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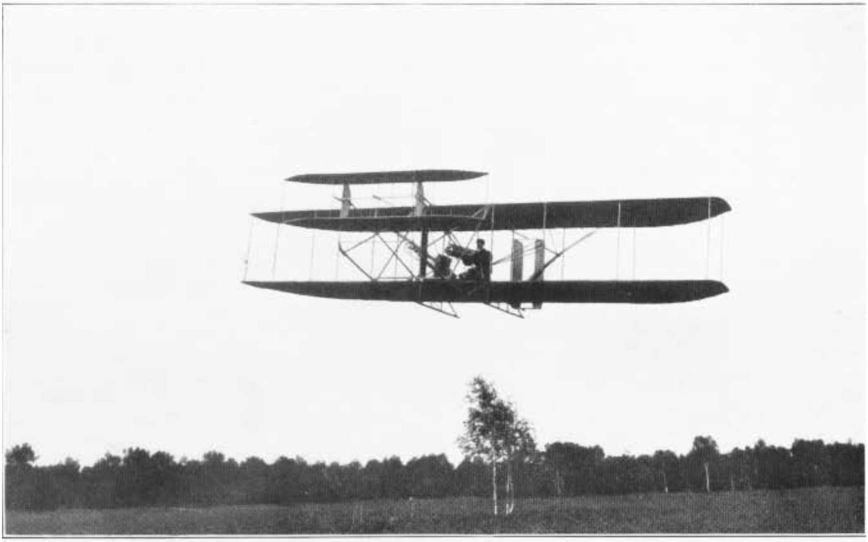
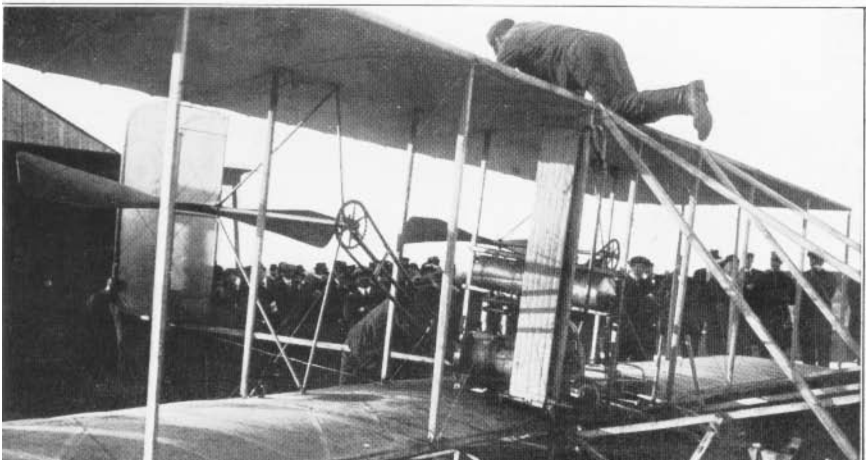


Wright flying at Le Mans.



AEROPLANES

AEROPLANES.

A SHORT ACCOUNT OF SOME OF THE PRESENT-DAY AEROPLANES, AND MOTORS FOR AERONAUTICAL PURPOSES.

By LIEUTS. W. D. BEATTY AND A. D. DE R. MARTIN, R.E.

OWING to the recent rapid progress in aerial navigation numerous periodicals dealing with this subject have come into existence. It is probable however that some of the information contained in this article will be new to most of the readers of the *R.E. Journal*, as much of it has been obtained from personal inspection of the various machines.

The most successful aeroplanes at present are those of the Voisin and Wright types.

VOISIN AEROPLANES.—MM. Voisin Frères have an aeroplane factory at Billancourt, a suburb of Paris. Their machines are all very similar in methods of construction, and vary chiefly as regards the number of planes and position of rudders. The aerofoil* consists of two or more supporting planes, with the ends—as a rule—and two or more partitions covered with canvas, thus dividing the body into several compartments. The tail is of similar construction and contains the vertical rudder, or both vertical and horizontal rudders if the screw is used as a tractor, as in the Goupy type. The tail is connected to the body by a light framework, which in some cases is open and in others covered in.

These aeroplanes are known to the public under the name of the aeronaut using them, *i.e.*, Farman, Delagrange, Goupy, Moore-Brabazon, etc.

The following is a description of an aeroplane used by Farman; this is a biplane machine, but it is understood that he has on occasions converted it to a triplane.

The body is of wood framework, covered on the top, bottom, ends, and two partitions, with a specially prepared waterproof canvas made by the Continental Tyre Company. This canvas is very similar to

* Aerofoil (Lanchester), from the Greek, lit., "An air-leaf," denoting the organ of sustentation of a gliding or soaring machine.

that used for canoe sails. The vertical and horizontal pieces of the framework are of ash, very carefully chosen, so as to be free from knots and to have the grain running lengthwise in each piece. The joints are made with aluminium compound brackets.

The whole framework is stiffened by cross ties of light piano wire.

The ribs in the supporting surfaces are of poplar, weigh about $1\frac{1}{4}$ lbs. each, and are spaced 18″ apart. The canvas on the ends and partitions is laced to the framework with whip cord and stiffened with slats similar to those used in a yacht's sails. All ribs and slats are covered with canvas on both sides, so as to avoid projecting surfaces and diminish resistance.

The supporting surfaces are formed to a curve—fore and aft—similar to that of a bird's wing, the camber being about 4″ at 18″ from the front edge in the length of 7′, and diminishing from this point to *nil* at the back and front.

In the Goupy type the ribs of the main planes are fixed at an angle to the uprights, so that when the machine is horizontal, the planes are set at a lifting angle of about 1 in 10.

The dimensions of the body are given in *Figs.* 1 and 2.

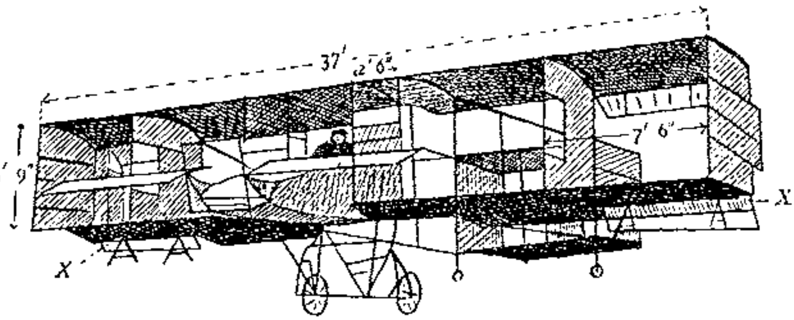


Fig. 1.—*Voisin* (*front view*).

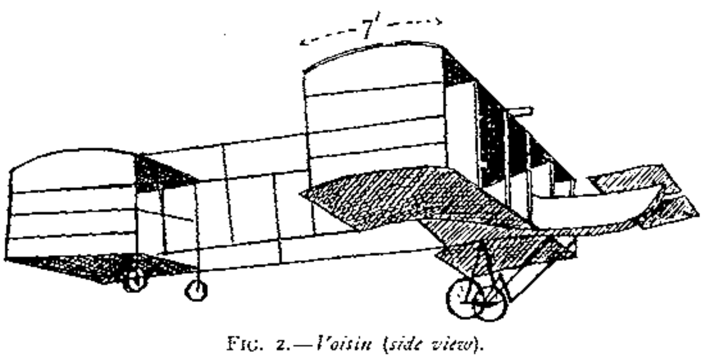


Fig. 2.—*Voisin* (*side view*).

The tail is of a total length of 22′ and consists of a box of similar construction to the body—8′ wide, 6′ long, and 5′ 6″ high—attached to the body by a light wooden framework, which in some cases is covered with canvas and in others left open. In the centre of this box tail is the vertical rudder, a wooden framework, canvas covered, 4′ 6″ high and 4′ wide, pivoted 1′ from the front. In some designs this rudder projects about a foot behind the tail, in others it only reaches to the back edge. It is actuated by turning the steering wheel and thus pulling cords attached to it.

The horizontal rudder is in front of the body of the machine, and consists of two planes—curved in the same proportion as the supporting surfaces—each 7′ by 3′, pivoted at about 7″ from the front edge on a 1¼″ steel tube. It is supported by a light wooden framework, projecting 7′ 6″ from the front of the body, and covered in with canvas. This rudder is actuated by pushing or pulling the steering wheel.

Chassis.—There are two spring-mounted castor wheels under the front corners of the box tail.

Under the body of the aeroplane is a framework of steel tubing, on which the body rests supported by long spiral springs. To this framework are attached two pneumatic-tyred castor wheels. Thus, if the aeroplane is caught by a side wind when on the ground it naturally moves round head to wind, and so avoids severe strains or capsizing.

The weight of the chassis is about 110 lbs.

The motor in this case was of the Antoinette type; in other machines Gobron Brillée, Vivinus, etc., are used. Weight, 265 lbs.; horse-power, 50; revolutions, 1,100. There is one direct-driven screw in this case, a propeller situated behind the body—diameter about 8′, effective pitch 7′ 6″.

In some of the Voisin machines the screw is used as a tractor and placed in front of the body, in which case the horizontal rudder is contained in the box tail.

When the screw is a propeller the engine is at the back of the body and the aeronaut in the front; when it is a tractor the positions are reversed.

The total resistance to flight of this machine is about 225 lbs.

Weight complete with aeronaut ...	1,500 lbs.
Area of supporting surfaces	535 square feet.
Area of vertical surfaces...	255 square feet.
Speed	45 miles per hour.
Gliding angle	about 8° or 9°.

Longitudinal Stability.—This is claimed to be automatic, but it is difficult to say if this is the case, as it is also under control of the aeronaut by means of the horizontal rudder.

Lateral Stability.—This is automatic. With regard to this, when an aeroplane is rounding a corner the higher speed of the outer edge tends to raise that edge and so give automatic banking. If this lifting goes too far the aeroplane capsizes, or falls inwards towards the centre of the curve.

At present—when this article was written—Farman's machine could only turn slowly and with wide curves for fear of capsizing, as there was no means by which the aeronaut could assist the lateral stability.

It is understood that he is now experimenting with some additional movable planes, by which he can increase the resistance to flight of one side of the body while diminishing that of the other, and thus counteract the "banking" effect. The planes shown at XX in *Fig.* 1 are a tentative arrangement of this sort.

R.E.P.—M. Robert Esnault-Pelterie has a monoplane under construction at his works at Billancourt.

It has a fish body of steel tubing, canvas covered, with a screw tractor. The body is of very strong and light construction; one special feature is a neat arrangement by which one lever works in two planes at right angles to each other. This is a similar lever to the steering lever on the Wright machine, but is somewhat different in design.

The wings are so hinged at the points where they join the body that they can be "feathered," *i.e.*, twisted about the lateral horizontal axis. By this movement the lateral stability is controlled. They have at their extremities a small wheel, which keeps the framework of the wing from contact with the ground when starting or landing.

DE PISCHOF.—Another aeroplane seen was that of MM. De Pischof and Koechlin at their factory at Billancourt.

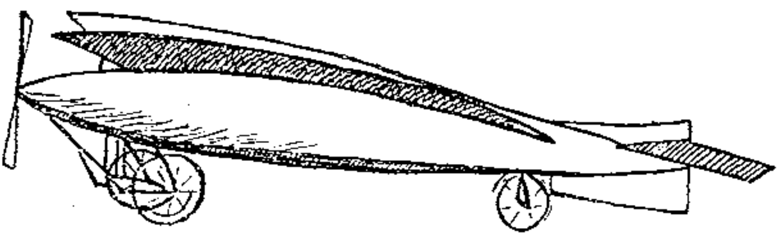


FIG. 3.—*De Pischof-Koechlin (side view).*

This machine is a monoplane and consists of a wooden fish-shaped body about 15′ long by 2′ wide by 18″ deep, mounted on a light chassis of bicycle tubing with castor wheels. The horizontal and vertical rudders are at the stern, and the light triangular-shaped wings, about 9′ long by 8′ at the base, are mounted near the front of the body. The engine is of the Buchet type of 16-H.P., weighing about 45 lbs., and is directly connected to a screw tractor made of tulip wood, 4′ in diameter. The total weight of the machine is about 530 lbs. and its speed about 30 miles per hour.

The steering arrangements of this aeroplane are rather neat. For the horizontal rudder the inertia of the aeronaut's body is taken into account. As the machine swerves up or down, the aeronaut's body swings forwards or backwards, and thus pushes or pulls the steering wheel—causing the horizontal rudder to bring the machine back to the level.

The vertical rudder is actuated by turning the steering wheel.

If the machine tilts over sideways the aeronaut instinctively leans towards the other side, and—by a lever attached to his body—twists or "feathers" the wings in such a way as to bring the machine back to the horizontal plane.

ANTOINETTE.—The Antoinette aeroplane is a fish-bodied monoplane with a screw tractor. It has skate supports under the wings for use when landing. The pipes of the radiator are fixed along the outside of the body.

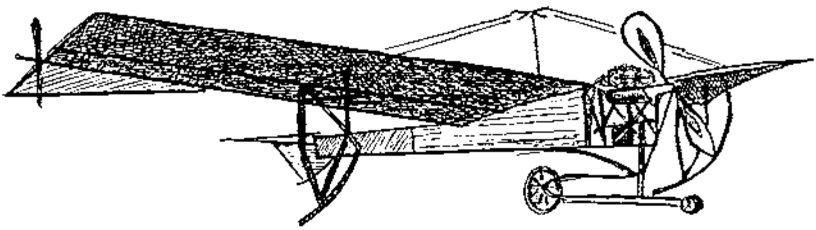


FIG. 4.—*Antoinette.*

WRIGHT.—The Wright aeroplane is of the biplane type, but differs considerably from the Voisin machines. It has no tail, and the main planes are so constructed and connected that they can be twisted so as to "feather" the outer edge, and increase the resistance of the inner or lower edge when rounding a corner, thus maintaining lateral stability.

The aerofoil consists of two planes 41′ long by 6′ 7″ wide, and about 5′ 11″ apart. The framework of these planes consists of two parallel beams 4′ 5″ apart, their ends being joined by the curved piece A (*Fig.* 6) which absorbs the shock if the end of the plane should touch the ground.

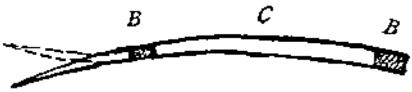


FIG. 5.—*Side View of Slats CC.*

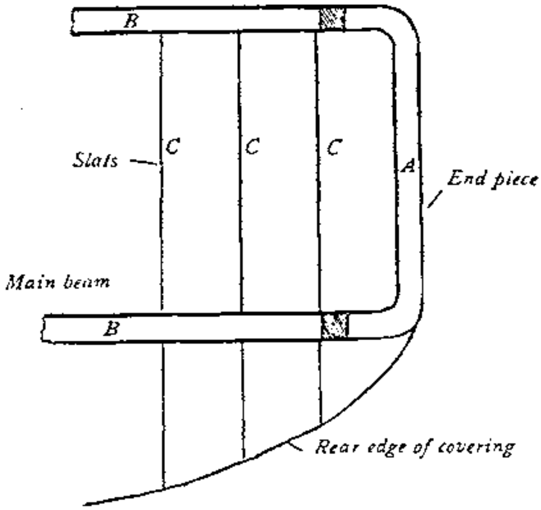


FIG. 6.—*Plan of Frame of Plane.*

There are 34 curved ribs or slats C (*Fig.* 5) on each plane; these support the covering material and give the plane the necessary curvature, which is about 1 in 20. The near end of these ribs is formed of two thin flexible slats, which are free to slide on one another, and thus alter the curvature of the back part of the plane when the air pressure causes them to do so (*cf.* feathers of a bird's wing).

The covering material is nailed to the front beams and also at the ends; at the rear, the upper and under coverings are sewn together. The material is put on diagonally, thus necessitating seams but avoiding wrinkles when the planes are twisted.

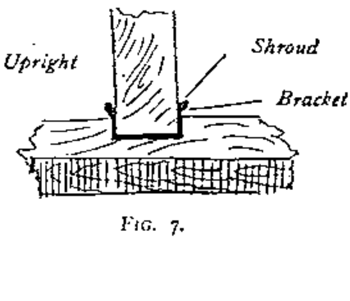


FIG. 7.

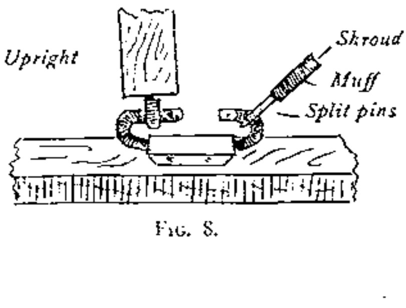


FIG. 8.

The two planes are connected by 18 uprights. The two uprights beside the centre one are fixed comparatively rigid, as shown in *Fig.* 7. The remainder are jointed, as shown in *Fig.* 8.

The wire shrouds have no straining screws; the ends are bent round to form an eye and passed back into a muff (*Fig.* 8) and soldered.

