before they went to court on one of the myriads of charges which could be brought against them. The Ripley Road was one happy hunting ground, and the Kingston police of the day thought they were established for the sole purpose of hunting cyclists and bringing them to court on some frivolous charge.

The Art of Perjury

The records of the proceedings of those days indicated that the police had developed the art of perjury to a point which, fortunately, is not known to-day. They were prepared to lie in order to secure a conviction. Even to-day, Kingston has earned for itself an unenviable reputation for needless prosecutions. It must be one of the districts at the top of the lists relating to the numbers of prosecutions brought against road users.

As we have said, this country opposes progress. It legislates against it. When the motor car first appeared on the roads of this country, it was opposed by that monstrous piece of repressive legislation known as the Red Flag Act. Drivers must not proceed at a speed exceeding 5 miles an hour, and they must be preceded by a man carrying a red flag. We always legislate against progress. In fact, legislation in this country has always been 25 years behind progress. As regular readers of this journal know, we have always opposed a speed limit in any shape or form. Volumes of statistics substantiate the accuracy of our judgment. We do not believe that a man is a safe driver at 30 miles an hour, and unsafe at 31, or 41, or even 51.

Rise of Accidents

The numbers of accidents, in spite of all the regulations, continue to rise. The Government does not face up to the fact that road transport is inevitable and must be encouraged. They try to prop up our obsolescent railway systems, and have imposed over 2,000 regulations against motorists in an attempt to kill the motoring industry. We do not provide parking places for vehicles and we include bicycles in this category. We make it illegal for a man to park his car or his bicycle for "an unreasonable time." The policeman, of course, decides what is a reasonable time. New vehicles were coming on the roads at the rate of 400 cars per week before the war. The Government met this by a fresh crop of regulations. When this war is over, this form of inverted and perverted legislation must cease. The roads must be for vehicles and pedestrians must be made to bear their share of responsibility. It may be that in so doing they will defer the sound of Gabriel's horn. All road users must realise that you cannot hold back progress, and progress in our road policy is essential to progress in other directions.

If there is a post-war plan to remedy the known defects of our road systems, we have yet to hear of it. Many millions of pounds have been paid into the Road Fund for the express purpose of improving our road system. Lloyd George gave the undertaking that the Fund would be used for no other purpose. It is now used as a Budget balancer, and the Ministry of Transport can only spend money after Treasury approval on the presentation of a White Paper. Road users will not tolerate after the war the present system of persecution and regulations designed to make an obsolete system work. It is indeed a pity that, during the war, the police should not be given more useful work to do than the trapping of road users, and hiding behind trees. It can scarcely be said that they are helping the war effort, or doing a man's job.

Lighting Regulations

Note also the revision of the lighting regulations. Does this not amount to an admittance on the part of the Ministry of Transport that they were wrong in restricting the area of rear lights and the intensity of wing and headlights of cars? If they were right, there was no need to modify the lighting laws. In, therefore, admitting that they were wrong, they are really apologising for the statements they had formerly issued to the press that accidents were due to a rising carelessness on the part of road users. This was patently false, for fewer vehicles are on the road during black-out and the war than at any other time. The fact that accidents increased showed that it was the conditions which had created the perils.

A Sane Road Policy

We can hope that the Ministry of Transport when the war is over will heed the advice we have so often given in this journal, and evolve a sane road policy, if necessary adopting the slogan "Safety Fast." The present slogan of "Safety First" seems to have failed ignobly. We can also hope that when peace returns, we may have directing our road policy and our road users those not blinded by bias and unable to see the viewpoint of others. There are indications that those in authority have already perceived where they have been misled and who has misled them.

We must have a road policy designed, not for the specific and often selfish interests of one section of road users (having a lively eye on propaganda), but for all, and we must at last acknowledge that roads are for vehicles, not for pedestrians.

This water-cycle, constructed by J. Atkinson, of Sydney, Australia, is constructed with a bicycle frame, two pontoons, and a special geared drive for the propeller. The machine is capable of 8 knots.

Paragrams

New Hostels Opened

SINCE the start of the war twenty-seven new youth hostels have been opened in Britain.

Hostels Safe for the Duration

SOME seventy youth hostels have been scheduled by the authorities as safe from official requisitioning for the duration.

Offside Door Trouble

AT Liverpool recently a motorist was fined 15s. and 5s. costs for causing hurt by negligence. It was stated that he struck a cycling policeman when he opened the offside door of his car.

North Shields Veteran Active

GEORGE SWAN, the North Shields cycle agent, is still active and fit. He won two Herne Hill veteran's races in pre-war days, and still rides an ordinary in the Northumberland lanes.

First Over 10,000

LOCK Eck youth hostel, Argyllshire, is the first in Scotland to have more than 10,000 overnight callers in a year.

Road to Carrick

THE village of Carrick, on the Argyllshire mainland, can now be reached by road for the first time. Formerly the only approaches were by sea and by a rough path.

Eighty -and a Cyclist

THE oldest Newcastle cycle trader, Mr. Kirsop, of Kirsop and Co., Pilgrim Street, is eighty years of age, and still rides his bicycle. He has had more than fifty years in the business.

"Flying Squad" for Scots Hostels

CYCLISTS in Glasgow have combined to form a "flying squad" to look for new youth hostels which are urgently needed owing to the demand for week-end and holiday accommodation.

Camping Record at Cumnock

THE number of tents and campers at this year's Cumnock rally of the West of Scotland Cyclists' Defence Committee was actually more than last year. If conditions permit, the rally will be held again next June.

Electric Bicycles

BOTH the U.S.A. and Sweden have now electric cycles. These are driven from accumulators housed very low in the frame. The complete weight of the machines is 200 lbs.