Vertical Rudder.—The vertical rudder is 8′ 10″ behind the main planes, and consists of two vertical planes A (*Fig.* 9) 5′ 11″ × 18½″ × 18½″ apart—slightly curved in outline.

They are rigidly connected and are attached to the main planes by the pieces EK, as shown in *Fig.* 9.

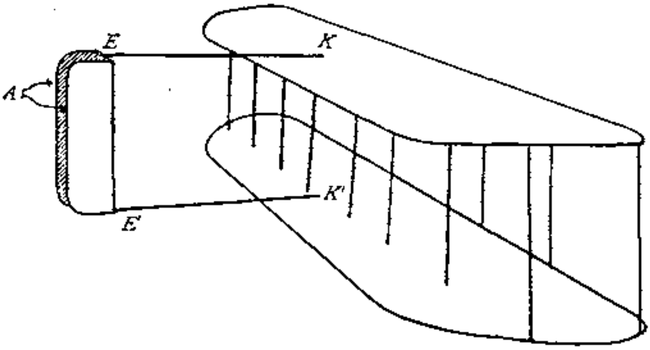


FIG. 9.—*Sketch of Wright Machine showing Vertical Rudder.*

FIG. 10.—*Plan of Rudder.*

Skates.—The machine is supported on two skates of spruce about 1½″ × 2″ and 21′ 4″ long. Projecting 1′ 8″ behind the main planes, they are attached to the bottom plane by three struts about 1′ 8″ long (*Fig.* 11). It should be noted that these struts are not placed directly under the uprights of the body. About 13′ from the front edge of the aerofoil the skates curve upwards to form supports for the front or horizontal rudder. Although well braced, they have plenty of spring, which is very noticeable when the machine touches the ground.

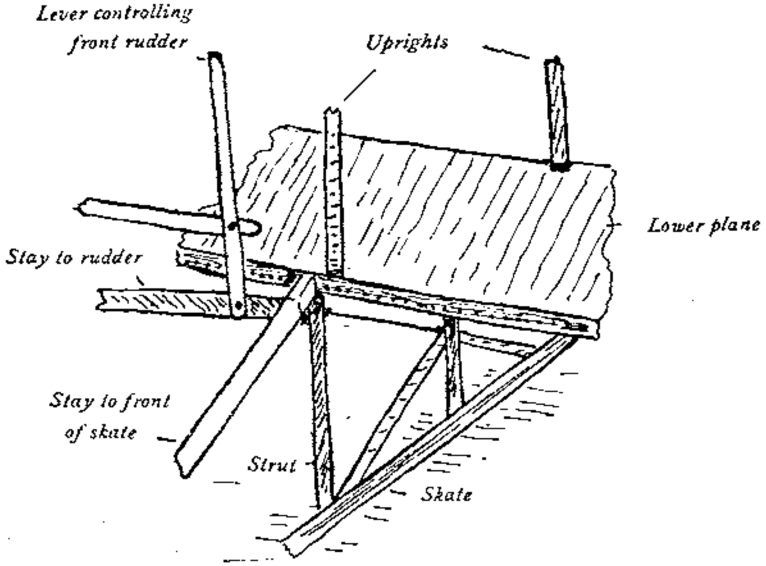


Fig. 11.

Horizontal Rudder.—This is composed of two horizontal planes $17' \ 3'' \times 2' \ 7\frac{1}{2}'' \times 2' \ 11\frac{1}{2}''$ apart, of the same curvature as the main planes, but this curvature is varied when the rudder is moved, as can be seen in *Fig.* 12.

Between the main planes are two fixed semicircular vertical planes.

The top plane of the horizontal rudder is about on a level with the prolongation of front edge of upper main plane.

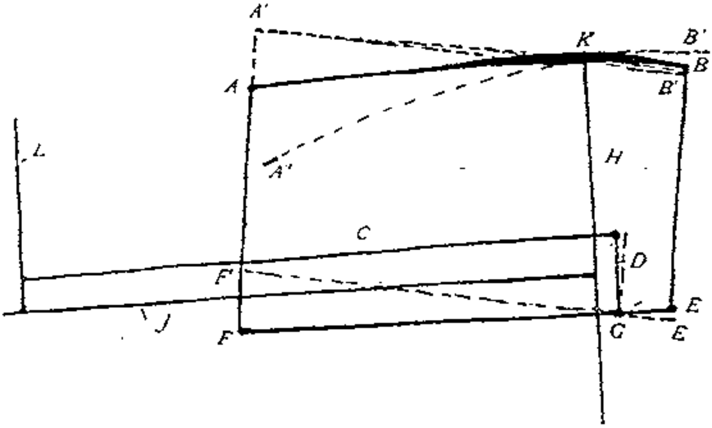


Fig. 12.—*Sketch showing Section of Half of Front Rudder.*

AB is top plane of horizontal rudder, H is one of the uprights which support the rudder, and which are in prolongation of the curved ends of the skates.

L is the lever which works the rudder and is pivoted on the stay J. On pushing L forward, the connecting rod C moves the short lever D forward. D is rigidly connected at G to EF, which is pivoted at G.

E therefore moves downwards and F upwards, but as EG, GF is not in the same proportion as BK, KA, the connecting rod FA moves further than the rod EB, and the curvature of AB is altered, becoming less when the rudder points downwards and greater when it points upwards.

Motor.—The motor is of a special design, of which few details are available.

It has four cylinders, each about $4\frac{1}{4}''$ diameter by $4''$ stroke.

Ignition is by magneto; there is no carburetor—petrol being supplied by direct injection.

There is a double exhaust, (*a*) exhaust valve, (*b*) at end of stroke. The engine is water-cooled by means of a circulating pump. The radiator is 5′ 8″ high and formed of four series of vertical pipes.

Weight of the motor is about 200 lbs.

H.P., 20/30. Revolutions, 1,200.

It is placed symmetrically with the aeronaut with respect to the longitudinal axis of the machine, and drives two propellers by means of two chains, one of which is crossed. The gear ratio is 33:10.

Both chains run in light steel tubes, and by crossing one the propellers are made to revolve in opposite directions, and thus the side reactions of the screws balance each other. The propellers are of

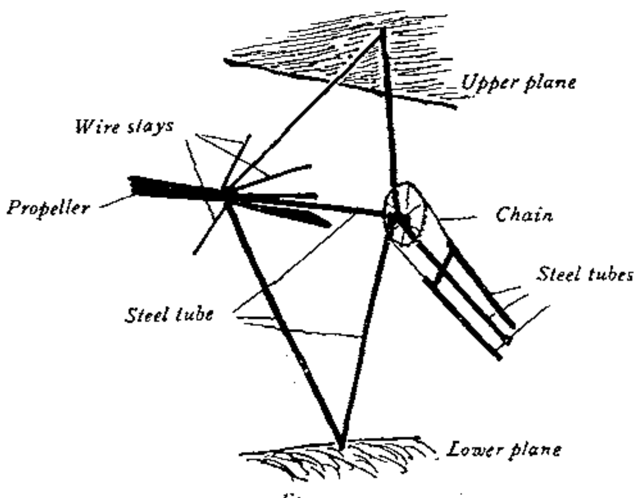


FIG. 13.

wood, and are 11′ 6″ apart, their axis being slightly above the middle of the distance between the two main planes.

Diameter, 8′ 6″; effective pitch, about 9′.

The propeller shafts are supported, as shown in *Fig.* 13.

The lever governing the vertical rudder, and also, the twisting of the planes has a four-way movement, *i.e.*, in two planes at right angles, so that the controlling of the "feathering" action may be done by the same lever, and at the same time that the vertical rudder is actuated.

Twisting the Planes.—The hinging of the uprights of the aerofoil admits of the twisting or feathering of the ends of the planes.

When it is desired to turn to the right the aeronaut pulls the controlling lever backwards and at the same time to the left, thus turning the veritical rudder to the right and at the same time lowering the right-hand end of the planes and raising the left. The resistance of the right or inner side is thereby increased and that of the left side decreased, thus raising the inner edge and overcoming the automatic banking effect due to the turning movement.

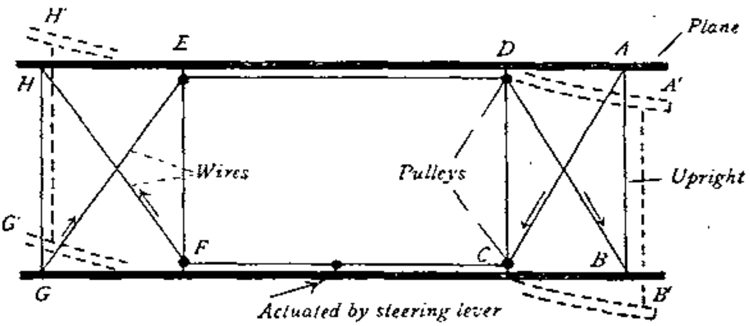


FIG. 14.—*Sketch to illustrate Action of Twisting Wings.*

The whole machine weighs, including the aeronaut, about 1,000 lbs., and the speed is about 40 miles per hour.

The area of the supporting surfaces is 500 square feet and the gliding angle about 7°.

The lateral and longitudinal stability are both dependent on the skill of the aeronaut.

ENGINES.—The following is a description of some of the principal engines made specially for aeronautical work, and it is the engine-makers whom we have chiefly to thank for the success which the heavier-than-air machines have lately attained.

Gobron Brillié Engine (*Fig.* 15).—This engine is made on the same principle as that used on the well-known car of the same name. It is of peculiar design, being in the form of a cross. There are eight

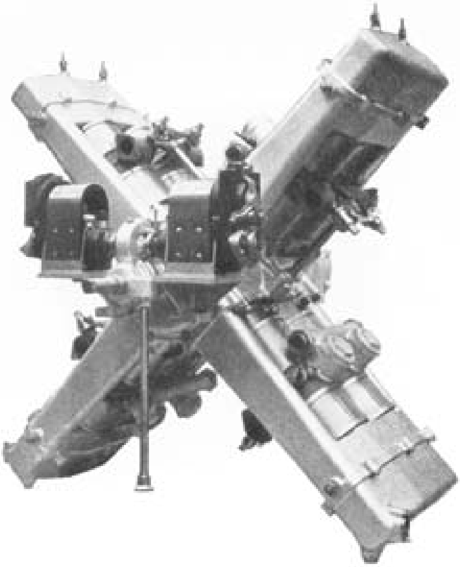


FIG. 13.—*Gobron Brillié.*

cylinders, two cylinders placed alongside being in each arm of the cross. The system of double pistons is adhered to, there being 16 pistons in all, *i.e.*, two in each cylinder, the cylinders being open at both ends. The pistons closest to the crank chamber are connected directly to the crank pins by connecting rods of the ordinary pattern, whilst the outer pistons are connected to swinging yokes, which are attached by longer connecting rods on either side of the cylinders to the crank pins. The explosion chamber is between the two pistons, the inlet and exhaust valves being situated half-way down the cylinder, as shown. The crank to which the inner piston is attached is longer than that of the outer one, in order to compensate for the additional weight of the moving parts of the outer piston.

The outer ends of the cylinders are cased in as well as the outer piston connecting rods, and all the lubricating oil can make its way from the top, through the cylinders, to the bottom of this casing, whence it is once again pumped to the top.

The lubrication maintained by this pump is said to be excellent. During a 14-hour run on the bench on full load, and using the

GOBRON BRILLEE

radiator supplied for use on an aeroplane, very little of the circulating water was lost from evaporation. This is especially good, since the radiator had not a continual flow of fresh air past it, as it would have in an aeroplane.

The water jackets consist of thin brass cylinders shrunk on, and this part of the construction is thus very much lighter than in motor-car work. The water is circulated by a pump driven off gearing on the main shaft; this gearing also drives the oil pump and magnetos, and is the only train of gear wheels on the whole motor.

The inlet valves are automatically operated by suction, and are on opposite sides of the cylinders to the exhaust valves. The exhaust valves are worked in pairs by a double-armed lever pivoted between them and actuated by a shaft, which projects into the crank chamber and is revolved backwards and forwards by two eccentrics on the main axle. The weight of valve gear is thus reduced greatly, and it is exceedingly simple and accessible. Ignition is by the two magnetos referred to above, and the sparking plugs can be seen close beside the inlet valve. There are double sets of rings on the pistons, which are said to give very good results. The accessibility of the engine is very good, the casing caps, which are fastened down by six nuts, having only to be removed to get at the pistons. The material used is of the best and the workmanship is excellent throughout.

Dimensions:—Cylinder diameter, 3·5″. Combined stroke of pistons in one cylinder, 7″. Weight of engine, piping, and carburetor (radiator full, 26 pints) is 330 lbs. B.H.P.=80 at normal speed, but at 2,000 revolutions per minute=*120*. Cost £500.

R.E.P. Engine (*Fig.* 16).—This engine is made at the works belonging to, and set up specially for that purpose by, Monsieur Esnault-Pelterie, at Billancourt. The engine is of first-class workmanship, and is made in varying sizes, as many as 10 cylinders being connected on one shaft with but four crank pins. The cylinders attached to a crank pin are all in one plane at angles of about 25° apart. With a 10-cylinder engine the arrangement of the cylinders on the four cranks is as follows:—Two pistons on each of the end crank pins and three on each of the centre pins. The method of connecting the connecting rods to the crank pin is by having a loose ring on the crank pin, having as many lugs bored to take gudgeon pins for connecting to big end as there are cylinders working on the crank. The inlet and exhaust valves are combined in a very neat type of piston valve worked by push rods and rocking levers.

A 35-H.P. model, everything included, weighs 140 lbs. It is air-cooled, and in the monoplane constructed by Monsieur Esnault-Pelterie was placed in front driving a tractor screw. Cost of this model is £400.

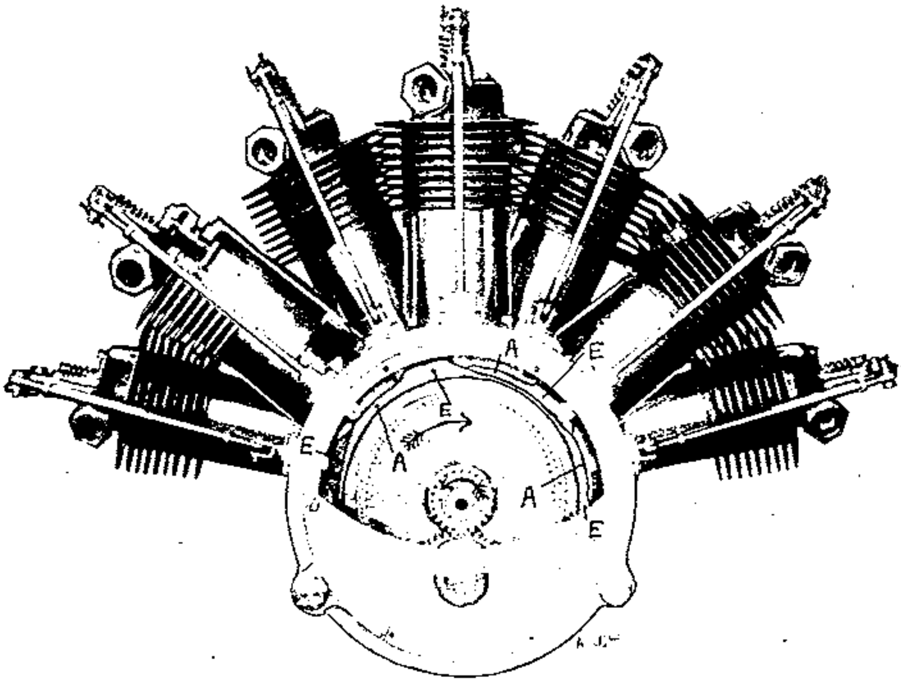


FIG. 16.—*R.E.P.*

Gnome Engine.—This is an engine of unusual design. It is air-cooled, and to this end the seven cylinders are mounted round an aluminium crank chamber at equal angles. The crank is fixed, the cylinders and crank chamber revolving about it, and the propeller being fastened to the crank chamber.

The combined inlet and exhaust valves are mounted on the cylinder heads, while a couple of high-tension ignition plugs are also mounted in each head on the opposite side to the combined valve. The valves are actuated by push rods connecting the rocking lever on the cylinder heads to the 2-to-1 gear mounted on the two spindles visible on the face of the crank chamber. The ignition is by magneto or by accumulator, the connections and distribution being somewhat complex owing to the system of revolving cylinders being adopted. Lubrication—which was said to be a cause of difficulty at first, as all the oil found its way into the cylinder heads by centrifugal action—is said to be good, the difficulty referred to having been got over.

One feature of the engine is that it is mounted wherever possible on ball bearings, and another is the hollow crank shaft through which the mixture is supplied from the carburetor to the cylinders. The workmanship of the engine, so far as was possible to find out, was good, an engine not being seen dismantled.

The engine is quite accessible, but seems unnecessarily complicated, and, owing to the main body of the engine with valve gear revolving, rather liable to get out of order.