Second-Hand Racket

SO keen has become the demand for second-hand bicycles that general dealers, not bona-fide cycle agents, are buying up machines for the second-hand market in rural areas. The dealers travel in cars, taking the machines back to the cities for renovation and selling them at a handsome profit.

Scots Road Improvements

ROAD improvements are going ahead on the famous Rest and Be Thankful road in Argyllshire. The section down Glen Kinglas is being improved, while on the east side part of the new road is now in use.

Death of Edinburgh Pioneer

JAMES R. ALEXANDER, of Alexander's, the Scottish bicycle distributors, who died recently at the age of 89, was a pioneer of cycling in Scotland. In the "90's" he was a keen rider, and when he was 41 he set up the Scottish 100 miles tandem record with Michael Bruce, former Scots champion.

Record Hostel Popularity

THERE are now more than 12,000 members of the Scottish Y.H.A. in the Glasgow area. This record figure was attained at the end of September. The new record membership is 3,000 more than in the previous best year, 1939, when there were 9,300. Most of the new members are cyclists.

Nazis Restrict Cycling

RESTRICTIONS on the use of bicycles are now being made in Germany. Rubber is short, and machines must only be used for essential journeys. Teachers who do not prevent scholars from using their bicycles on short trips will themselves be prevented from buying new tyres.

Douglas C.C. Members in Forces

GLASGOW'S famous road club, the Douglas C.C., now has sixty members serving in the Forces. Despite this, the club is carrying on, and continues to hold regular runs, and to gather at its Stepps club-rooms. Outstanding Douglas event of the year was the September open "25" which attracted an entry of 70 riders, the best Scots entry of 1941.

Former Official as Hostel Warden

MISS MARY KETTLES, former secretary of the Scottish Women's C.A., is now acting as warden of the youth hostel at Langhaugh, in the Manor Valley, near Peebles.

Jean Reid as Lumber Girl

MISS JEAN REID, of the Caledonian C.C., a popular and successful time triallist in pre-war days, and also an official of the Scottish Women's C.A., is taking up forestry work at Luss on the banks of Loch Lomond.

Armour's Supremacy in Scotland

BY the end of the 1941 season, Jack Armour, Auchterderran Wheelers, had won time trials on practically every Scots course. In the final Clydeside "25" of the year, promoted by the Nightingale C.C., Armour clocked 1 hr. 1 mn. 11 secs., within 17 seconds of the Scots "25" record put up last season by Will Scott, Crawick Wheelers. In this event, Glasgow Wheelers also improved on their Scots "25" team record set up earlier this year. The new record aggregate is 3 hrs. 8 mins. 35 secs. and the riders were J. Brinkins, A. Hendry, and H. Herd.

My Point of View

By "WAYFARER"

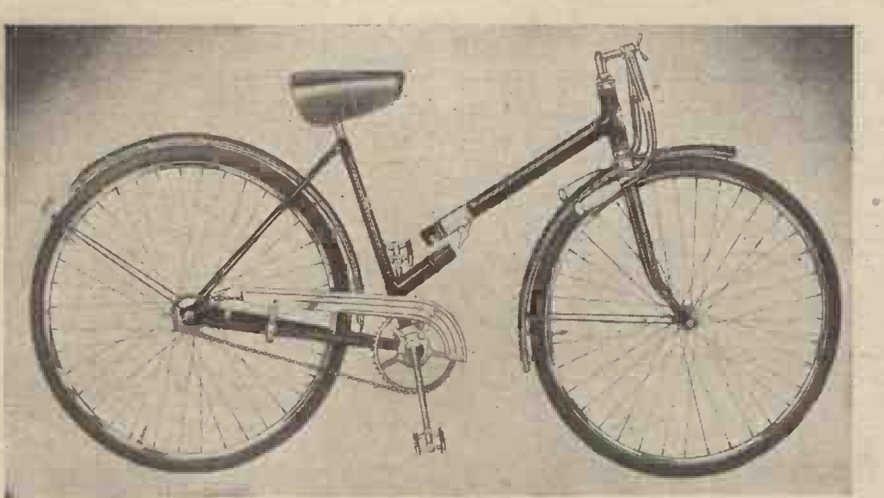
Five Nights . . .

HOLIDAYS are not easy to come by n these strenuous times, but I managed to annex the first week of September, and spent a glorious six days along the road. I went alone (I am always amused—and amazed—at the cyclists who cannot move across the road without company!), and had a thoroughly enjoyable tour. Sunday duties interfere with my comings and goings, and thus I was restricted to five nights away from home. My experiences in the matter of accommodation were mixed, but, on the whole, completely satisfactory. On the first night, I went to bed in the bar of an inn in Central Wales, after a 68-mile ride done almost entirely in rain. It was my second attempt at securing a room, and the evening was so cold and miserable that I promptly accepted the offer of this accommodation. The inn-keeper thought that objection would be raised to occupying a room ou the ground floor, but I recalled—and remarked—that a tourist in Scotland might never go upstairs to bed. So at 10 p.m., when all the drinking customers—both of 'em!—had said "Goo' night!" and stumbled into the outer world, a shutter was pulled down over the bar counter (*and locked*—evidently the inn-keeper's motto is "Safety First"!) and a bed was made up for me, and I had a bonnie sleep. On getting up in the morning, I washed in the open yard with the aid of a bowl of rain-water (of which the night had continued to produce quantities)—and it is noteworthy that there was no apparent abatement in price. I was charged ten bob for supper, bed, and breakfast. Mind you, I make no complaint (when touring, I am usually too full of the joy of living to growl at adverse conditions, financial or otherwise), but I imagine that the price would have been just the same had a regular bedroom been forthcoming, with use of the bath-room.

On the second evening I was 78 miles away, and secured a delightful and well-furnished room in an elevated farm-cottage whose windows gaze at grim mountains. What peace and quietness! On the third day, with 67 miles on the tally, I "docked" at a delectable village at the southern base of Snowdon. My usual house of call was full, and so, apparently, was everywhere else. But my friends at "Plas Colwyn" got busy, and finally secured a crib for me—a tiny room in an immaculate cottage, with the River Glaslyn in full song beneath the window. What a clamour that baby stream made, and how delightful it was to go to sleep with such delightful music for my lullaby! A 70-mile journey then brought me to a favourite cottage in Shropshire, and there I lay in great contentment of mind, rejoicing at my presence in that tiny bedroom which looks out on the Holyhead Road—the Road to Ireland—and on distant hills. Unintentionally, on the next day, I travelled 76 miles, including a circular lane jaunt of 23 miles in the morning. Intent on trying a new stopping-place to which I had been commended, I found it full, and, after some speedy cogitation, I decided to turn in my tracks and race back to the Shropshire cottage which had sheltered me on the previous night. I very seldom turn back, but the thought of doing so on this occasion was irresistible. On the sixth day, 75 miles brought me home by a roundabout route. The total mileage (if figures are worth anything) was 433, giving an average of 72 miles per day. But the dominating features of this lightning tour cannot be expressed in figures. Indeed, they can hardly be expressed at all. What a joy it all was—and what delightful memories remain for brooding over in the dark days of winter!

. . . And Some Meals

TRAVEL nowadays is beset with difficulties, and it may interest readers to know how I fared with meals. I made a bad start, my lunch on the first day consisting of four-pennyworth of dry biscuits (of inferior quality), with two bits of cheese which one would have been almost ashamed to place in any self-respecting mouse-trap, plus a bottle of stout. This unexciting meal was consumed in a wayside pub. to the accompaniment of sousing rain. A bad start, as I say—but no blame attaches. By tea-time I was as empty as a drum, and after two or three refusals I managed to "click." The answer to my enquiry for eggs was that "officially" the caterer had none. So I asked for, and obtained, an unofficial egg, which was very acceptable. Next day, at a hill-top farm, I had for lunch a couple of new-laid eggs, with bread and butter, tea, and cakes. (When I say "butter," I mean it: I did not taste margarine during the week.) That night I heard the dread announcement over the air that three eggs was to be my allowance—and yours!—for September. I had already had four—and I ate 15 more before the week was out! On the third day I fared badly for lunch. Having waited in a cafe for 45 minutes, I then walked out foodless, in disgust, and made do with a sixpenny slab of chocolate I had managed to buy during the morning. The remaining three days made ample amends, in the way of lunch, for the shortcomings mentioned, and I was enabled to forget that there was a war on. Taken as a whole, I had a grand time, at an extremely reasonable cost. I hold fast to the opinion, based on many years' experience, that there is no holiday like a cycling holiday. There are current difficulties, as has been suggested, but many of them "yield to treatment" if you know how to go about the job—and the knowledge is gained only through the medium of travel.



The Campax Sports Traveller

AROUND THE WHEELWORLD—By Icarus

The Fellowship of Old Time Cyclists

I WAS present at the early stages of the luncheon given by the Fellowship of Old Time Cyclists to its members at Slaters Restaurant in the Strand on Saturday. October 4th. The Fellowship does not issue invitations to the press, although the reason for this remissness eludes me. Surely, the Fellowship desires to keep itself alive, and there must be many hundreds of cyclists qualified for membership who have not yet heard of it; nor will they hear of it unless publicity is given to their activities in the press *generally*.

I met many old timers including Charles Jarrott, W. G. James, C. A. Smith, Sir Albert Atkey, G. P. Mills (who contributes to *The Cyclist*), Ben Tillett, Percy Beardwood, and many others. Most of them expressed astonishment that the press had not been invited to a function where so many of those who laid the foundations of the cycling, motoring, and aeronautical professions were present.

It would appear, therefore, that the Fellowship does not desire publicity, for they do not issue notices to the press. We have, of course, our own means of obtaining news, for there is no section of the cycling movement which we are unable to report when we desire to do so. In fact, the files of this journal indicate that in most important matters we are abreast of our competitors. In connection, therefore, with this function, our reporter present at the meeting, and who prefers to sign himself "T.W.W.," writes: "Once upon a time mechanical locomotion was restricted to riders of what we now term the penny-farthing, and they look upon themselves as pioneers. Rode the Six Hundred! Six hundred of these riders of penny-farthings belong to the Fellowship. For many years past they have eaten, toasted one another, reminisced, and dispersed once more. There are no songs and no music. On October 4th over a hundred of these spruce and white haired old followers of our pastime met at Slaters Restaurant in the Strand, and sat down to a meal wh. * compared favourably with the exquisite cooking of the finest French restaurant. The chicken and the soup, the pastries and the coffee were excellent. G. P. Mills was in the chair, and E. P. Moorhouse reminded the old roadsters of Mills' extraordinary career as a racing man. He broke many records in his first six years of riding (cheers).

"Sir Albert Atkey of Nottingham, who was appointed the new Chairman, spoke. He gave some details of his early essays in bicycle riding. Holbein, now over 80, stout and a contrast to the lean and wiry G. P. Mills, and Ben Tillett, aged 81, contributed their quota to the post-prandial oratory. Nearly £50 had reached the Hon. Sec. in response to his appeal for funds. It is likely that Scarfe will resign from the Hon. Secretaryship. There had been feeling amongst the members because a similar function had not been held last year.