Weight of engine (seven cylinders), complete with magneto accumulator, tank, carburetor, etc., was 143 lbs., and B.H.P. was 50. Cost £400.

Buchet Engine (*Fig.* 17).—Somewhat like the R.E.P. engine is the Buchet, which also is made in varying sizes. A 16-H.P. model is used by Monsieur De Pischof in the De Pischof-Koechlin monoplane, giving satisfaction.

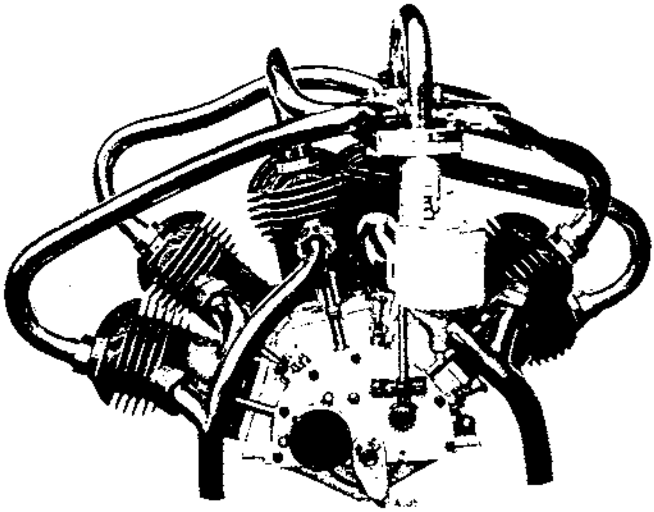


FIG. 17.—*Buchet.*

The 24-H.P. model with six cylinders, arranged at angles of $22\frac{1}{2}°$ to one another, has two crank pins with three cylinders on each. Each cylinder has its supply of combustible mixture regulated by a distributor, which is driven by bevel gearing. This distributor is placed at the junction of the six induction pipes, its function being to allow a cylinder to get its proper share of mixture, notwithstanding a longer length of induction pipe. It is an air-cooled engine, being otherwise fairly normal in design. The inlet valve is actuated by suction, the exhaust mechanically by three cam shafts actuating the six necessary push rods.

Weight of 24-H.P. model is 110 lbs.

Clement-Bayard.—This is another multi-cylindrical engine with its cylinders arranged equi-angularly round a crank chamber. It is designed to work with the main crank shaft vertical.

It has seven cylinders and, like several other aerial engines, the valves are worked by a single push rod and rocking lever per cylinder. The seven push rods are actuated by a cam, concentric with the crank shaft, driven at half-speed by a lay shaft, which also carries the distributor. Beneath the crank chamber is a circular chamber, in which is a centrifugal pump direct driven from the crank shaft, and an annular mixing chamber round the shaft, to which the induction pipes are brought and which is connected also to the carburetor.

Other Types.—There are several other types designed specially for aerial work.

Of these, one is the Farcot engine (*Fig.* 18), with eight cylinders set radially in two planes round a crank chamber and two-throw crank. The inlet and exhaust are very cleverly combined in one. A special feature is the fan driven by the main shaft for cooling the engine; and also the driving shaft at right angles to the main shaft, considerably geared down to enable the engine and also the propeller being run at economical speeds. B.H.P., 50; weight, 121 lbs. At 1,200 revolutions 69 H.P. has been obtained. Lubrication is by force pump through hollow steel crank shaft.

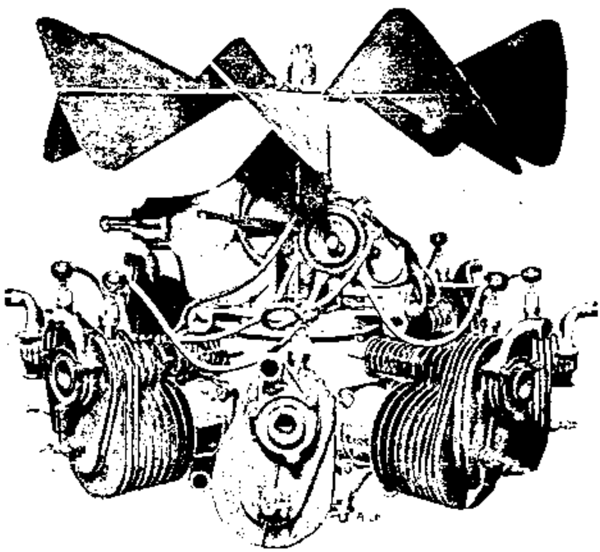


FIG. 18.—*Farcot.*

There are several engines made on the V principle, the 8-cylinder E.N.V., 8-cylinder Pipe, and 8-cylinder Antoinette being the most notable.

Details of Types Described.

Engine.	Weight, everything included.	B.H.P.	Cost.	Remarks.
Gobron Brillée (*Fig.* 15)	330 lbs.	80	£500	120 at 2,000 r.p.m.
Gnome	143 ,,	50	£400	1,200 revolutions.
R.E.P. (*Fig.* 16)	140 ,,	35	£400	1,600 ,,
Buchet (*Fig.* 17)	110 ,,	24	—	1,800 ,,
Clement-Bayard	150 ,,	50	—	1,200 ,,
Farcot (*Fig.* 18)	121 ,,	50	—	69 at 1,200 revs.
E.N.V.	310 ,,	50	—	1,000 revolutions.
Antoinette	220 ,,	55	—	1,600 ,,
Pipe	288 ,,	70	—	1,800 ,,

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NOTES ON THE EMPLOYMENT OF SAPPERS ON THE WORKS.

By A COMPANY OFFICER.

IN considering the question of the employment of R.E. labour on the works it will be of interest, as well as of some assistance to us, to take note of the needs which originated the policy of enlisting tradesmen into the Army. Before the year 1772 the works at Gibraltar were carried out by civilian workmen from England, who were under no agreement and could leave whenever they pleased. Consequently the works suffered considerably, and it was decided to raise a body of workmen who should be amenable as soldiers to military discipline, and whose services could always be counted upon. The Soldier Artificers, as they were called, were exclusively employed on the works, and in the first instance were not armed at all, though the different companies gradually acquired weapons of varied natures which had been discarded by the troops, or were otherwise obtainable. Only their uniform distinguished them from their civilian fellow-workmen, as well as the fact that they could be punished by means other than fines or dismissal. Little or no attention was paid to military efficiency, and at the end of the 18th century we read that drunkenness was very prevalent and discipline seriously relaxed. The appointment of Engineer officers to companies was merely nominal, and being constantly shifted from one unit to another, they were disinclined to take any great interest in the men. Altogether the state of the Corps was unsatisfactory.

It was evident that these evils could only be checked by a more rigorous attention to drill and military exercises, though at the same time an improved class of man was recruited. At this period therefore the military element began to make itself felt in the Corps, and since then our military duties have continued to take up more and more time, until at the present day they threaten, in some units, almost entirely to prevent the employment of sappers on the works.

But while his training as a soldier is of vital importance, the fact remains that the sapper's trade is the only feature which distinguishes him from the bulk of the Army, and it is to his skill as an artificer that we must always look to maintain a reputation for efficiency in the Corps. On the other hand, in wars and sieges our duties as field engineers have become so varied and arduous that it is only by devoting a considerable proportion of the sapper's time in peace to this branch that we can hope to attain the requisite efficiency, and this must of necessity reduce the number of days during the year on which his services will be available for the purposes of the division officer. Indeed, in these days of scientific soldiering our standard has become so high that, in field units at any rate, preparation for war must come first, and any saving which may accrue through the employment of sappers on the works must be looked upon as a by-product of the process of turning out good field engineers. So that now the artificer of 1772 has become a soldier who has, in addition to his military accomplishments, certain trade qualifications which are of high value to an army in a theatre of war, and which must be fostered and improved as much as possible during peace.

It therefore becomes necessary in some way to divide up the sapper's time between employment at his trade and training for war, and it is suggested that the most satisfactory solution of this would be that he should, roughly, work during the winter and train during the summer. If this were done the winter would be entirely devoted to work, in the sense that between the 15th September and the 15th March no man would be taken either for inspections, reviews, winter training, or any other form of military duty for a single day. It cannot of course be contended that 6 months during a year, of which a proportion is probably spent on furlough, are sufficient to maintain such standard of skill at trades as would be necessary in civil life. The arrangement would at best be a compromise, but it could hardly fail to be an improvement on the present system, which often necessitates men leaving their jobs half finished to go on drill, signalling, etc.

It is also important, as far as possible, to employ the sapper on such work and under such conditions as will most fit him for the duties that will be expected of him in war. No matter how good the supervision may be, the ordinary routine of incidental work is almost sure to give him opportunities for "slacking," and very often a considerable proportion of his time may be occupied in journeys from his place of work to the R.E. yard and back. Odd jobs about barracks do not interest him, and do little to improve his skill at his trade. They also tend somewhat to relax discipline, and on this account alone are undesirable.

The conditions most favourable to the maintenance of efficiency in any R.E. unit (exclusive of the "specialist" units such as telegraphs, search lights, etc.) appear to be :—

(1). That the officers of the unit shall be the designers of all work undertaken by their men.

(2). That the N.C.O.'s shall directly supervise the work.

(3). That the sappers shall work in parties under supervision, each section of a company, as far as trades allow, being employed on some definite service.

Under such a system the officers would have a more direct interest in the work of their companies than is at present the case, while the men would feel that they were really working for their company officers, as distinct from the division officer, whom they perhaps do not know, and that good work will bring them material advantages in the way of promotion and indulgences.

To fulfil the above conditions it will be seen that only new work or work under Part II. (Minor Alterations) will be suitable. Division officers at stations where there are R.E. units may argue that their allotment for minor maintenance will not admit of repairs being carried out entirely by the contractor. In answer to this it may be urged that it is for the benefit of the Army to make such increases in those allotments as may be necessary for our purpose, and, further, that the employment of sapper labour on any work merely conceals, without very greatly reducing, the actual cost to the public of that work. The savings on those items undertaken by the sappers should also be treated as a set-off against the additional expense caused by the carrying out of repairs by the contractor.

If the system outlined above were followed, the division officer, as soon as the allotments were received from the War Office, would have to consider what services could, through not being of the first urgency, be conveniently postponed till the autumn. Of these, he would, in conjunction with the captain of the company (they will often be one and the same person), select such as could in the opinion of the latter be conveniently carried out by his company. The captain would thenceforward entirely take the place of a contractor as far as those particular services were concerned.

Now there are several points which here call for careful consideration. Firstly, the services selected would have to be within the powers of the unit to perform in the time available, due allowance being made for bad or frosty weather, which will cause delays. It is not an easy matter to estimate the amount of labour which a company will provide during a winter. The numbers will fluctuate more especially at this season, owing to drafts, furloughs, etc. There are three classes of units to be considered, namely, (1) field troops, (2) field companies, and (3) fortress companies, practically all the other units having their special technical duties, to which the whole of their time must be devoted.

(1). In a field troop the care and exercise of the horses during the winter absorbs most of the men's time. It will not as a rule be possible to count on much labour as being obtainable from these units, except from the drivers with their pairs, nor does the present organization seem to give a reasonable chance of skill at trades being maintained. If it were thought desirable to remedy this state of affairs it would appear necessary for the establishment of sappers in a field troop to be increased, and by the introduction of a longer period with the colours the proportion of men under instruction in riding could be reduced.

(2). The field company establishment of 100 sappers would appear at first sight to give a large party of men for the works, but on closer inspection we find that immense deductions have to be made to arrive at the actual number we shall find on the daily working parade during the winter months. To begin with, at the present time all units are kept permanently at 33 per cent. below establishment, leaving 66. Next, in order to allow every man his six weeks' furlough during the 26 working weeks, another 25 per cent. (say 16 men) must be deducted, leaving 50. Then there will be the tailor, shoemaker, saddler, wheeler, storeman, cook, four cook s-mates, etc., say 12 men in company employ; also probably three printers, one or two engine drivers, and one or two required as clerks in the C.R.E.'s or D.O.'s Office. The R.E. Workshops possibly absorb five or six more. Hence, out of our imposing establishment of 100, we are left with a working party of no more than 25 sappers.

(3). Fortress companies, whose establishment of sappers averages about 40, can seldom turn out a working party even 10 strong during the winter, for while they have less than half the strength of a field company, the numbers absorbed by "company employ," etc., do not decrease in proportion. With so small a party, in which there is a fluctuating proportion of trades, it will hardly be practicable to undertake constructional work with any hope of completing a job in a given time; it is therefore not intended to include fortress companies in the scheme herein proposed. They can be usefully employed on incidentals, advantage being of course taken of any small new works which may present themselves.

Taking, then, our field company average daily working party of 25, we now wish to arrive at a rough estimate of the extent of work to be expected of them during the winter. It may help us to adopt the following method :—Take from the local schedule the average rate per diem paid for civil labour in the various trades. This in the Chatham sub-district works out at 4s. 8d. for an 8-hour day for the 15 commonest trades, with 25 per cent. of labourers. Then, as the number of working days during our 26 weeks is about 125 (allowing Saturdays for fatigues, etc.), the value of the labour obtainable from the company should be £730. We must however deduct, say, 10 per cent. from this on the grounds that a proportion of our tradesmen will not be up to the standard of skill contemplated by the schedule, giving us a figure of £657. Taking the ratio of labour to material as 45:55, as is the case in erecting an ordinary brick building, we arrive at the conclusion that the company ought to complete a service, or services, shown in the annual estimates at £1,460.

Although at first sight this appears to be a low figure, it is doubtful whether any company commander would wish to dispute it, or expect more from his company. With things as they are, the only way to increase it would be to reduce the number of men taken away from the works. Companies are at present maintained below their peace establishment for administrative reasons which are doubtless unavoidable. But it is open to objection that the printers, photographers, draughtsmen, lithographers, etc., should be posted to service units when they are to be used for station requirements only. They belong more properly to the Supernumerary Staff, and their places in the company could be filled by artificers, who would really form part of it. The inclusion of three clerks in the establishment might possibly be altered, and one only considered sufficient. They are often used for station purposes, and it is sometimes even necessary to take skilled tradesmen for clerical work in the C.R.E.'s or D.O.'s Office, which is surely very undesirable. If a proper staff of clerks could be provided for the R.E. offices it would be unnecessary to call on the companies for assistance of this nature.

The duties of the officers now call for consideration. The captain, having selected the services for execution, would arrange for one of his officers to prepare line drawings fully dimensioned and fitted to sites. So far the only drawing available will be the rough sketch attached to the correspondence in which the service was proposed, or there may be no sketch at all. The officer will have to go into the matter thoroughly and make drawings fit to work from. He would have to find time for this during the training season. These line plans would then be submitted in their rough state for the C.R.E.'s approval, and if approved would be drawn out in the draughtsman's office—these drawings being preserved, to be produced when the company is inspected. During the progress of the work the officers would be on the spot as much as possible. There is no doubt that all field company officers would, under these conditions, take a very real interest in the works, and would gain experience such as cannot now always be obtained.

As regards the N.C.O.'s, there would probably be more sergeants and corporals present than would be actually necessary for purposes of supervision. Those who show most aptitude for the duty should be selected, and these would be in the position of minor foremen of works. They would take over the stores purchased for their particular service, arrange with the section sergeant for the transport they require, get their workshop jobs in hand, keep a diary, and supervise all the details of their work. This is a system which at certain stations has been followed with conspicuous success, and might well be generally adopted. Their confidential reports should show, in the column provided for "Special Qualifications," whether they had been notably successful or the reverse.

Those corporals for whom there may be no independent works to supervise might with advantage be handed over to the D.O. for employment, *e.g.*, as acting foremen of works at out-stations, superintendents of R.E. civil labourers working on roads, etc., or if there is no such work for them, they must of course work at their trades, and at their own wish should always be allowed to do so.

The selection of services suitable for execution under this scheme would be a matter of some difficulty, owing to fluctuations in the proportions of the different trades. A single complete building of suitable dimensions would be the best, if such is to be built, and furloughs could be fairly well arranged to suit. But it is unlikely that a company would often be lucky enough to get such a job, and the object in view in selecting work would be to provide each man with a suitable task for his winter's work. If several smaller services were taken, the selection should include a building job, a water or gas-piping job, a sanitary or plumbing job, and if possible a wood or corrugated-iron hut, which would give the carpenters practice in a very important branch of their duties in a theatre of war. The aggregate estimated cost of these services should be as above computed.

In order to increase the output of work from the artificers, every possible use ought to be made of infantrymen as labourers. At present a couple of sapper bricklayers are often employed on a job which could be equally well done by one bricklayer with a labourer. Infantry brigadiers and C.O.'s have hitherto been generally averse to allowing their men to work for the R.E., but now that every soldier must learn a trade the above would appear to be a useful and instructive form of employment.

The knowledge they would acquire of concrete, mortar, paint, scaffolding, etc., would also probably be far more useful to them in civil life than the telegraphy and carpentering which they are now endeavouring to learn, but in which they are unlikely ever to reach a high enough standard for civil employment.