"The oldest old-timer present was J. W. Raybould who was 94. Among those present were Percy T. Pyne, Arthur Ilsley, Bathroad Smith (he who talks and writes of chain wheels and their teeth), "Boots" Green, Charles Jarrott, and many others."

The luncheon space was very limited, and the reason given was that such an attendance had not been anticipated. Why? Surely those responsible for arranging a luncheon are able to estimate a little more closely than in this case? Fifty were expected, and a hundred turned up. Did no one ask the members to let the Secretary know by a given time? We do not congratulate the F.O.T.C. on this aspect of their luncheon. The restaurant was not suitable for 100 guests; 50 of them arrived at short notice, and there is room here for improvement in the arrangements for checking up on those who do, and do not, intend to be present. When you run a luncheon or a dinner, you do not "anticipate" how many will be present. You go to some trouble to *ascertain* how many will be present within a narrow limit. However, as I was not present at the luncheon, I did not suffer any discomfort on that account. It was noted that many of those present do not now ride bicycles. It was also noted that some of those who do not now ride bicycles were the loudest in their advocacy of cycling as the finest, etc., etc., etc. As a social institution the F.O.T.C. has much to recommend it, for it meets but once every year at most. As a cycling club it must be classed with the Pickwick and similar non-cycling institutions. All the same, I am glad to know that many of these old timers still retain a passing interest in the pastime. Of those present who regularly cycle, I chatted with two—C. A. Smith, and Percy Beardwood.

The Rule of the Rude

HAVE you observed how Army drivers and particularly those of the opposite sex (sort that one out!) curse when they miss you nowadays? These Army drivers are really the extreme edge—shocking drivers, evidently put in charge of a lethal machine without adequate tuition. I observed a scandalous piece of bad driving along the Great West Road the other morning on the part of a lady driver. Without warning of any sort, she drew into the kerb and narrowly missed decapitating some poor wight of a cyclist. To add insult to injury, the female proceeded to abuse the cyclist in round terms, whilst the cyclist made some fleeting reference to the former occupation of the lady which I gathered to be that of a barmaid. These rising accident statistics are, no doubt, caused by the great influx of military drivers with only wartime experience, probably trained by those who also only have wartime experience—the blind leading the blind!

An American Folding Family Bicycle

THE latest American development in the cycling world is a separable folding model designed by the Westfield Mfg. Co. for sport and general utility purposes.

This model, one in a line of Columbia bicycles famous for more than sixty years in American cycling, has been given the name Compax Sports Traveller.

As illustrated, the Compax has a jointed single steel tube extending from the head to a point on the seat mast a little above the crank-hanger bottom bracket, which makes it a compromise between a diamond-frame and a drop-frame machine. The joint consists of a flat hook on the end of the forward portion which fits into a slot on the rear portion of the main tube and engages a transverse pin. A sliding ferrule or sleeve slips over the joint and is tightened by means of a wing bolt, no tools being required. By means of this joint, which is declared to be strong and fool-proof, the two parts of the machine can be assembled or taken apart easily in fifteen seconds, even by a child.

The handlebars also are jointed at the middle, and provided with a wing-nut lock so that they are adjustable for height and can be folded down flat against the front fork.

Absence of a horizontal top tube in a frame of universal 18-inch size, wheels of 26-inch diameter, and adjustability of the saddle and handlebars make the bicycle equally suitable for use by both male and female young and adult members of a family.

Notes of a Highwayman

By Leonard Ellis

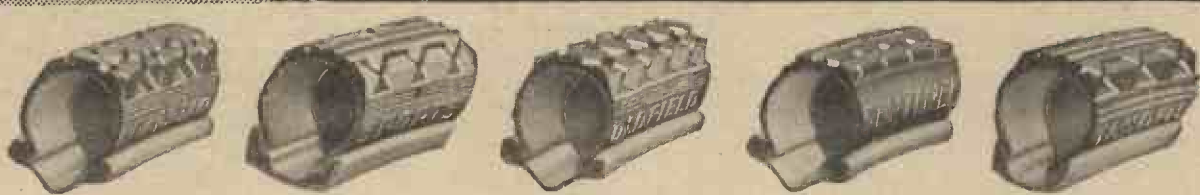
The Quaker Country

EVEN without the squirrel's reminder, other things inevitably bring the mind back to that which I had gone out to forget. As I passed the old Meeting House at Jordans I realised that here was a definite link with America, so definite that hundreds of Americans come over every year to visit the spot. Here lies the body of William Penn, the founder of Pennsylvania. It is not remarkable that one wonders just what the present "drawing together" of the two great democracies owes to this man's activity many years ago. The history of the Penn family is most involved; in fact, there were several families of Penns, not even remotely connected, and even historians have confused them. William was the son of Sir William Penn, one of Cromwell's admirals, and in later years he quarrelled violently with his father on account of his Quaker beliefs. In time Penn married the daughter of Isaac Pennington, another well-known Buckinghamshire Quaker. Isaac died and was buried at Jordans, where many secret meetings were held. William Penn set sail in the *Welcome* in 1682 and founded the great state of Pennsylvania on a tract of land along the Delaware river, given to him by James II. He returned to England and was welcomed back at the court. He died at Twyford in 1718 and was brought to Jordans to rest with his friends and relatives. The tombstones now to be seen of the Penn family are not old—they were erected only 70 years ago. Americans still visit Penn village, not many miles distant, on account of the confusion that still exists, but it is stated on high authority that the Penns of Penn were not connected with William, although it was William himself who often tried to establish a link. Thomas Ellwood, a great friend of the poet Milton, is also buried in this secluded little graveyard.