It is hardly necessary to say that the same men would need to attend daily and work at the same trade continuously, and as far as possible with the same sapper. They should receive the labourer's rate of 4d. per diem, which might be charged against the item.

In addition the ordinary infantry working parties could be used for excavation, moving heavy stores, etc., whenever available.

The question of piecework is one that may here be mentioned. At present the regulations do not contemplate the employment of sappers in this manner. To do so would, in the first place, put a premium on hasty and careless work. Then it may be argued that as the sapper is given only a very small remuneration for his day's work as compared with his civilian fellow-workman, it is not fair to expect more than an average day's work from him; and, further, that if he idles on the work it is open to the C.R.E. to reduce his rate of Engineer pay. Or, again, the soldier, being sure of his daily bread, would not, if naturally an idle man, be induced to work any harder for the extra pay obtainable, while the measuring up of tasks and the keeping of the necessary records would involve a considerable amount of work for the superintending staff.

Conversely, it may be advanced that an industrious and hardworking man ought, if he wishes, to be able to earn more than his more idle comrade; that the N.C.O. in charge of each job could without any difficulty keep all necessary records; and that any tendency to put in bad work could be checked by taking the offender off piecework.

On the whole, the arguments against the system seem to be strong enough to at any rate make its general introduction undesirable. But there would seem to be no reason why a good tradesman should not, if he elects to do so, be allowed to take piecework with a view to earning some addition to his Corps pay. It would first of all be necessary to determine what rates should be paid for various jobs, so as to give the desired result. The pieceworker would of course continue to receive the Corps pay paid to him under Royal Warrant. We should want to give him a proportionate increase for any work he might have done over and above what we should ordinarily look for from a sapper in a day's work, and we should want this increment to be substantial enough to induce men to take piecework, provided that the public were not the losers.

A system was introduced in South Africa, and worked with some success, by which the men were enabled to earn up to 2s. per day on piecework. A special schedule, comprising some of the commoner jobs on which they were employed, was prepared, its prices being arranged so that a good day's work ought to bring the man in about 2s., the difference between the amount earned and his Corps pay being found from the item. It is suggested that some such scheme might be made general. The preparation of this special schedule would need a great amount of attention, and it would probably take the experience of a few years' working to adjust the rates exactly. But the number of items contained in it need not be large, as it would only provide for work of a simple nature being done by piecework. It would seem however more logical to put no limit on the amount that the sapper could earn in a day, for such a limit appears to defeat the object of a piecework system, which is to get as much work done as possible. And to make the system workable there should be no multiplication of checks and vouchers. The measurements should be made by the N.C.O. in charge of the job, and checked by an officer, whose signature should be sufficient authority for payment. Extra earnings should be paid over to the sappers weekly in cash by the division officer, and not credited in their accounts, so that they could more easily realize that they are being paid for their extra efforts on piecework.

In order to encourage the N.C.O.'s to get as much work as possible out of their parties, it is strongly recommended that they should be given some pecuniary interest in the results of their work. They might be rewarded in proportion as the actual ascertained cost of the work falls short of the original estimate, though space does not here admit of the elaboration of such a scheme.

The above notes have been written chiefly from the point of view of a field company, both for the reason that the writer's experience has been with these units and that it is the field companies which appear to be most in need of some settled scheme which will reconcile their military duties with that trade standard which it is so important that they should maintain.

Finally, it is not claimed that any of the arguments used or the suggestions made are original. Each point has doubtless been already considered and successfully dealt with at some station or other. But it is felt that, if only the experience gained could be collected and issued for general information, it would go a long way to settling the many questions on this subject, which modern conditions nowadays often render very pressing.

SOME POSSIBILITIES OF MODERN FORMS OF TRANSPORT.

By CAPT. R. WALKER, R.E.

WHEN studying the various problems connected with transport in the Service, the first point to consider is for what uses it will most probably be required. The principal of these are :—(1), For weapons, such as rifles, machine and field guns, etc.; (2), for ammunition; (3), for men and possibly horses; (4), for the carriage of technical equipment, food, and kits; (5), for the carriage of veterinary equipment and hospital stores, etc.

In order to meet these requirements, the following are the various forms of transport at present in use :—

(*a*). Man carriage—either on the person or by wheelbarrows, etc.
(*b*). Animal—pack-horse, mule, ox, camel, elephant, etc.
(*c*). By cart or wagon.
(*d*). Water transport, by barge, steamer, etc.
(*e*). By rail, tramway, etc.
(*f*). By cycle—either ordinary, folding, or motor.
(*g*). Mechanical transport, such as motor car, motor bus, delivery van, lorry, tractor, etc.

And possibly in the near future

(*h*). Aerial transport, by dirigible balloon, aeroplane, etc.

Detailed comparisons of various forms of transport are given in Table I., but (*a*) to (*d*) fall outside the scope of the following notes, and it is proposed only to consider the others in so far as they have a special military bearing.

The first form of transport to be considered therefore is that of railways. In war both existing rail and tramways may be used in whatever form they occur, but in the case of electric railways a great drawback exists in that the power plant will generally be well behind the frontier, and the use of the railway will for this reason be easily denied to an enemy. It may therefore be better for him to destroy an electric railway, as its destruction is a particularly simple matter, whereas the repair is by no means so simple.

If railways are required and do not exist, it is usual to extend existing ones with the same gauge as far as possible. Where this cannot be done, tram lines with horse or mechanical haulage must be extemporized.

Owing to the introduction of the motor there is a constant diminution in the numbers of suitable horses, and we may anticipate ere long the substitution for them of steam, petrol, or electric tramways in localities where the roads will not admit of motor road transport. In some cases, such as sieges, etc., an electric system will be desirable, if not imperative, owing to the noise and smoke of steam or petrol engines, and if ever the monorail comes up to expectation, it will, without doubt, be the easiest tramway to construct.

The next form of transport to consider is the cycle, and it is obvious that its greatest use is in transporting men rapidly from point to point as M.I. Ordinary and folding bicycles are already used for this purpose, and the principle might easily be extended to motor cycles. If this were done the men might be armed with heavier rifles—such as the Hotchkiss Q.F. rifle—as they would never be called upon to carry them far. If a force so armed were supplemented by one or two motor cars carrying machine guns and extra ammunition, it would probably prove most useful.

In addition to the above, cycles might be used for reconnaissance or the transmission of orders and information, whilst staff officers would find tricars or trailers extremely useful on occasion.

The drawbacks to the use of cycles are :—

(1). Liability to puncture.
(2). Inability to travel fast across country.
(3). Length of road occupied by a body of men (*cf.* Table II.).

In addition motor cycles are :—

(4). Heavy to push across country or up steep hills, and
(5). Noisy.

Excepting (5) the above are obvious drawbacks, but it is conceivable that a judicious use of silencer and exhaust direct into the air would enable one to deceive an enemy as to one's distance.

The tactical use of cyclist infantry is practically the same as that of M.I., their greater mobility making it possible to cover greater distances in a given time. A reserve entirely mounted on motor cycles would be a most useful asset. The most useful organization would seem to be by battalions for M.I., and special cyclists allotted to staffs, cavalry and infantry units.

Foreign Practice.—*Austria* has a motor cycle volunteer corps; all motor cycles are registered, and reservists who own them will generally be called upon to use them in war time. They have been tried for laying telephone wires, and as M.I. attached to cavalry.

Denmark has a motor cyclist battalion armed with Q.F. rifles.

France has motor cycles allotted to staffs, and folding cycle companies.

Germany has motor cycles allotted to staffs.

Italy has a cycle volunteer corps, and motor cycles allotted to cavalry and infantry units. She also has folding cycle battalions.

Mechanical road transport, which has next to be considered, embraces not only the forms in daily use, but also many special forms which have been evolved to meet the peculiar requirements of active service. It is doubtful however whether it would be expedient to use the latter, as they have to be specially manufactured and are soon out of date, whereas the usual patterns are always to be had in large quantities and thoroughly up to date.

The question of driving power is a very important one in mechanical road transport, and all experiments so far have taken the line of distributing it as much as possible.

Four-Wheel Drive.—The commonest way of doing this is to arrange that all four wheels of the motor vehicle are drivers, the power being transmitted to the wheels from one or two engines and differential gears, or from four engines direct. A particular form of the latter is one in which the wheels are each driven by an electro-motor, taking power from a dynamo driven by a petrol engine, the dynamo sometimes being specially designed to give constant watts at constant speed (Mercédes Mixte); such a combination may have an efficiency of 75 per cent., whereas 50 per cent. is as much as can be obtained by mechanical transmissions; on the other hand, the *personnel* require an electrical as well as mechanical knowledge, which militates against their being introduced for civil work.

The advantages of a four-wheel drive are twofold; firstly, there is less chance of sticking owing to the wheels not gripping sufficiently in bad places on the road, and secondly, the whole weight of the vehicle is utilized to grip on the road, and the tractive power of a vehicle nearly doubled. Roughly speaking, with one pair of wheels driving a vehicle will pull its own weight, and if this weight is small it can only pull a small load; by increasing the number of driving wheels the weights of vehicles may be kept small, and this is done in certain special road trains, where a pair of wheels on every truck is driving, such wheels may be driven mechanically (Renard) or electrically (Siemens, Porsche), the latter being the more efficient.

Another attempt to solve this problem is the peculiar drive known as the "Caterpillar," in which a pair of endless chains, long lengths of which rest on the ground, take the place of wheels. The links of these chains have square blocks on them which act as feet; the facility with which they can go across country promises well for their future; in turning sharp corners however they rather cut up the roads.

Armoured cars with and without guns have been designed, but they seem to have no *raison d'être*; it were better to trust to speed to avoid being hit than to run the risk of being knocked over by a shell. It might however be worth while armouring gear boxes, crank pits, and providing a duplicate radiator.

Cars have been fitted with special guns for firing vertically at dirigible balloons, which would be chased by the cars.

The uses to which automobiles can be put is apparently limitless; the following are the most important :—

(1). To move staff officers and orderlies about rapidly, and to carry out reconnaissances.

(2). To assist cavalry reconnaissances and in the transmission of information, for which they might some of them be fitted with a wireless telegraph equipment.

To bring machine guns and ammunition near the point where they are required. To collect supplies for the strategic cavalry which may entail covering large distances.

(3). With artillery they may be used to move the staff rapidly from position to position. To save the teams by towing guns when on the roads; this would appear to be worth considering for R.H.A., as it would enable them to cover great distances without fear of tiring the teams before coming to cross-country work.

To tow or carry all ammunition which is not actually required in the position, thereby economizing horses, reducing the length of a column and allowing the ammunition to be placed further behind, as it can rapidly be brought up when required (*cf.* Table III.)

(4). Engineers might find them useful for carrying technical equipment more rapidly than is now possible, and thus allow it to be normally further to the rear.

Officers could prepare for work by getting to the sites in the minimum time. The engines of the cars could be utilized for driving such machines as search-light dynamos, pumps, circular saws, and other tools, which are necessary for the repair of guns and motors.

Possibly they might be of assistance in laying telegraph wires.

(5). Infantry could use them—in the same way as motor cycles—for the rapid transport of men. The ordinary car, even if provided with special bodies to carry say eight men, would take up more road space than infantry marching, but the motor bus would not; in both cases the speed is much greater (*cf.* Table II.).

The men so carried could be armed with Q.F. rifles, and machine guns with tripod mountings could be carried, as well as a large supply of ammunition.

Table IV. shows the potentiality of this form of transport, making use of the motor vehicles in London.

(6). For transport and supply the heavier motor vehicles are required. By using them for columns and parks it would be possible to reduce their length, and hence their vulnerability, and it would also be possible to leave them further to the rear than would otherwise be the case.

Table V. shows the advantages worked out for the 2nd line transport of a division.

Special Difficulties.—The military automobilist encounters special difficulties under prolonged Service conditions, by no means the least of which are bad weather and road conditions, which necessitate the use of high-powered vehicles and very careful driving and attention.

Bridges.—The necessity for all vehicles, which will use them, being sufficiently light not to damage military bridges is another point to be carefully considered. The usual military bridge will take ordinary field loads, but is not strong enough for lorries, traction engines, or motor buses, nor, for the matter of that, for heavy artillery (60-pr.). It would seem advisable therefore either that bridges should normally be strong enough to take the 60-pr.—in which case they would take the average lorry—or that they should be built in such a way that they could easily be strengthened to take lorries, all main road bridges being normally so strengthened. Table VI. shows some of the loads brought on bridges.

For reconnaissance purposes motor cars may have to cross minor obstacles, and should be supplied with a light equipment to take them over gaps up to about 20′ in width.

In our service we may be called upon to fight in any portion of the globe, and at very considerable altitudes. The effect of altitude on steam engines is negligible, but not so in the case of explosive engines; an ordinary petrol engine taken up to 5,000′ will only give out about one-half its power, owing to the rarity of the air and loss of compression; and the greater the altitude, the less the power will be. By specially altering an engine its power may be increased up to 75 per cent. for an altitude of 5,000′, 50 per cent. up to 8,000′, etc.; but when so altered the engine is not suitable for a much lower altitude. It would be impossible to be constantly altering your engine for each change of altitude, and for a theatre of war varying from 0 to 5,000′ therefore it would be necessary to have an engine twice as large as would, at first sight, appear to be required. Steam-engine plants can be made which weigh barely twice that of a petrol plant of the same power, so that for altitudes of 5,000′ the weights of engines would be about the same, and for heights above 5,000′ the steam plant would be the lighter. Should the two-cycle petrol engine become a commercial article, the petrol engine will again be the superior. To obviate this difficulty from arising it would seem advisable for Government to either encourage the introduction of a sufficient number of cars, specially designed for high altitudes, or to favour the use of steam cars.

There is a similar loss of power in hot countries during the day-time, but this is partly compensated for by the possibility of using a heavier oil than ordinary petrol, and one which is safer to handle and easier to store.

Tactics.—Besides being used for reconnaissance work and the transmission of orders and information, motor cars for M.I. would prove superior to motor cycles as regards the tactical advantage of rapid concentration at a considerable distance. This advantage would be great in the case of an invasion of England, as under a well-organized system some 100,000 men could be rapidly transferred to the coast from London. On account also of their great mobility there would not be the same fear of sending the troops on a wild-goose chase, as they could rapidly be diverted and sent to another portion of the coast if necessary. In fact, they differ from our railways in helping to fulfil the conditions necessary for the strategic defence of a long frontier (*cf.* Table IV.).

The most suitable organization would appear to be the same as for motor cycles, viz. :—(1). Detailing special cars for reconnaissance and orderly duties to different staffs and units, and (2) providing for the transport of technical equipment, and allotting cars (say 10 per cent. in excess of requirements to guard against breakdowns, etc.) to battalions of motor M.I., who would be specially trained for the work required of them.

It would not be necessary to buy all the cars required, they could be registered and called up for service in case of necessity ; special bodies for carrying men could be made and kept in store ; they would not cost much, as they need not be elaborate, a man's kit serving him as cushion. Lorries and traction trains could be registered in the same way, and for home defence some of the lorries could be allotted to batteries to get their ammunition up, guns and teams being sent by train.

Foreign nations are already making considerable use of motors.

Germany has a large number of cars, etc., belonging to the army ; these are allotted to staffs and transport units. She has also an automobile volunteer corps for staff work.

On the French frontier are a number of subsidized cars, which will presumably be allotted to staffs and cavalry on mobilization.

In addition there are a few special cars fitted with anti-dirigible balloon guns, whose *rôle* will be to chase and bring down these balloons.

Electric four-wheel driven trains have been tried, but so far without any marked success; their heavy transport vehicles are not over reliable, the Fowler trains supplied from England being their best.

Austria, owing to bad roads, has comparatively few cars, but all these are registered and liable for service; they would presumably be allotted for staff work and to carry machine guns and ammunition for their motor-cycle infantry volunteers (they have been used this way at manœuvres).

There are a certain number of lorries and traction trains allotted to transport units, and the Government, by sending these round and putting them at the disposal of agriculturists, etc., is endeavouring to advertise them and so create a stock which would be available for war. There is also an automobile volunteer corps for the use of the general staff.

Armoured cars with Q.F. guns have been tried, and so have four-wheel drives in various forms, traction and automobile repair shops, motor ambulances, etc.

Italy has a large number of cars allotted to staffs and transport units, and also some light lorries for the cavalry divisions. All cars are registered, as are chauffeurs, who would if reservists be called upon to drive instead of rejoining their particular arm of the Service. There is also an automobile volunteer corps for staff work.

Experiments have been carried out with cars for carrying wounded, electric road trains, automobile repair shops, automobile wireless telegraph stations for use with cavalry.

France—after England—has the largest number of cars, but they too are unregistered. Her staffs are supplied with cars, and a number of transport units have them. She has also tried armoured cars with Q.F. guns.

Russia has few cars owing to the bad roads. She has tried Q.F. guns on armoured cars, and is thinking of the other uses. In Manchuria an electric road train to carry 4 tons was used.

Aerial Transport.—Although flying is in its infancy, it is possible to foresee its great use. Until the problem of flight is thoroughly solved armies have to be content with the dirigible balloon as being the most easy form of flying machine, though probably the one that is least likely to last. These enable us, at present, to cover considerable distances on suitable days, but when the flying machine proper is perfected they may find themselves relegated to the scrap heap, on account of their unwieldiness and the huge target they offer an enemy.

Dirigible balloons consist of a cylindrical gas bag, with semispherical, or cigar-shaped ends, and with a framework attached to it which carries the engine and car. The gas bag is generally flexible and made of silk or of goldbeater skin, as in England, but Zepellin has a rigid framework of metal covered with silk.

To make up for leakage and the expansion and contraction of the hydrogen, caused by changes in altitude and temperature, the gas bag is supplied with one or more ballonettes, into or out of which air can be pumped as necessary, and so the balloon kept taut. With goldbeater skin ballonettes are unnecessary, as the material itself is sufficiently elastic to keep its shape, besides being more gas-tight.

The gondola, or car, carries the engine and propeller, or propellers, on a rigid framework. This framework is in some cases built into the balloon itself (Zepellin); in other cases it is suspended by ropes (Parseval); and in others, again, a compromise between the rigid and flexible forms of attachment is used (Patrie and Nulli Secundus). The advantage of the rigid form is that the propeller more or less directly drives the balloon, but its disadvantage is that if the ground be touched on landing, the balloon is liable to be torn; with the flexible attachment the latter is unlikely, and in case of a burst the balloon itself tends to act as a parachute.

Aeroplanes are in reality kites fitted with a propeller to force them along, and thus give them their lifting power. The box kite form has so far proved the most effective, but there is no theoretical reason why it should always be so; a single plane, on account of its simplicity, may eventually prove to be all that is required. Aeroplanes are so designed that under normal conditions they tend rapidly to right themselves when moved from a stable position. If however they break a wing or rudder, they lose this stability, and in order to make them safe the aeroplanist will have to alter their trim before they reach the ground—a stage which even the Wright brothers have probably not yet achieved.

The first tendency when experimenting, both for dirigibles and aeroplanes, was to get an engine as light as possible, and in some cases even a weight of 2 lbs. per horse-power only has been attained. The Wrights and Parseval however have always advocated the use of a heavier and more reliable engine, since an accident may mean a serious disaster, and so far the French with 100-h.p. engines have not been able to achieve nearly the success that the Wrights have done with a 24-h.p., whilst the latter seem still to have plenty in reserve.

For some unknown reason it is commonly assumed that aeroplanes should be like birds, but this is quite incorrect. The motor car does not resemble a race horse, nor does a ship resemble a fish, although it is true that the imperfect submarine is not unlike a whale, and some monoplanes very like birds.

Hélicoptères are machines designed to lift the machine off the ground in the first instance by means of a propeller revolving horizontally, and then to move it forward by one working vertically. So far they have not met with much success. There is one at present in course of construction in which a propeller can be moved from the horizontal to the vertical position, or to any of the intermediate positions. There are also planes to enable the machine to raise itself and gradually change the vertical into a horizontal movement, and to become in the final stage an aeroplane pure and simple.

The military uses to which aerial transport might be put in the near future appear to be (1) reconnaissance (for which purpose they could be fitted with a wireless telegraph equipment); (2), communication between two forces which are separated by an enemy or natural obstacle; (3), the attack of captive balloons and other aerial vessels; and possibly (4) to drop projectiles. They could also be used at sea to follow the movements of submarine boats, as these would be visible from a great height.

In order to attack dirigibles and aeroplanes shrapnel is the most likely projectile, as the gas bag is the most vulnerable part of a dirigible, and the propellers and rigging of an aeroplane. The Germans are experimenting with phosphorous bullets to set the gas on fire, and the Italians with bullets linked together to tear big holes.

The dirigible is a very good target if stationary, as it is unwieldy and cannot combat heavy winds, but it can hover and make observations with ease. Its speed is necessarily limited owing to skin friction, and it is particularly vulnerable owing to the inflammable nature of the gas and petrol. Even a spark from the exhaust or ignition of its own engine may cause it to explode.

The aeroplane may be comparatively inconspicuous and fit to travel in all weathers, but it will only be able to circle round a spot, unless some way be found of staying head to wind like a kite. There seems no limit to the speed at which aeroplanes can travel, nor any reason why they should not carry large weights; but they require suitable starting and landing places, or else a catapult such as is used by the Wrights.

The hélicoptère would get over any hovering, landing, and starting difficulties. The tactical uses will probably be the same as for cavalry on land and for cruisers by sea, viz., to obtain information and at the same time to prevent the enemy from obtaining it, and also to carry important messages. Eventually they may be used to transport small bodies of men for raids, but this will hardly be in the immediate future.

For the present the most suitable organization appears to be the same as that of captive balloon and kite equipments, which can be allotted to any force requiring them.

France, at various places along the German frontier, has sheds for the reception of dirigibles. She is said to have ordered several Wright aeroplanes, presumably to be so distributed. The French apparently intend to lead the world in the flying-machine industry in the same way as they did with automobiles, and they bid fair to have a long start of other nations.

Germany is also installing sheds for dirigibles along the French frontier.

Most other countries are experimenting, to a greater or less extent, with both dirigibles and aeroplanes.

I.—*Time taken by Transport to Consume its Own Load.*

	Load. Lbs.	Consumes Lbs. per Day.	Consumes Load in Days.	Max. Miles per Day.	Consumes Load in Miles.	Remarks.
Man	50	4	12	20	240	(*a.*)
Pack horse ...	200	12	16	30	480	(*b.*)
Draught horse ...	700	12	56	30	1,680	(*c.*)
Motor (coal) ...	up to 24 tons	up to 12 per mile	—	100	4,000 -5,000	(*g.*)
,, (oil) ...		,, 6 ,,	—	100	8,000--9,000	

II.—*Time and Space for* 1,000 *Men carried by Transport, etc.*

	Formation.	Interval. Yards.	Yards per Man.	Total Yards 1,000 Men.	Miles per Hour.	Max. Miles per Day.	Time to Travel Own Length.	Time to Embark or Disembark.
Infantry	4 abreast	1	½	500	2½	20	7	0
M.I.	2 ,,	4	2	2,000	4	30	17	2
Cyclists	4 ,,	5	1¼	1,250	8	30	6	1
Motor cyclists ...	4 ,,	20	5	5,000	20	150	6	2
Motor cars (4) ..	4 per car	20	5	5,000	30	400	6	1
,, (8) ..	8 ,,	20	2½	2,500	30	300	1½	1
Motor buses ...	40 per bus	20	½	500	10	100	1¾	5
Railways	1,000 per train	5 min.	3	3,000	20	400	5	15

III.—*Possibility of Motor Transport for a Brigade, R.F.A.*

Normally there are 18 guns, 54 wagons, 7 S.A.A. carts, and 34 G.S. wagons, all horsed, as well as 70 spare horses, length in column of route being 2,500 yards about.

With lorries there might be 18 guns, 18 wagons, all horsed, and 100 spare horses, and 25 lorries, towing 18 wagons and 7 S.A.A. carts as well as carrying the loads of 18 wagons and 34 G.S. wagons, length in column of route being reduced to 1,250 yards about—the lorries would only have about 3 tons apiece.

IV.—*Movement of* 100,000 *Men from London.*

Nature of Vehicle.	Number of Vehicles.		Men per Vehicle	Total Men.	Miles per Hour.	Interval. Yards.	Time to Cover 100 Miles on			
	In London	Taken.					1 Road.	2 Roads.	3 Roads.	4 Roads.
Motor cars ...	20,000	12,000	4	36,000	30	20	7½	5½	4¼	3¾
Motor buses ...	1,000	500	40	18,000	12	20	10¾	10½	10¼	10¼
Motor cycles ...	9,000	7,000	1	6,000	20	20*	6	5½	5½	5¼
Lorries, etc. ...	3,000	1,000	40	36,000	8	20	15½	14	13½	13¼
Lorries	—	500	guns	ammunition	8	20	14½	13½	13¼	13
Railways ...	—	—	guns	560 guns	20	5 mins.	17	11	9	8

* 4 abreast.

V.—*Details for Various Forms of Transport. 2nd Line Transport of a Division* (540 *Tons*).

	Men.	Animals.	Vehicles.	Miles per Hour.	Max. Miles per Day.	Road Space. Yards.	Remarks.
Normal	1,910	3,820	436	3	30	6,445	
140 lorries with trailers (4 tons).	280	—	280	6	100	2,100	
47 traction trains (12 tons).	94	—	188	4	60	1,410	
Pack horses	1,900	7,600	—	4	30	45,600	
Coolies	56,000	—	—	2½	?	56,000	Would take 15 hours to start on 1 path.

VI.—*Loads on Bridges.*

	Maximum Load.	
	Per Foot-Run. Cwts.	Per Pair Wheels. Tons.
Infantry	5	—
R.F.A.	—	$1\frac{3}{4}$
60-pounder	—	$4\frac{1}{2}$
Motor car	—	1
Lorry (3 tons)	$6\frac{1}{2}$	$4\frac{1}{2}$
Motor bus	6	$4\frac{1}{2}$
Traction train	10—12	6—8

THE MAIN UNDERGROUND TELEGRAPH SYSTEM OF GREAT BRITAIN.

(Continued).

A Paper Contributed by MAJOR W. A. J. O'MEARA, C.M.G., *Engineer-in-Chief British Postal Telegraphs, at the first International Conference of Telegraph and Telephone Engineers, Budapest,* 1908.

Translated from the French.

CABLING.

The drawing in of the lead-sheathed cable into pipes is carried out to-day practically in the same manner as that adopted in connection with the provision of the first lead-sheathed cable between London and Birmingham. In fact, the only change made has been the introduction of the recently patented wire cable grip (*Fig.* 5), by means of

FIG. 5.—*Cable Grip.*

which the cables are pulled into the pipes. In the early stages of these works this device was not in existence, and a clip had to be fastened on to the end of the cable by means of two screws, for which holes had to be bored through the lead sheath with a gimlet. The conductors had to be forced out of the way, so as to allow the screws to pass through the cable end. The end of the cable with the clip attached was then immersed in melted paraffin wax, which thoroughly filled the interstices caused by the screws. The pulling-in rope was provided with a link to enable it to be connected with the clip fixed to the cable end. This method of attaching the pulling-in rope to cables has now been entirely abandoned, and the wire cable grip is exclusively employed by the British Telegraph Administration. The device has given entire satisfaction when the necessary care is exercised in attaching the grip to the cable so as to ensure that the end of the cable will not rupture and break away should by any chance difficulties be encountered during the passage of the cable through the pipes. The grip is so attached that it may have a bearing on the conductors, and this is achieved by driving back the conductors at the end of the cable with a steel punch, so that they tend to form a terminal knot which the grip can clutch. The sheathing is also uniformly thickened by being closely dressed upon the conductors. The mouth of the grip is drawn forward until it tightly fits the cable, and then secured with a tie of prepared tape. When everything is ready for drawing in the cables, the joint holes in the sections are opened, and a mop made of spun yarn is drawn through the pipes to clear them of any grit or water which may have got into them.

The drums containing the cables are placed almost over the joint holes. The cable grip having been fastened to the cable end in the manner described and the pulling-in rope attached thereto, the operation of paying the cable into the pipe is proceeded with. Six men are employed at the cable drum, one of whom takes his place in the jointing pit and serves the sheathing freely with petroleum jelly; a second man keeps the cable well out from the drum as it is coiled off, whilst four men assist in revolving the drum at a convenient speed and keep the layers of cable from getting too slack. Each man carefully examines the lead sheathing as it passes through his hands, to see that there are no visible defects. This examination has brought to light damage in the lead sheath caused by bad packing, and in such cases the defective cable lengths have been returned to the manufacturers. The men handling the cable are provided with felt aprons and also with leather gloves, to reduce the risk of lead poisoning. It is important to avoid the risk of buckling the cable at the mouth of the pipe during the process of drawing in. In order to avoid this danger the cable should describe a curve of large radius after leaving the drum, and enter the pipe in a horizontal position.

In the early days of the employment of lead-sheathed cables petroleum jelly was used only in connection with the larger sizes of cables, the jelly being intended to act simply as a lubricant to facilitate the passage of the cable along the pipes. During the past few years it has been definitely ascertained that petroleum jelly very effectively protects the lead from chemical attack by street refuse, which finds its way into the joint boxes and pipes, and it is now the practice to coat all lead-sheathed cables with this jelly (see Appendix V.).

At the pulling-in end a crab winch is anchored down to the main pipe by means of a rope, as shown in *Fig.* 6. Four men usually work

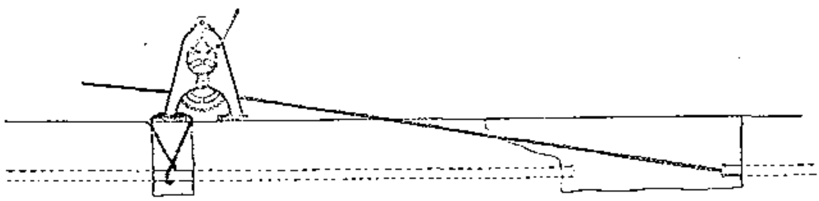

FIG. 6.

the winch, whilst one or two men hold the rope taut as it comes off the barrel, and another coils the slack rope on to a drum, so as to keep it free from grit and other foreign substances, and to facilitate its transport.

Before the cable grip was introduced the cable end on which the clip had been fitted had to be sawn off when the pulling-in operation was complete, and the open end sealed.

A considerable time has frequently elapsed before the jointers have been available to join up the several cable lengths drawn into pipes. In such cases the two ends of the cables have been carefully laid side by side in the trench and protected by timbers at the two sides and on top. The ground has then been filled in and the surface made good.

During the progress of the underground work to the north it was decided to draw a cable containing seven screened conductors into the pipe laid between Stafford and Warrington, to be available as a temporary measure in the event of interruptions caused by storms. Fortunately it was not necessary to bring these wires into use in this section. This cable remained in the pipes from February to October, 1903, when the permanent cable was laid between the places named. The temporary cable was then transferred to the pipe line between Manchester and Leeds. As the length of the cable recovered was not quite long enough to bridge the distance between the two towns, eight gutta-percha wires were drawn into the pipe to complete the communication at the Leeds end of this section of the pipe work. This screened cable was required for use after it had been laid between Manchester and Leeds, but, unfortunately, during the process of withdrawal from its first position and the relaying in the second position the copper tape screen had become displaced and had penetrated the paper insulation. In consequence, some trouble was experienced with the temporary circuits established by its means, but this has been overcome and the cable is still in use.

Cable Jointing.

The operations in connection with the laying of pipes and drawing in of cables already described have occasioned very little trouble and anxiety, but in connection with the jointing of the cables considerable difficulty has arisen, as it has not been possible to find men in the open market with sufficient skill and knowledge who could be entrusted with the very important work of joining together the cable lengths. This difficulty was finally overcome by the department taking in hand the necessary measures to train the men for the work of jointing the conductors and of making the plumber's joints on the lead sheaths.

The number of men employed in a jointing gang has varied to a small extent. A foreman is always placed in charge of the gang, and it has been found convenient to employ two plumbers, four jointers, and four jointers' mates in each gang. In addition to the skilled men mentioned, a certain number of labourers are necessary in order to open the holes, work the desiccator, and act as night watchmen.

The number of joints made in a day and the time taken to make a single joint has naturally depended on the number of conductors in the cables to be jointed. The rate of progress in two actual cases, in which the numbers of conductors in the cables were 96 and 110, has been four completed joints per diem, executed by gangs constituted as above described.

For jointing, a hole 1·8 mètres long by 1 mètre broad by 1 mètre deep is dug, and a narrow trench is made over the end of the pipe line for the purpose of placing a C.I. solid slide in position ready for drawing over the completed cable joint. The general arrangement is shown in *Fig. 7*. The sides and bottoms of the hole are protected by

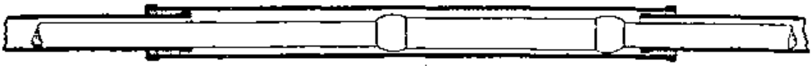

FIG. 7.—Solid Slide for 3¼" Pipe.

iron sheets, and every precaution is taken to protect the exposed cable end from moisture. Two jointers' tents fitted end to end are placed over the hole, and in rainy weather a tarpaulin is placed over the tents to make them waterproof.

As the joint holes are occasionally situated in permeable soil in the neighbourhood of springs, or under conditions which render it necessary continually to remove the water entering them, and are liable to be flooded suddenly during rain storms, it has been found advisable always to have a lift pump with flexible hose at hand.

The leading jointer first proves the wires for crosses, contacts, and continuity, and, if everything is satisfactory, the length of cable over and above that necessary for the overlap is sawn off.