Friends' Meeting House at Jordans

Autumn in the Chilterns

THERE was a nip in the air and the frost still lay on the west side of the hedges as I trundled slowly along the Buckinghamshire lanes. Always beautiful, but perhaps, in spite of the implied farewell to summer, autumn sees Buckinghamshire at its best. Then its magnificent abundance of beech leaves turn into a positive riot of reds, golds, browns and russets. As November approaches the leaves fall and form an unbroken carpet of rich colour, but this morning this stage had not been reached. The leaves were still fluttering bravely in the breeze, although beginning to change their tints. Four blue, black and white birds fluttered up from the field on my right. Magpies, of course, but I knew long before I saw them. One cannot mistake that harsh chatter like the distant rattle of those wooden castanets beloved of football fans at a Cup Final. A little grey squirrel ran along the road in front of my wheel; no doubt he was doing as all wise householders are doing at the moment—stocking up for the winter. There was plenty for him to do as the hazel nuts hung in thick clusters from the hedges.



Roadster. *The deep rugged tread of the Firestone Roadster gives greater safety and mileage. Underneath are cords of the finest quality, giving extra strength and flexibility. Sizes 28 x 1½, 26 x 1½, 26 x 1⅜.*
TUBE 2/7. COVER **7/5**

Sports. *The Firestone Sports tyre is designed for speed with extra safety. Its light weight is achieved by extra fine quality—ensuring flexibility and liveliness and great strength. Sizes 26 x 1⅜, 26 x 1¼, red or black.*
TUBE 2/4. COVER **6/4**

Oldfield. *This deep rugged tyre is renowned for its substantial saving in first cost, yet giving wonderful mileage and safety. Sizes 28 x 1½, 26 x 1½, 26 x 1⅜, 26 x 1¼.*
TUBE 1/10. COVER **4/7**

Sentinel. *High quality at a wonderfully low price, only made possible by the experience and skill of Firestone Tyre engineers. Sizes 28 x 1½, 26 x 1½, black only. 26 x 1⅜, 26 x 1¼, red or black.*
TUBE 1/7. COVER **3/7**

Sports Tandem. *With a deep tread of Sports tyre design and cord fabric impregnated with extra rubber the Firestone 26 x 1⅜ Tandem tyre has extra strength and liveliness perfectly balanced.*
TUBE 2/7. COVER **6/4**

Purchase Tax additional.

Bicycle Chain Gearing

How the Efficiency of Chain and Chain Wheels is affected by Tooth Form

By A. C. DAVISON

IN the issue of *Practical Mechanics* for September, my old friend, C. A. Smith, gives his views on bicycle power transmission by chain. As Mr. Smith could do his 50 miles in 2 hrs. 30 mins. and 100 in 5 hrs. 20 mins. on the much inferior roads of his time, his practical experience as a speed man deserves serious consideration, and although my 'times' for the distances mentioned might have been more like his figures reversed, I have had, from my business, more experience of chains from the workshop angle, and I quite endorse his views. The tendency for a long time has been price competition with bicycles; this means mass production, and the curse of mass production is that someone always finds a way of making something a little cheaper, and a little worse, and many of the stamped-out chain wheels of to-day fully substantiate this contention. A first-class chain on well-designed and well cut chain wheels has the remarkable mechanical efficiency of about 98 per cent. —while clean and run indoors, of course—an efficiency equalled only by an electric motor, and not often by that.

All the makers of high-class machine

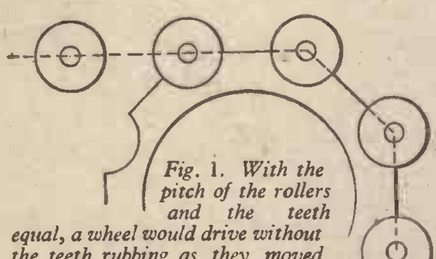


Fig. 1. With the pitch of the rollers and the teeth equal, a wheel would drive without the teeth rubbing as they moved in and out of gear.

tools employ "machine-cut" gears, meaning shaped from a solid blank by a milling cutter hob, but we need not look far amongst bicycles to find chain wheels stamped out of thin sheet metal with teeth of every form, running eccentrically, wobbling from side to side, and possibly quite out of line with each other. How far the efficiency of these arrangements is below 98 per cent. it is impossible to say, but it must be considerable, and the cyclist desiring to get a little more power out of his machine has to supply it himself, and it would add to his present ease and comfort, unless he has a mania for hard work, to insist on cut gears, even if they cost him a little more in cash instead of perspiration. Of the best class chains of to-day there is not much to complain; they are made with great accuracy and deserve better treatment than being run in mud and slush. One would not carry, as a wrist watch, a chronometer with a Kew A certificate.

Chain Wheels

With regard to the chain wheels, the first requirement is that they should run true concentrically, and this, as regards the back cog, is not met by the usual process of screwing on, which owing to the interchange of different makes, results in a rather sloppy fit. Fitting on a taper with a "Woodruff" key would be the ideal method, but as tapers are difficult things to duplicate exactly, and as there is a present tendency towards standardisation, a sliding fit on a parallel shaft with a feather to prevent turning and a lock ring might meet the case practically. Half a thousandth of an inch allowance would ensure interchangeability and not affect the running. To get the front chain wheel firm and true is a more difficult matter. To begin with, the wheel, generally about one-eighth inch thick sideways, is too flimsy to remain free from side wobble for any time and should be stiffened.