The lead sheathing is next removed, after passing the lead sleeve over the end on the terminating pipe side of the jointing box. Where terminating pipes are provided at double junction boxes, and it is necessary to use an air cap lead sleeve, suitable sleeves are used, having an air cap towards one end to permit of the sleeve being inserted well into the pipe, and to expose a gap of sufficient length for the joint. The cable is then halved out, that is to say, the layers of wires are separated from each other, being secured by string ties near the lead sheath, and each layer afterwards halved into an upper and lower portion, *Fig. 8*. This process of stripping and halving usually occupies one and a-half to two hours.

All is now in readiness for making the first conductor joint. The practice is to commence with a wire in the centre of the bottom half

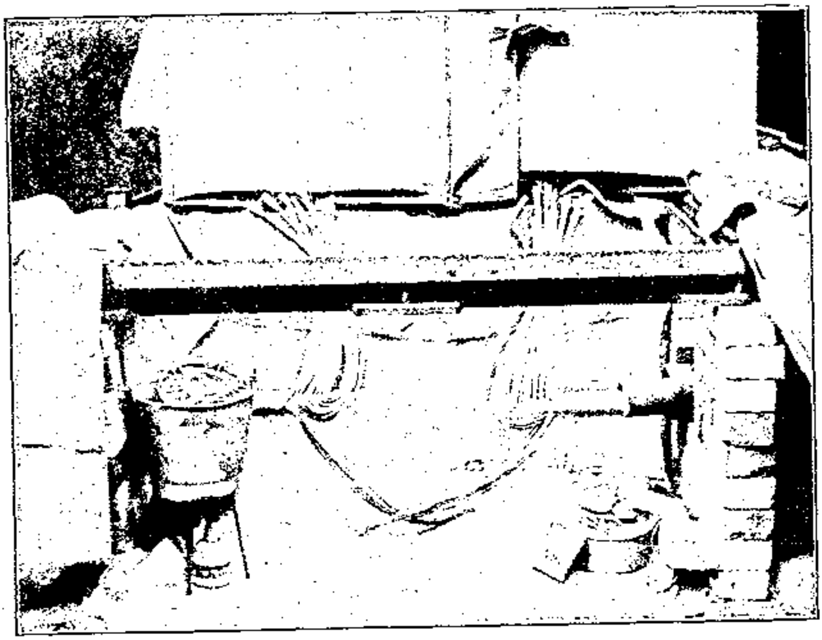

Fig. 8.

of the outer layer of wires and work from the bottom of the cable upwards, and not from the centre of the cable outwards. The latter course is sometimes adopted by a novice, but it leads to waste of time, because it involves the jointing of wires in awkward positions under completed joints.

A competent jointer dealing with a composite cable will handle his wires in the following manner. If he commences with a 4-wire core, he first untwists the paper wrapping and removes the thread common to each pair. Roughly cutting off the surplus length of conductor, he slips on a paper sleeve, unwinds the single wire thread to a point near the sleeve, ties and snaps off the spare length of thread, and turns up the paper insulation. The end of the conductor is now sandpapered and cut to the exact length. Dealing with the other side, the jointer untwists the core wrapping and removes the pair cottons, and, as before, the single wire thread is unwound, tied, and snapped off. An expert workman will tie and snap off the threads with great celerity without weakening the knot or wasting time in handling the cutters, and, generally speaking, it is in the avoidance of unnecessary handling of tools that the skill of a jointer is revealed. If he has to cut the conductors to exact lengths, he will cut several while the cutters are in his hand, and when he is using the soldering iron his work is so arranged that several joints will be soldered before his attention is turned to anything else. This principle extended to a multitude of similar operations results in a considerable saving of time.

The wire is next cut to a length which leaves a small space between the two opposing ends, and is sandpapered. A copper jointing tube is slipped for half its length over each of the ends and pinched with the side cutters to hold it in position. The tube and wires are now soldered together with the lineman's solder, with resin as a flux. The paper is now turned down from each side upon the conductor and the sleeve drawn forward. The four joints in each core are made side by side, and the core wrappings from the right and left are brought to an overlap at the paper sleeves, and tied so that the four wires may at once be identified as a complete core.

Turning his attention now to a screened wire, the jointer takes first what will be termed the short end, puts a tie round the metal screen, and tears the latter off neatly at the tie. There are three separate spirals of paper between the screening and the longitudinal paper covering which lies next to the conductor, and of these one is removed at the tie and the other two are bent back, whilst the paper next to the conductor is also torn off at the tie. Turning then to the other side of the joint to deal with the long end, the screen is tied and torn off as before, two spirals of the paper are turned back, and the third removed. The paper sleeve is drawn over the wrapping lying next to the conductor. The end of the conductor is sandpapered, cut to length, and the copper tube put on and pinched. The short side is also fitted in the tube and pinched, and the joint is soldered as previously described. The spirals of paper from the short side are re-wrapped for about 1·25 cms., and the sleeve from the long end brought forward to a position where it overlaps the longitudinal wrapping on the long side and the re-wrapped spiral on the short. The spirals on the long side are then re-wound as far as the paper sleeve, where one is torn off short and the other continued over the sleeve to the far end, where it is secured by a tie.

A capable man will joint his wires in such a way that he works always as it were on a bulging surface. If the conductor joints are completed in a way that tends to form a sort of well or hollow, the free handling of wires requiring to be jointed in the hollow is greatly hindered.

The two most prominent difficulties which impede a jointer are awkward positions as regards the joints and the presence of water. Better joints and more speedy work can be expected when a man can sit square with the cable and have the joint well under his hands. The presence of other cables and pipes sometimes prevents access from above, and the cable must be jointed from below, the jointer lying underneath the cable.

Both the multiple-twin and quadruple-pair cables present some initial difficulty in jointing. Ordinary twin cables are jointed straight through, pair to pair. With the multiple-twin cable care has to be taken to joint different coloured pairs together in each core, as each of the different coloured pairs is laid up with a distinctive lay or twist. Thus, in a core of eight wires, the

White	pair	is joined	to the	green	pair
Red	,,	,,	,,	blue	,,
Green	,,	,,	,,	red	,,
Blue	,,	,,	,,	white	,,

This method equalizes the length of "lay" over a long section. Similar precautions have to be taken with the quadruple-pair cable. The pairs forming a quadruple core are laid up with different colours, and each core has a different colour. In jointing it is necessary that dissimilar coloured cores be jointed together, and also that pairs of dissimilar colour in each core be jointed together, and that the position of pairs diagonally opposite to each other in the cores be unaltered. By this means the pairs which are laid up with unequal "lay" are made equal in length, and therefore equal in resistance over a long section. If these precautions were not taken, two bunched pairs would be of unequal resistance over a long section, the electrical balance would be upset, and successful working and super-imposing would be impracticable.

After completing the conductor joints, the lead sleeve is pulled again over the gap, and after being dressed down upon the cable sheath, is closely wrapped at each end with prepared canvas and india-rubber strip successively.

A joint is thus made temporarily watertight and reasonably secure until such time as a plumber is available, but the interval between conductor jointing and plumbing should be reduced to a minimum. When this officer is ready, the joint is carefully dried by means of a charcoal brazier, and before wrapping the whole joint with paper a small piece of silvered glass is held over the conductors in order to detect any moisture. Should there be any appearance of vapour on the glass the drying by means of a brazier is continued. When the drying has proved satisfactory, the plumber takes possession and proceeds to fix the lead sleeve.

Needless to say, an awkward position affects a plumber adversely as well as a jointer, and in some circumstances considerable experience is needed to effect a thoroughly sound wiped joint. The time occupied in the various duties incidental to plumbing is as follows:— Cleaning out the hole, half an hour; preparing the sheathing and lead sleeve, three-quarters of an hour; wiping two joints on the one lead sleeve, one hour. Caulking down the manhole lid usually occupies another half an hour.

Desiccating.

When the underground cable was laid between London and Birmingham, no very reliable means were at hand to test the efficiency of the plumbers' joints on the lead sheathing, but since the completion of this section of the main underground scheme the desiccator pump has been introduced into the Telegraph Engineering Department, and every plumber's joint is tested with air pressure by its means.

After five or six cable lengths have been joined up, the exposed ends of the cable are fitted with lead caps having air nozzles. A pressure gauge is connected to one of the nozzles and a pressure gauge and desiccator to the other (*Fig.* 9). The compressor is then started,

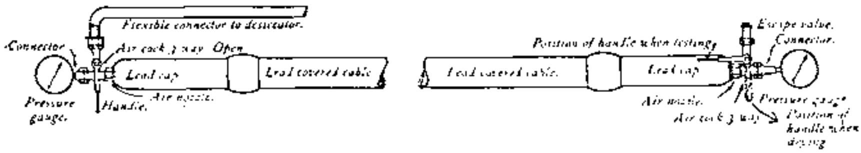

Fig. 9.—*Testing and Drying of Lead-Covered Air Space Cables.*

and when the pressure gauges at the extremities of the cable indicate 20 lbs. pressure the plumbers' work is tested by smearing soapsuds over the wiped joints. If any flaw is discovered, the joint is entirely re-made.

After the pump has been stopped and while the pressure is still in the cable, observation is kept on the pressure gauges, so that any fall due to an imperfection in the sheath of the cable may not escape notice.

An air-pressure test of each completed 5-mile section is also made. The ends of the cable are fitted as shown in *Fig.* 9, and pressure maintained until the gauge at the distant end indicates 20 lbs. The three-way cock is then closed to prevent the air leaking back through the desiccator and the pressure allowed to equalize throughout the cable. A note is made of the time when the gauges read alike and another reading taken 24 hours later. During this period the fall of pressure must not exceed 5 per cent.

Faults.

Although, as I have explained, the cable lengths have been tested before being despatched from the factories, some trouble has been experienced during the progress of the work in dealing with manufacturers' faults after cables have been drawn into the pipes, and a great deal of inconvenience was caused by the discovery of faults arising from the existence of metallic filings in the insulating paper used in the cables delivered between Exeter and Taunton in the early part of this year, with the result that seven faulty cable lengths had to be returned to the manufacturers. As this period of the year unfortunately coincided with the termination of the Parliamentary financial year, it was quite impossible to replace these lengths in the short time available before the 31st March, and in consequence a considerable amount of the money voted for this work was unexpended on the date mentioned and had to be surrendered. In order to prevent the possibility of faults of this nature remaining undetected when the cables are tested at the factories, it has been decided to test the cables at a pressure of 1,000 volts instead of 600 volts, as was the practice until the beginning of this year.

It has usually been possible in these cases to localize the earth faults by means of the loop test to within about ·2 mètre of the point at which they have occurred.

I may say that our experience up to the present time with the lead-sheathed cables provided on our main routes has been very satisfactory. The cables have not certainly been entirely free from interruption since they have been brought into use ; a few faults have developed which may be traceable to faulty workmanship ; in a few cases cables have been accidentally damaged by workmen employed by the road authorities, and in two cases, where the route passes over coal workings, the roadway has subsided, though in only one of these cases did interruption to the circuits result. The first of the subsidences referred to above occurred in 1907 south of Hamilton, in Scotland, where from 36 to 45 mètres of the roadway sank some 3 mètres below its original level ; the pipes were drawn, but the cable remained intact, although it has no doubt been somewhat stretched. In the case of the second subsidence, which occurred north of Hamilton in March, 1908, the lead sheath of the cable was ruptured, causing a complete interruption to the traffic.

A schedule (Appendix VI.) is attached, giving particulars relating to the cases in which actual interruptions to the circuits working in the cables have been caused.

An eminently satisfactory feature in the situation arises from the fact that in the original section of the cable between London and Birmingham, in which 125,476 conductors' joints and 1,651 plumbers' wiped joints are involved, only three interruptions have occurred since June, 1900, when the cable was first brought into use, and the cost of removing the faults has only amounted to 2,350 francs.

Description of Circuits Working in Cables.

It will have been observed that the first of the three types of cables used on the northern route possesses no screened conductors, this type not then having been introduced. With high-voltage Wheatstone circuits it has not been found possible to secure successful working simultaneously on neighbouring unscreened conductors (or a distance exceeding 20 kilomètres. It would thus be necessary to work Wheatstone on loops through the first section of cable, and then insert a repeater, the signals being repeated to a single aerial conductor earthed at both ends (*Fig.* 10).

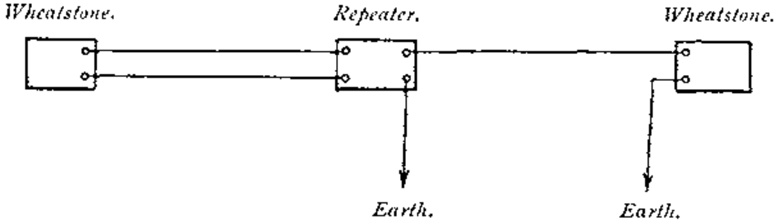

FIG. 10.

The majority of the circuits in use are however wholly in the underground cable, and in such cases loop-working is adopted throughout (the repeater not being required), whilst an additional circuit, key-worked, is superimposed on the loop, as shown in *Fig.* 11.

Between London and the various large cities on the route of the cables described there are working, on loops, 38 circuits, made up as follows:—

12 Wheatstone Duplex,
10 Hughes Duplex,
3 Wheatstone Simplex (for news work),
9 Double-Current Sounder Duplex,
4 Quadruplex (one with Wheatstone),

and upon 26 of these loops additional double-current duplex circuits are superimposed. This gives a total number of working channels of 133, and additional superimposing is possible up to the total number of loops available, viz., 38.

Fig. 11 gives a diagrammatic representation of the apparatus connections necessary for superimposing a key-worked duplex circuit upon a cable loop, which may be a duplex-worked Hughes or Wheatstone, or a quadruplex.

The two conductors of the loop and the loop apparatus are shunted at each end of the circuit by a high non-inductive resistance, from the centre of which is taken the line connection of the superimposed or "plus" circuit. Thus the conductor of the superimposed circuit consists of the two wires of the loop in parallel, with the addition of resistance at each end. In the case of lines under 240 kilomètres in length each of the superimposing coils or arms has a resistance of 3,000 ohms, and on lines over 240 kilomètres in length 5,000-ohm. coils are used. Each arm of the superimposing coils is shunted by a condenser, which acts as a signalling condenser for the

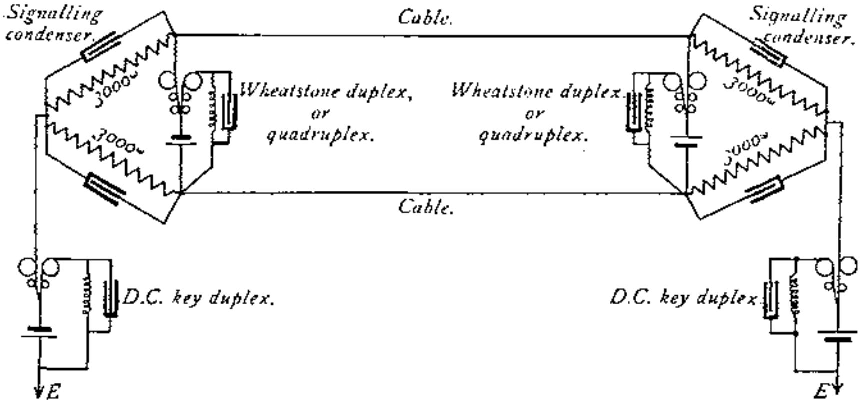

FIG. 11.—*Plan of Loop and Superimposed Circuits.*

plus circuits, increasing considerably the range of working of the circuits. The capacity of these condensers is 10 mfs. for circuits over 240 kilomètres in length, while for lines of less than 160 kilomètres no signalling condenser is required.

From an examination of the theoretical diagram of the circuits (*Fig.* 11) it will perhaps be noticed that the battery of the superimposed circuit ensures on the two conductors equality of potential at all adjacent points so long as the conductors are throughout equal in resistance and capacity.

Similarly the points of connection of the superimposed circuit with reference to the loop battery are of equal potential, being in the exact centre of the two electrically parallel circuits traversed by the loop currents.

Owing to the non-effective circulation of the current in the superimposing arms, the arrangement entails some waste of current from the loop batteries at each end of the circuit. This is however a small matter compared with the advantage obtained by the increased number of channels.

In the Western Cable the following circuits are working from London, in some cases for the whole distance, and in others for the greater part of their lengths :—

Wheatstone Duplex	4
Quadruplex	10
Double Current Duplex	25
Double Current Simplex	8

It should be understood that in addition to the above many long-distance circuits are working for a part of their length through the cable, and are brought out at various points and continued therefrom by means of aerial conductors. The question as to the final allocation of circuits in the cable is still under consideration, and many changes are in course of progress.

UNDULATOR WORKING.

One of the first experimental uses made of the Western Cable was to make up a direct circuit, London to Cork (Ireland), worked by means of the undulator, the repeater formerly in use for ordinary working being in the meantime cut out of circuit.

The circuit comprised on the English side 192 kilomètres of underground cable and 269 kilomètres of aerial wire; 120·64 kilomètres of submarine cable; and on the Irish side 192 kilomètres of aerial cable. With simplex conditions, a speed of 130 words per minute was obtained. At duplex however disturbing effects from neighbouring wires in the submarine cable led to a reduction in the speed of working to 86 words per minute.

The extreme sensibility of the undulator renders it very valuable on long circuits subject to a sudden fall in insulation. This is shown by the fact that duplex working between London and Cork, a distance of 893 kilomètres (with long lengths of underground and submarine cable), is practicable without a repeater, even when simplex working only is possible on ordinary Morse circuits with the aid of a repeater.

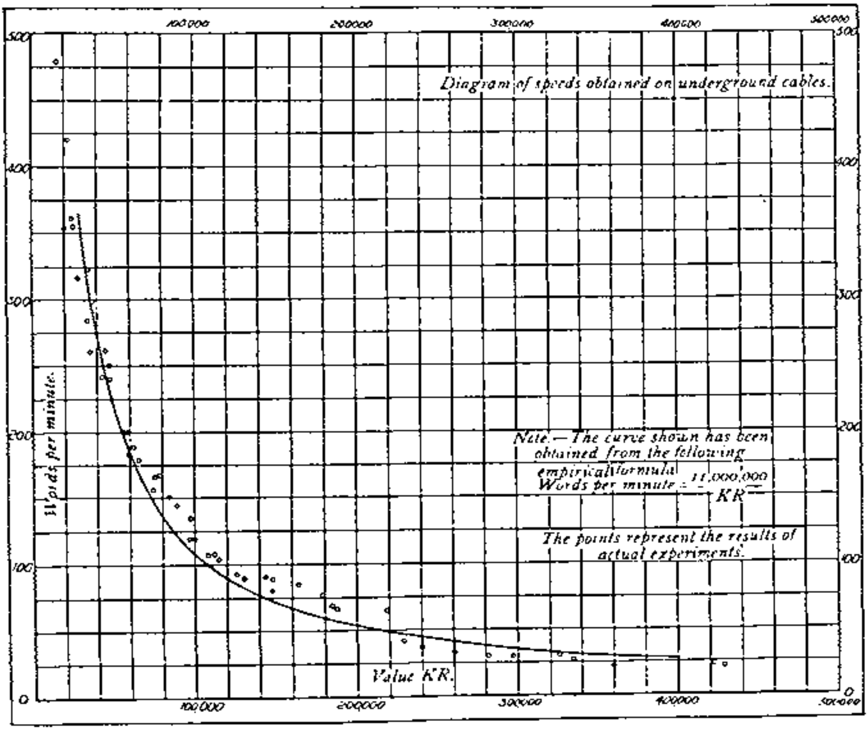

FIG. 12.—*Diagram of Speeds obtained on Underground Cables.*

SPEED TESTS.

I have thought it desirable that some information be given upon the actual working speeds which have been secured upon cable circuits. For this purpose the curve diagram, *Fig.* 12, may be referred to.

The curve has been obtained from the empirical formula :—

$$\text{Words per minute} = \frac{11{,}000{,}000}{KR}$$

and shows the number of words per minute for successive KR values up to 400,000. It should be observed that these trials were made under simplex conditions.

The results of some speed trials under both simplex and duplex conditions on single-screened conductors may be of interest, and are given in the following Tables. In each case the voltage was 125 :—

Length of Line in Kilomètres.	Total K in mfds.	Total R in ohms.	KR.	Speed.	
				Sx.	Dx.
187	12·75	1465	18680	353	231
243	16·57	1903	31530	300	195
386	26·269	3017	79253	153	103
467	31·82	3656	116330	111	71
666	45·34	5208	236140	51	34

With unscreened loops the following values were obtained :—

Length of Line in Kilomètres.	Total K in mfds.	Total R in ohms.	KR.	Speed.	
				Sx.	Dx.
187	7·17	2301	14560	390	—
243	9·32	2639	24590	316	200
386	14·77	4184	61794	182	122
467	17·90	5069	90740	125	—
666	25·50	7222	184150	54	35

Conclusion.

The annual maintenance cost incurred in connection with the upkeep of these cables, which includes attention to joint boxes, test pillars, and the removal of the faults referred to, averaged out for the twelve months ending 31st March last at .5 *franc* per kilomètre of conductor, which compares favourably with the average annual cost of the similar service in respect of open wires, which amounted for the same period to 4·1 francs per kilomètre (5s. 3d. mile).

When a large number of wires are involved, as is the case with the main routes described in this Paper, the capital cost of underground construction per kilomètre of conductor is approximately the same as that of overhead construction, and when the greater freedom from interruption of the underground conductors, as compared with that of open wires, and also the probable longer life of the underground plant is considered, clearly there is much to encourage the rapid extension of the main underground network of telegraph wires.

In conclusion * * * * *
much of the work originally proposed has been carried out, and there seems a likelihood that at an early date we shall have immunity from storm interruptions so far as our main telegraph lines are concerned.

APPENDIX IV.

PILLAR TEST BOXES.

In order to facilitate fault testing in long sections of main cables, test pillars accommodating cable connection boxes are fixed at suitable points.

The cast-iron pillar itself is merely a protective case to prevent accidental damage to, or unauthorized interference with, the cable connection box inside.

The pillar stands on a foundation of brickwork, 22·5 cms. thick, built on a bed of concrete 15 cms. thick, to which it is firmly bolted down.

In some cases it is necessary to fix a joint box close to the pillar, in order to change the type of cable or to accommodate inductance coils.

The plinth of the pillar test box may be used to lock down one side of the joint-box cover. When the joint boxes are intended to contain apparatus which might be tampered with, special covers fitted with a locking arrangement are supplied.

Enamelled caution plates, with cuphead bolts for fixing, are issued for use in districts where disfigurements of the pillars by bill posting or other means is apprehended.

A pillar test box is not necessarily erected over a line of pipes, but is invariably fixed in such a position as will ensure it against damage due to the incidence of road traffic.

Bonding at Test Pillars.—The pipes at a test pillar are bonded together, and an earthplate 75 cms. × 75 cms. buried in damp soil near the pillar test box and connected to the cable connection box by a soft copper wire. The stranded conductor is placed under one of the nuts holding the lid of the box on the air space side.

APPENDIX V.

PETROLEUM JELLY.

The jelly used for lubricating and protecting from electrolytic action the lead cables of the British Post Office has a melting point of 51° C., and is a well-refined yellow jelly. As a check upon the quality, the viscosity at 60° C. is determined by Redwood's Viscometer, and we specify that 50 cubic centimètres shall take not less than 200 seconds to pass through the instrument. A jelly giving a value appreciably lower than this is liable in hot weather to flow off the cable during the operation of pulling into the conduit, and it consequently becomes inefficient as a protective coating. In practice the jelly is applied liberally to the surface of the lead-covered cable as the cable passes into the conduit, and, approximately, 31·5 kilogrammes of jelly per kilomètre is required for a cable of 6·8 cm. diameter.

APPENDIX VI.

Schedule of Faults in Main Underground Cables since Commencement of Work on System.

Description of Cable.	Locality of Fault.	Length of Section Affected.	No. of Wires in Cable.	No. of Wires Stopped.	Date and Duration of Stoppage.	Approx. Cost of Repair.	Nature and Cause of Fault.
		Kilomètres.				Francs.	
Main Northern Cable—London to Glasgow. Type—Air space paper core. Work commenced 1897.	34 kilomètres north of London.	34	76	All	March 04 ½ hour	925	Defective jointing.
	Weedon, Northants, 118 kilomètres north of London.	70	76	All	July 00	850	During a severe thunderstorm lightning set fire to the leads of a test hut, and thus destroyed the leading in cables.
	Shirley, 10 kilomètres from Birmingham.	37	76	All	August 06 10 hours	575	A workman in digging a hole for a pole accidentally broke the pipe and drove a pickaxe through the cable, which became flooded for a length of several feet.
	Hamilton, Scotland ...	18	97	All	March 08 3 days	2,500	Owing to a considerable subsistence due to coal workings, the pipe was fractured at one place and the cable damaged. The pipe joints were drawn apart to the extent of about ½" for a distance of about 150 yards. A temporary interruption cable was laid above ground whilst the cable was being repaired.
Main Western Cable—(Commenced December, 1904; completed London—Taunton, July, 1908). Type of cable—Air space paper core.	6 kilomètres west of London.	10	169	6	1 May 08 2½ hours	250	A pickaxe was accidentally driven into the cable by a workman.
	6 kilomètres west of London.	10	169	80	27 July 06 60 hours	1,250	A heavy thunderstorm occurred whilst joint was open. The cable lay between two hills, and water flooded manhole and damaged the cable. The majority of the wires were working after 25 hours.
	67 kilomètres west of London.	59	104	All	29 April 08 55 hours	2,500	A pickaxe was accidentally driven into the cable by a road workman.

THE R.E. HEADQUARTER MESS.
(*Continued*).

By Lieut.-Colonel B. R. Ward, R.E.

General Sir Arthur Thomas Cotton, K.C.S.I. (1803—1899),* is the only representative of the Madras Engineers commemorated in the Mess. Many distinguished Engineers have at various times done duty in the Southern Presidency, but none has probably left so lasting a mark upon the country of his adoption as Sir Arthur Cotton.

All his soldiering was done in 1824 as a subaltern in the first Burmese War, where he led the storming parties against seven forts and stockades. After the war he was posted to the Public Works Department, and in 1828 he was appointed to the separate charge of the great irrigation works on the river Cauvery. The fertile districts of Tanjore and Trichinopoly were entirely dependent on an ancient system of irrigation channels which were in existence before the British occupation of Southern India, but in 1828 the system was seriously endangered by the increasing tendency of the waters of the Cauvery to flow down the Coleroon, thus deserting the southern branch and its dependent irrigation channels. Cotton's investigations were carried out with great care over a series of years, and resulted in the preparation of a scheme consisting of two large dams, or anicuts, which were built in the winter of 1835–6, during the brief season of the cessation of freshes in the river.

"They were built at a most critical time, for in 1837 a failure of the rains took place, which, without the new works, would have caused immense loss to the people and to the Government. The great utility of the works was at once realized. The principal collector of Tanjore writing to the Board of Revenue in 1838, declared that there was not an individual in the province who did not consider it (the upper anicut) the greatest blessing that had ever been conferred upon it, at the same time expressing his conviction that 'the name of its projector would, in Tanjore, survive all the Europeans who had been connected with it.'"†

Ten years after the construction of the Coleroon works, Cotton laid before the Madras Government a project for building an immense

* *Dictionary of National Biography*, Supplement, Vol. II., p. 63, and *R.E. Journal*, 1899, p. 187.

† *Dictionary of National Biography*, Supplement, Vol. II., p. 64.

dam across the Godaveri River. The stream is 3½ miles wide at the point selected, but the actual waterway is reduced to 2¼ miles by the presence of three islands in the stream. "Even so it was a stupendous work, the Dowlaishwaram branch of the anicut being alone of greater length than the two Coleroon anicuts put together."*

The work occupied five years in construction, and proved as successful as the first one. The district, which formerly was continually in a state of extreme poverty, is now one of the most prosperous in India.

On completion of the Godaveri work, Cotton proposed a third scheme of irrigation by the construction of a dam on the Krishna River. This scheme was actually planned by Colonel Sir Henry Lake and constructed by Major-General Orr, but the allotment of funds for its construction was undoubtedly due to the enthusiastic advocacy of Cotton.

The following extract from the records of the Government of Madras show how highly the stupendous irrigation works originated and carried out by Sir Arthur Cotton were appreciated by the Government :—

> If we have done our duty, and have founded a system which will be a source of strength and wealth and credit to us as a nation, it is due to one master mind, which, with admirable industry and perseverance in spite of every discouragement, has worked out this great result. Other able and devoted officers have caught Colonel Cotton's spirit, and have rendered invaluable aid under his advice and direction, but for this creation of genius we are indebted to him alone. Colonel Cotton's name will be venerated by millions yet unborn, when many who now occupy a much larger place in the public view will be forgotten.†

° ° ° ° °

If further testimony is required to the immense value of his work, the following figures give a good idea of the benefit it has bestowed on the Madras Presidency. During the great famine of 1877, 4,000,000 persons are supposed to have perished in the more or less unprotected districts of Madras, whilst not only were there no deaths from famine in the districts protected by his work, but in addition surplus food was exported sufficient to save 3,000,000 lives elsewhere.

Sir Arthur Cotton lived to the great age of 96, and up to within a short time of his death still took a keen interest in Indian affairs, noting with delight how God had blessed the British rule in India. "If any man had written when I went out," he wrote to a friend some three years before his death, "expressing a hope of anything

* *Dictionary of National Biography*, Supplement, Vol. II., p. 64.
† *Dictionary of National Biography*, Supplement, Vol. II., p. 65.

approaching the present state of things, he would have been thought the greatest fool in India."

Lieut.-General Sir Andrew Clarke, G.C.M.G., C.B., C.I.E. (1824—1902), throughout an extraordinarily varied career, worked as few men have ever worked, with a singleness of mind and clearness of aim towards the building up and consolidation of the Empire. "The story of his life is the record of a man who from his first start in the world was determined to succeed, who felt that he had in him the ability to get on, who seized the opportunities that offered themselves, and by his strenuous character made a name for himself in a succession of very diverse services to the State."*

As a subaltern he served his apprenticeship under two famous Colonial Governors—Sir George Grey in New Zealand, and Sir William Denison in Tasmania.

In 1853 he was appointed Surveyor-General of Victoria, and before sailing for England in 1858 he had been offered the Premiership of the Colony. After a short period of service in England he was sent to the Gold Coast, where he was mainly occupied in the preparation of a report in which he collected a great deal of valuable information. The report was published in July, 1864 and was considered the best description of the coast in existence up to the time of the Ashanti Expedition of 10 years later.

From 1864 to 1873 he was Director of Engineering and Architectural Works at the Admiralty. The construction and launching of the Bermuda floating dock, a visit to Egypt and a report on the Suez Canal, a scheme for manning the Navy, the construction of a new dock at Malta, docks at Portsmouth, Chatham, and Cape Town, the Alderney and Portland Breakwaters, and a joint report with Sir John Hawkshaw on Dover Harbour, were the result of these nine years of strenuous work. The honour of a K.C.S.I. and the following letter from the First Lord of the Admiralty show how highly his services in connection with the Navy were appreciated.

"*From* THE RIGHT HON. G. J. GOSCHEN.

"*Admiralty*, 20*th September*, 1873.

"DEAR SIR ANDREW CLARKE,

"I cannot deny myself the pleasure of repeating in writing what I expressed to you when we parted on Thursday, that in losing your services at the Admiralty I feel that we are sustaining a heavy loss, and that personally I shall be most sorry to miss you from amongst us at Whitehall. I have been greatly impressed by your conspicuous devotion to the public service, and by the energy which you throw into everything you undertake.

* *The Life of General Sir Andrew Clarke, G.C.M.G., C.B., C.I.E.,* by Colonel R. H. Vetch, C.B., p. 8.

"I will not repeat what has been stated in our official letter to you as to the sense entertained of your engineering ability and the great works which have been constructed under your auspices. Let me only say that you have most worthily filled what was a most important post when you first succeeded to it, but which you have rendered still more conspicuous and useful to the State by the way in which you dealt with it. Wishing you every success in your future career,

"I *remain*, yours very truly,

"George J. Goschen."*

It is not possible to do more than touch on the many high appointments held by Sir Andrew Clarke after this date.

From 1873 to 1875 he was Governor of the Straits Settlements, where perhaps the most important work of his life was effected, viz., the establishment of ordered Government under British supervision throughout the Malay Native States which had hitherto been in a state of anarchy. From 1875 to 1880 he was member of Council of the Viceroy of India. In 1881 and 1882 he was Commandant of the School of Military Engineering, and from 1882 to 1886 he was Inspector-General of Fortifications. His work in all these high offices bore the impress of his vigorous and original mind.

Sir Andrew took a great interest in all Corps Memorials, the portraits of Sir William Denison and Sir Lintorn Simmons were painted on his initiative, and it was at his suggestion that Mr. Onslow Ford, R.A., was selected as the sculptor of the Gordon Memorial at Chatham. "Never was a committee more fortunate in its choice of an artist. He threw himself into the work *con amore*, and thought of nothing but getting as near as possible to his ideal.

"After making some sketch models of Gordon in British uniform of the conventional type, Mr. Ford had an inspiration. This was to seat General Gordon, dressed as Governor-General of the Soudan and Field Marshal in the Egyptian Service, on a camel, and to depict him in the act of overawing Suleiman and the Arab slave dealers by his sudden and solitary appearance at Shaka and by the personality of his commanding presence. There was some hesitation on the part of the committee at this bold proposal and departure from conventionality. Some thought the camel would draw attention from the man, others that there was no precedent for a camel statue, but, backed by the support of Sir Andrew Clarke and an enthusiastic secretary, Mr. Onslow Ford's brilliant idea prevailed. Opposers and hesitators gave way, and the beautiful bronze statue of Gordon on the camel was the result."†

The bronze bust of Gordon in the north annexe is another of the

* Vetch's *Life*, p. 117.
† Vetch's *Life*, p. 291.