I had made for myself a wheel cut from $\frac{3}{16}$ in. thick cast-steel plate, and this with hardened teeth was ideal, but what it cost I never ventured to go into. The blank was turned on its own spindle, forwarded to Hans Renold, who cut the teeth (cost 15/-), and afterwards hardened and tempered the wheel. This process would be too expensive for commercial production. The best way to stiffen the wheel laterally is not too clear, but as the strengthening is required at the centre, perhaps a three-arm attachment made rather large and well thickened at the root, with a comparatively narrow chain ring with cut and hardened teeth, would be a practical solution. Supposing the blank to be running true, the shape of the teeth arises, and this is a very simple one, the outline being that of an involute curve, or that traced by a pencil attached to a cord that is being unwound from a cylinder.

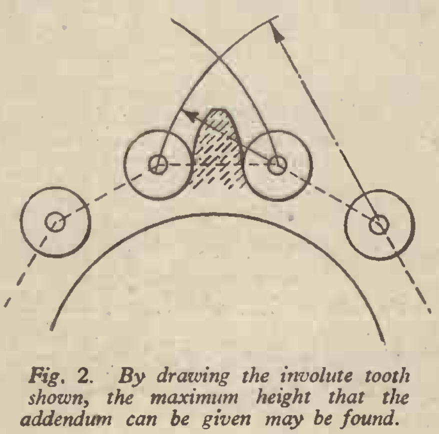


Fig. 2. By drawing the involute tooth shown, the maximum height that the addendum can be given may be found.

Pitch Lines

Taking the lower part of the tooth first, a wheel as in Fig. 1, with the pitch of the rollers and the teeth equal, would drive,

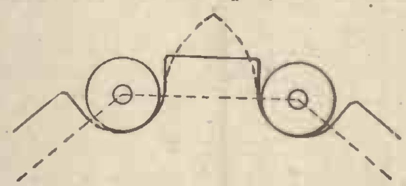


Fig. 3. A bad form of tooth. Here the teeth will catch on the corner with a jerk, and this should be taken away.

and there would be no rubbing of the teeth as they moved into and out of gear; but owing to the swaying of the chain it would be very apt to jump off. But it is impossible to make an unstretchable and unwearable chain and teeth, and in addition to providing an extension of the teeth to deal with swaying it is wise to provide a little working clearance. The pitch line of the teeth is a circle described through the centres of the rollers, and the maximum height that the addendum can be given will be found by drawing the involute tooth shown in Fig. 2. In this any roller coming out of gear turns in an arc about the centre of the next roller until the two links are in a straight line, when the first roller then

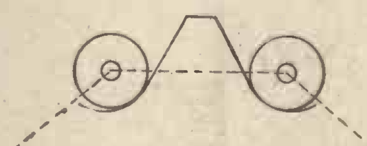


Fig. 4. Another bad form of tooth. Here the teeth, as they lift slightly, have a tendency to slide up the incline, and this chain will be noisy in use and inclined to jump off at the slightest chance.

describes a larger arc by turning with its neighbour round the centre of the next roller.

The teeth of a chain wheel, however, being short, do not project into this second part, and it will be enough to take the first part only. To prevent swaying it will be enough if the teeth project the height of the rollers. Supposing this form to be perfectly made, each roller, or block in a block chain, will roll or slide down the face of the tooth as it goes in or out of gear, and all the links in contact with a tooth will take a part of the drive. But elongation of the chain is bound to occur, and the roller will then strike the top of a tooth and the top should be rounded off a little. Two very bad forms of tooth are sometimes seen. In the first, Fig. 3, the teeth will catch on the corner with a jerk, and this should be taken away. In Fig. 4 the teeth, as they lift slightly have a tendency to slide up the incline, and this chain will be noisy in use and inclined to jump off at the slightest chance.

CUT CHAIN WHEEL

Apropos Mr. C. A. Smith's article in the last issue in which he advocated cut and hardened chain wheels, he has been in correspondence with chain wheels manufacturers, pointing out that some of the larger firms of bicycle manufacturers contemplate supplying cut chain wheels after the war, owing to the demand. He received the following reply from one leading maker of chain wheels: "We would say that we have always supplied chain wheels with cut teeth, as distinct from utility wheels, and we shall continue to do so." Mr. Smith replied: "I should like to try your cut wheels. Will you forward me a pair cut to Renolds tooth form, suitable for my Raleigh machine fitted with Sturmey-Archer gear?"

The chain wheel manufacturer replied: "We do not normally cut our chain wheels to Renolds tooth form, which is unsuitable for bicycle work. As the axles and cranks are not standard, we regret that we are unable to comply with your request."

We must emphasise that the Renolds tooth form, which is also standardised by the British Standards Institution is the most suitable form of tooth. Mr. Smith received the following letter from the Renold and Coventry Chain Company (extracts from which we gave in the leading article last month), concerning his article on the subject: "Mr. Hans Renold desires us to acknowledge the copy of your article which he has read with full understanding and appreciation of your interest in the matter. We are arranging for 1,000 reprints of this article, our Intention being to send a copy to all our Agents throughout the world and to use the balance as and when the occasion arises in contacts and correspondence with cycle manufacturers and others interested in the cycle trade. We have previously assured you that we are most interested in this question of providing the best transmission for bicycles, and greatly appreciate your efforts in maintaining the public interest."

Root Radius

This is quite a bad defect, and it would be better to make the root radius rather smaller than the roller to avoid it. Having wheels running true and with properly shaped teeth, the only question remaining is that of pitch. An unwearing, unstretchable chain being impossible, the question is what provision it is wise to make. Fig. 5 shows two wheels which can be regarded as driving or driven according to the direction of the arrows. Wheel 1 has the pitch of the teeth rather greater than that of the chain. Wheel 2 has the pitch of the teeth rather less than that of the chain. Taking wheel 1 as being driven, the roller (*a*) will be driving the tooth in front of it and the following roller (*b*) will finally come in contact with the next tooth, when the pitch of the chain being slightly small, it will strike at the point, and have to slide down it under the full pull to draw back the roller (*a*); this is bad, and the wear will be great. In wheel 2 with the teeth a little less than the chain, and considering it as driving, the acting tooth (*c*) will be at the top of the wheel, and as this moves out along the tooth, the following roller (*d*) will gradually move up and drive. This is obviously better than wheel 1.

If the wheels be driving instead of driven, the action will be just reversed. In wheel 1, (*a*) will be driving and (*b*), which is going out of action on the slack side, will have little pressure on it. From this it appears that a driving wheel should be made with its pitch a shade full, or with a little clearance between the rollers and the tooth, and this is easily obtained by making the actual diameter a little full, say, 2½ thousandths of an inch for each tooth in a half-inch pitch, and 5 thousandths for that of a 1-inch pitch.

Essential Points

Summing up the essentials of good design, they are:

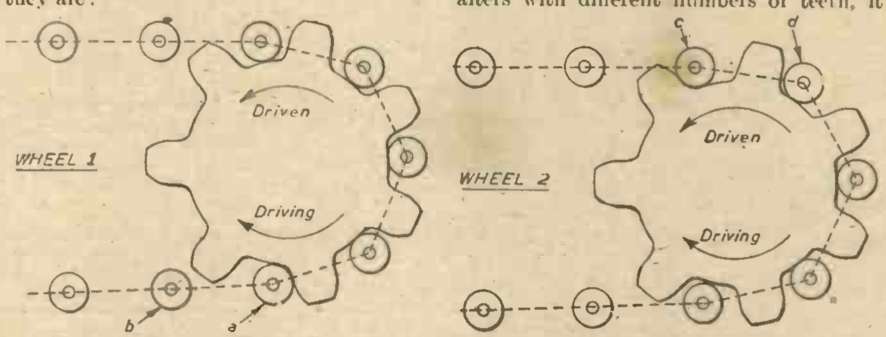


Fig. 5. Two wheels with differing pitches which can be regarded as driving or driven, according to the direction of the arrows.

1. Centres of rollers must lie on a circle circumscribing the pitch polygon and the shroud, or if none, the bottom of the tooth space must lie on a circle one diameter of a roller less.
2. To prevent mounting, the arc of the root of the tooth may be slightly smaller than that of the roller.
3. Rollers or blocks coming into gear must not strike tops of teeth.
4. To provide for stretch, the gap between two teeth should be slightly larger than roller or block in a *driving* wheel. In a driven wheel it may be the same.

Finally, teeth should be milled or hobbed from the solid. The usual procedure is to mill out the space, but as it is this that alters with different numbers of teeth, it necessitates a separate cutter for every integral number of teeth to be accurate, and as the tooth form is always the same, a milling cutter made to cut both sides of the tooth at once would serve for all sizes of wheel, and make cut wheels nearer to a universal commercial possibility.

WAYSIDE THOUGHTS

By F. J. URRY

Too Many Slip-shod Riders

THE cycling fraternity in the main is badly in need of riding lessons. The other evening I watched a crowd of some 2,000 workers leave a factory, at least 25 per cent. of them on bicycles, and while knowing the slip-shod methods of the utility cyclist fairly well, I was amazed at the amount of bad riding. I do not mean dangerous riding, though there was a degree of that; I mean sloppy cycling, using the machine as a means to an end without any considerations of ease or comfort. Here and there I could pick out a real rider, and the grace of movement of him or her—often her—was emphasised against the nondescript background. What are the chief faults displayed by these careless people? I think saddle height is as great as any single fault, for I noticed most of them were perched too far from the pedals, although a few were so lowly seated that they looked like hunched-up bull-frogs. And the saddle angles! Many of the peaks pointed to the skies as if the riders were fearful of spilling themselves on the top rail of the frame, a seat position which I know would cripple me in a dozen miles. Then down go their feet on the pedals, anywhere but in the right position, mostly with the middle of the foot resting where the ball should be. In such movement ankle action—that exercise expressive of ease in propulsion—is impossible. It is difficult to know why so many people will insist on making cycling uncomfortably hard work, unless it is sheer ignorance, even though they only ride a bicycle for convenience. If it is ignorance—and I can think of no other reason—then the trade have allowed to grow up in our midst a generation that knows not the easy pleasures of cycling, properly undertaken. If a text on the right way to ride a bicycle is required—and I think it must be—then the proper place to print it is in the cycle catalogues, for people read and study such booklets when the urge to cycle comes on them. To try and sell a manual on correct cycling is almost impossible—who wants to read such tripe when they can ride?—for the younger folk to-day know it all, they are born with the art of balance in their make-up; but from my experience few of them can cycle. I am keen enough on the pastime to want all folk to know the immense difference between knowing how to ride and how to cycle.

Do it Now

THESE dark nights should mean that you are giving a trifle more attention to your lamps than was the case but a few weeks ago. If you are now using electricity, whether from battery or dynamo, a clean-up is merely a proper precaution to take to ensure perfect service. So many people seem to think rain and wind and dust make no difference to contacts, whereas, of course, one of the greatest reasons for the failure of battery lamps is the rusty cases that short circuit the current. Five or ten minutes' attention in a cosy room is infinitely better than trouble on the road, particularly if it happens to come to you on a stormy night, and you are in a hurry to get home. I use battery lamps fore and aft most days, and after the morning journey usually switch them on for a second to prove they are working correctly, and will not delay my getaway in the evening. When the weather is stormy, I change the headlamp for an old oil lamp, the "Holophote," which has been doing the job of illumination for me for over thirty years. I do so because I have never known that lamp fail me on the windiest night, while its steady warm beam has been a comfortable beacon during many miles of night roaming. There are few things more irritating in the life of a cyclist than to have a good bicycle at his disposal for the home journey fitted with troublesome lamps, when the riding is meagre and the walking much, between the flickering flashes of faulty connections. If we experience these misfortunes, it is mainly the faults of our own neglect, for delicate things like electric lamps won't function indefinitely without a trifle of attention.

Keep Fit; Keep Cycling

DON'T give up riding this winter. Whether you ride for convenience or pleasure, or both, stick to your cycling, for it means freedom of travel, health and exercise. Winter riding is not half as difficult as it looks from the inside of a car, and I know one who has been doing it for the last 45 years, day in, day out, except when the snow is too deep to give steering grip. On the other hand, do not think winter riding is as easy as summer touring, because it isn't, and it would be silly to suggest it is, as I have often heard enthusiasts aver. You want to travel a trifle more slowly, to give yourself that extra few minutes to reach the works, so that you need not rush along and risk a skid on a wet road. In other words, if you are prepared to travel circumspectly, winter riding is the next best thing to summer cycling, always providing you are properly equipped for the job, and have seen to the needs of your vehicle. A big cape—plenty of room in it—a pair of leggings, and waterproof headgear—or an old cap—fill the first requirements and will keep you dry in the worst of rain. But when you don them, cut your normal travelling speed by a couple of miles an hour, for it is hot inside oilskins, and can be uncomfortable if you hurry. As far as the bicycle is concerned, see that your tyres are sound and your brakes in perfect order, then be liberal with the oil-can on all the working parts. If the chain gives creaking notice of wear, fit a new one, for any interruption of the smoothness in transmission is most irritating: it seems to make the machine "go hard." The people who hate winter cycling are always the type that have never taken the trouble to properly equip themselves or their machines for the job. They try to make "things do," and then one day of violent storm they are found out, and the sad experience disgusts them. Always they blame winter cycling, never by any chance do they blame themselves for the short-sightedness of under-equipment.

The Catering Question

A DEPUTATION of niece and nephews waiting on me just before the end of the school holidays, suggesting it was time I took them over the week-end to show them the hills and streams about which I so frequently chatter. These three youngsters would have made most delightful week-end companions, and I fell for their invitation to be a proper sort of uncle, at once. Then we tried to find somewhere to stay; we tried three days and spent much time and some of the firm's money on 'phone messages. But, alas! we had no luck: all my friends along the road were full up until the end of the month when these youngsters would be back at school; and then I had the notion of borrowing a caravan owned by a friend of mine, and dumped down by Severnside, but enquiries resulted in the information that he had just rented it for the month. As I did not feel like risking accommodation with three young hopefuls under my control, the whole thing was postponed indefinitely, to the great disappointment of all of us. This was just an indication of the condition of the catering business, not surprising it is true, but very upsetting to the younger folk. For myself, or in the company of one companion of like mind, I should always be prepared to take a risk, because ten miles extra at the end of a touring day does not much matter; but not with young people whose hardiness is not yet fully developed. As it happened, my young party did get one day of glorious September sunshine, and we spent it along the Fosse-way on the ridges above Walton Park, with a beefsteak pie for lunch and thermos flasks of coffee, and in the early evening a real farmhouse tea a friend of mine prepared specially for my protégés. I think there is nothing more delightful than to act as guide to a small party of young people keen on country lore and country life.

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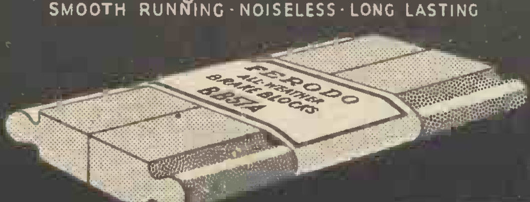

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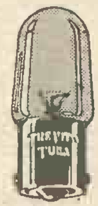

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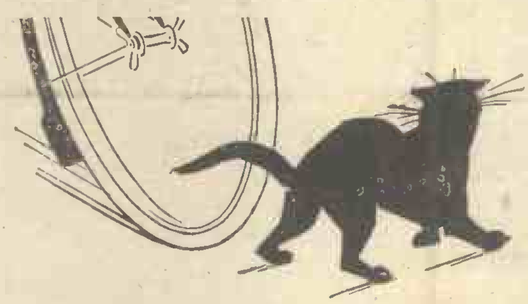

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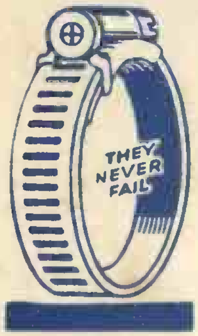

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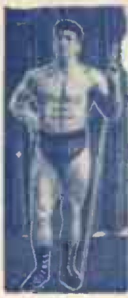

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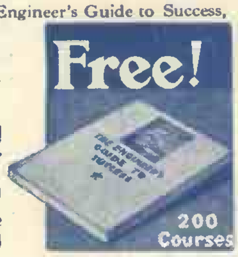

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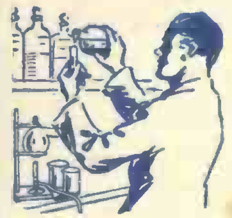

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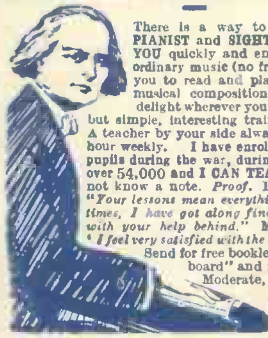

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