Corps Memorials carried out by Sir Andrew's committee, and is also the work of the same distinguished sculptor. Sir George Clarke, who served under Sir Andrew when he was Inspector-General of Fortifications, has written a preface to Colonel Vetch's interesting biography. The preface closes with the following words :—"Readers of this volume will recognize a life of exceptional public usefulness worthy of record, and they will not fail to realize the intensity of interest and the wide scope of the careers which our Empire can bestow upon its favoured sons. Those who knew Sir Andrew Clarke will never forget his great kindliness and broad sympathies. Those who served under him will cherish the memory of a chief who was always considerate, always inspiring, and always open-minded. In the intensely complex affairs of our national life he played a notable part, and it is by reason of labours such as his—often unknown and unrewarded—that we move, however slowly, towards the light."*

The bust of Sir Richard Harrison bears the following inscription :—

COLONEL RICHARD HARRISON, C.B., R.E.,
WHEN ASSISTANT ADJUTANT AND QUARTERMASTER-GENERAL
AT ALDERSHOT, 1881—1886.

HE BECAME QUARTERMASTER-GENERAL OF THE FORCES
IN 1897, 1898,
AND INSPECTOR-GENERAL OF FORTIFICATIONS
IN 1898—1903.

There is no need to go into detail with regard to Sir Richard Harrison's career. We are fortunate in having him still among us, and he has found time to give us an interesting account of his eventful life in the autobiography recently published by Smith, Elder & Co., and reviewed in the March number of the *R.E. Journal.*

The bust of Vauban, now kept in the Ladies' Reception Room, stands on a wooden pedestal, on which is written the following extract from the *Eloge* of Fontenelle on the famous Engineer and Marshal of France :—

VAUBAN.

Un sens droit & étendu, qui s'attachoit au vrai par une espèce de simpathie, & sentoit le faux sans le discuter, lui épargnoit les longs circuits par où les autres marchent. . . .

Il a fait travailler à 300 places anciennes, en a fait 33 neuves, a conduit 53 sièges & s'est trouvé à 140 actions de vigueur. . . . Il a eu la gloire de ne laisser en mourant qu'une fortune médiocre. . . .

C'étoit un Romain qu'il sembloit que notre Siècle eut dérobé aux plus heureux tems de la République.

Fontenelle.

* Vetch's *Life*, p. 14.

Fontenelle was perpetual Secretary of the Academy of Sciences from 1699 to 1741, and wrote in his official capacity the *Histoire de l'Académie des Sciences*, containing extracts and analyses of the proceedings, and also the *Eloges* of the members. The death of Vauban in 1707 was the occasion of the eulogy quoted above, in the transcription of which the old 18th century French spelling has been retained.

Below the 18th century French inscription is an English 19th century record to the following effect:—

Taken from the French Engineer's Office at Antwerp in May, 1814, and respectfully presented to the Inspector-General by Lieut.-Colonel Carmichael Smyth, Commanding Engineer with the Army in Flanders.

This bust of Vauban is one of the most interesting as well as being the oldest war relic in the possession of the Mess. To Engineers of the 20th century the name of Vauban is no longer one to conjure with, yet in the long list of men distinguished in the profession of military engineering there is certainly no name that so well deserves commemoration.

The features are those of Vauban at the height of his fame in the 17th century. The work is that of a French artist of the 18th century, the inscription on the base reflecting something of the homage and admiration felt for the great engineer and soldier when he breathed his last in 1707. His first military service was in 1653, and in 1703 he attained the rank of Marshal of France, being the first French military engineer to attain this high distinction.

An English Plutarch, writing parallel lives of French and English heroes, would probably select Burgoyne as the English Vauban. In sound judgment and common sense the two men were not dissimilar. In length of active military engineer service they both surpassed all their contemporaries; and Burgoyne, like Vauban, was the first military engineer of his nation to attain to the rank of Field Marshal. Neither of these distinguished men ever commanded an army in the field, but Vauban and Burgoyne will surely always remain supreme in the hearts of all military engineers of their respective nationalities as the embodiment of the highest ideals attainable by the Corps de Génie and the Royal Engineers.

MEMOIR.

LIEUT.-GENERAL JAMES CROFTON.

By MAJOR W. BROADFOOT, LATE R.E.

LIEUT.-GENERAL JAMES CROFTON, Retired List, Royal (late Bengal) Engineers, died at his house, 12, Westbourne Square, London, W., on November 22nd, 1908, in his 83rd year. His chief commissions were as follow:—Captain, August 13th, 1858; Major, December 9th, 1864; Lieut.-Colonel, March 1st, 1867; Colonel, March 1st, 1872; Major-General, December 31st, 1878; Lieut.-General (Hon.), on retirement. He was the third son of Lieut. Morgan Crofton, R.N., whose grandfather was created Baronet in 1801. His mother was Helen Elizabeth, daughter of Col. H. O'Hara, of O'Harabrook, co. Antrim. Born in Harcourt Street, Dublin, on May 7th, 1826, James Crofton was educated privately and at Cheltenham College, which he joined on the day it was opened, and was the first to pass from the college into Addiscombe. Thence he qualified for the Bengal Engineers, his commission as 2nd lieutenant bearing the date December 9th, 1844. Ten Engineers were appointed on that day; of them, Major-General W. W. H. Greathed, C.B., Major-General F. T. Haig, and General J. T. Walker, C.B., may be mentioned; whilst of those who may be called contemporary, General Sir Alex. Taylor, G.C.B., Colonel J. H. Dyas*, Major-General Ralph Young†, Sir Andrew Clarke, G.C.M.G., C.B., Sir John Stokes, K.C.B., and Sir Richard Sankey, K.C.B., Crofton's cousin, acquired distinction.

Whilst at Chatham he had the misfortune to be seriously hurt on board a steamer on his way *viâ* London to Ireland. There was fog on the river and he was caught in a collision with another steamer which ran into them; an arm was crushed and his collar bone was broken. The arm was not properly set, and consequently he never had the full use of it; though the damage did not interfere with his work, in after life he suffered from its effects.

Crofton arrived at Calcutta on December 16th, 1846, by which date the first Sikh War was over and the expedient was being tried of

* *R.E. Journal*, April 1st, 1899.

† *R.E. Journal*, January 1st, 1898.

governing the Punjab through a Council of Regency under the guidance of a British Resident. Like other Engineers, he did duty for a short time with the Bengal Sappers and Miners, and in 1847 he was appointed to the Public Works Department.

In those days there were few Engineer officers available, and the recently annexed Cis-Sutlej territory—extended in 1849 to the rest of the Punjab—demanded attention; consequently service in the grades of Assistant was either very brief or altogether dispensed with, and men commenced their careers as Executive Engineers instead of spending four or five years as Assistants, as was usual some 15 or 20 years later. Yet these fortunate persons never seemed to realize what they owed to this long start, which placed them in the highest positions when still young, and in which they remained serene (for there was no limit of tenure) till prepared to retire or till removed by some other cause.

In Crofton's case there is some ambiguity as to the dates of various civil appointments, but the following note of his services is near enough not to materially mislead. The names of the offices held have been changed, which does not tend to lessen the confusion, but records show that in December, 1849, he was serving as Assistant Superintendent on the Western Jumna Canal.

Early in 1850 he marched from Delhi to Lahore in order to commence surveys for the Bari Doab* Canal. This great work, like many other irrigation canals in India, was preceded by a native-made channel called the Hasli (Huslee), a work which though often faulty in detail yet showed, as is attested by Lieut.-Colonel Napier,† a remarkable degree of judgment in construction, for it carried water—intermittently no doubt—from the foot of the Himálaya to the gardens of Amritsar and Lahore more than 100 miles distant. Napier, who in 1850 was Civil Engineer in the Punjab, or, as we now term the office, Chief Engineer, quickly saw the wide field for improvement opened by annexation, and promptly sent as many officers as could be spared to make a reconnoitring survey of the Bari Doab, and to take levels in order to send in a project for extended irrigation. Besides the hope of profit at some future period, there were at the moment wandering about the country great numbers of disbanded Sikh soldiers whose employment was politically expedient; consequently there was every disposition on the part of Government to advance the scheme. This was entrusted to Lieut. Dyas, whose talent, zeal, and industry were justly acknowledged, and whose right-hand man and dear personal friend was Lieut. Crofton.

Work was pushed on in spite of defective maps and surveys, and the project was submitted to the Board of Administration in October,

* Bárí: contraction of Beás Rávi. Bárí Doáb = the land between the two rivers, Beás and Rávi.

† Afterwards F.M. Lord Napier of Magdala.

1851. In due course sanction was obtained, but experience showed that revision of the estimates was necessary. Crofton carried this out whilst work was in hand, and in 1856 the revised estimate was submitted.

Next year progress was arrested by the outbreak of the Mutiny; funds were curtailed and the labourers were reduced. A considerable number of them however found congenial employment as soldiers, being enlisted as pioneers under command of Lieut. H. W. Gulliver and marched to Delhi, where they looked forward to fighting and plunder. They distinguished themselves greatly and formed the nucleus of the 32nd Sikh Pioneers. These events and the transfer of several officers caused delay which at the time was deeply deplored; experience however has shown that the evil was mitigated, for errors, then unavoidable, would have been more frequently repeated if work had not been interrupted.

On March 1st, 1858, Crofton married Mary Susan, daughter of Sir Robert Montgomery, then Judicial Commissioner of Lahore, a distinguished officer prominent during the Mutiny in disarming native regiments and in adopting wise measures for the suppression of revolt, who afterwards became Lieut.-Governor of the Punjab. To Mrs. Crofton fell the ceremony of admitting water to the canal on April 11th, 1859, work having been pushed on night and day for three weeks in order that Crofton—who had to leave that day on furlough—might be present. Whilst at home his wife died at Kingstown, near Dublin, on December 22nd, 1860; a year later he was back in India, and by January, 1862, had returned to Lahore. From May, 1863, till September, 1864, he was employed as Superintending Engineer on the Eastern Jumna Canal, on surveys for the Sirhind Canal, and was then transferred to the charge of the Punjab canals in place of Dyas, who was sent to the North-Western Provinces.

During Crofton's tenure of office in the Punjab, work increased greatly; irrigation was developed, drainage received attention, old channels were remodelled, and surveys for new projects were made. The irrigation service was consequently strengthened, and the present writer, who met Crofton in January, 1865, was in 1868 appointed to the Secretariat of the Punjab Government to assist in driving the coach.

In 1867 Crofton married, as his second wife, Clara Elizabeth, daughter of Capt. Edward Lake, R.N., and cousin of General E. Lake, C.S.I., Financial Commissioner of the Punjab, and by her had 10 children, six of whom survive.

Crofton held office in the Punjab till 1874; on his departure the Lieut.-Governor (the late Sir Henry Davies, K.C.S.I.) issued a complimentary order expressing "his high appreciation of your services. He desires especially to record his sense of the great value of your matured experience and good judgment in all matters connected with irrigation, your thorough mastery of the details of canal management, whether professional or administrative, and your indefatigable industry in carrying out the duties of your office. Your name will be associated with one of the most important irrigation works in progress—the Sirhind Canal—the design of which is your own and the success of which, his honour trusts, will be commensurate with the conscientious care which you have bestowed upon the undertaking from first to last."

On leaving the Punjab, Crofton was appointed Inspector-General of Irrigation and Deputy Secretary to the Government of India, the highest appointment in the canal department. He held this post till retirement from the Service in January, 1882, when he settled in London, first at Clapham Park and afterwards at Westbourne Square, Paddington. There Mrs. Crofton died on December 16th, 1890. So long as strength remained Crofton employed himself in local business; he served eight years on the Board of Guardians and as a member of several religious committees; he also was treasurer of Sunday schools, of the Church Missionary Society for Paddington, and of a working man's club in the Harrow Road.

Throughout life Crofton was a deeply religious man, who, whilst holding his own views strongly, was yet tolerant to all forms of Protestant worship. Though in appearance delicate (he was about 5′10″ in height and weighed about 8 stone), he had great vitality, whilst his endurance, either in the saddle or on the office stool, left nothing to be desired. His health and memory began to fail a few years ago, but till recently he was able and pleased to see old friends In business matters he was easy to work with, and was much liked by the heads of other departments with whom he was brought in contact. Courteous in manner, grave, but with a saving sense of humour, and patient, he was devoted to his work, from which indeed he seldom sought relaxation. That with him did not take the ordinary form of games or sport, for which he showed no desire, but rather was found in camp life, inspecting canals all over the country, and escaping to the wilds from the distractions and entertainments at headquarters. Similarly after retirement his leisure was chiefly devoted to good works, and he has now, after a long and useful life, entered into rest.

TRANSCRIPT.

AN APPRECIATION OF AUSTRIA-HUNGARY'S MILITARY POSITION.

From the *Neue Militärische Blätter* (Berlin), 28th December, 1908.

ALTHOUGH the hope that peace will not be disturbed still—and rightly—exists, there are manifold evidences at hand which impel us to think of the possibility of an armed conflict.

The Austro-Hungarian War Department must reckon with the extreme case, and make its arrangements in such a manner that, if in the course of this year it should come to open hostilities, action shall be taken immediately and with the superiority in *personnel* and *matériel* which is required in order to assure rapid and decisive tactical blows.

We must recognize in the measures of the War Department the steps necessitated by the development of the external political situation. Even late in the summer, long before the annexation had been announced, the Sarajewo Army Corps and the detachments in Southern Dalmatia had been moved into positions which would enable them to energetically oppose any sudden attempt at a rising by Montenegro and Servia. They were supported by the fortified positions, which were brought up to a war scale of mobilization, so as to secure the strategical deployment of the forces destined for a campaign. Later on followed the double necessity of not only taking measures in Bosnia and in the Herzegovina to prevent raiding by bands, but also of strengthening the defence of the border along the Drina-Danube-Save barriers.

The respective measures were, (1) the organization of punitive corps, composed by raising the peace strength of all the troops garrisoning the territory formerly occupied, and by this means bringing the XVth Corps to a fighting strength of 50,000 men, and (2) by retaining the junior reservists. Servia's obvious preparations for war next required further measures, and all reservists were accordingly retained, which was equivalent to increasing the peace strength by about 100,000 men. Besides this, it is contemplated—in case the situation requires it—to call up more sections of the reserve and militia. The preparation of the southern front as a base of operations, and the despatch of more troops for observing the frontier, went on hand in hand with the above measures so that the formation of a new division of two mountain brigades became necessary. The fighting strength of the XVth Corps now amounts to 110,000 men.

As regards the details of these measures, it can be said that this display of military strength by the Monarchy is not only appropriate to the actual present state of affairs, but is comprehensively worked out for all possibilities which could arise in the course of the development of the international situation, and for which the Monarchy wishes to be prepared.

In estimating the strategical relation of the Monarchy to Servia and Montenegro, it should be emphasized that the course of the boundary line makes an advance on convergent lines—and in the case of Montenegro even a concentric advance—possible. Yet the length of the frontier, the lack of efficient communications, and the obstacles which the local conditions oppose to military undertakings must be regarded as most weighty considerations.

Austro-Hungarian Zones of Strategical Deployment.

As zones of strategical deployment against Servia, the areas north of the Danube barrier come under consideration, especially the lower Banat and Syrmien, and also the area from Zvornik to the junction of the Drina and the Save. The lower Banat—the area west of the railway line Weisskirchen-Temesvar up into the Danube-Save angle—is almost throughout a well-cultivated plain, with numerous large towns providing good billeting accommodation. The communications are for the most part good roads, but the numerous cart-tracks are of little use in wet weather, as the top soil is clay mixed with black earth. Five sets of rails lead into this area along lines of deployment, but, with one exception, they are only local branch lines of somewhat small capacity. The Danube can also be used as a line of strategical deployment, but there is so little water in the river in the winter that only slow moving shallow-draught boats can be used. Syrmien (Szeben)—the area west of the reach of the Danube from Slankamen to Semlin as far as the Bosut—is, in its northern portion, rich in large towns securing favourable billeting conditions, and has considerable resources at disposal. Communications are not particularly favourable, as there are only four good roads running north and south. Four lines lead into this area, including the main line Budapest-Neusatz-Semlin. The Danube and the Save can also be taken into consideration for the strategical movement into this area, but their utility in war would be limited to transport of materials and reinforcements. The conditions of strategical deployment are most favourable at Pancsova, where four good roads and two lines of railway lead to the river.

The Danube has special importance as a frontier barrier; it is 450 to 1,200 mètres wide, 4 to 18 mètres deep, and slow moving. The banks are high and broken, the approach to the water's edge is, to a great extent, rendered difficult by low-lying swampy ground, and by the lack of good communications available at all seasons. Of great importance are the passable protecting dykes, which also lead partly inland and could be used for the advance and for the transport of bridging material. These dykes are only found on the northern bank and are guarded by the river watchers, who are connected by telephone both with each other and with the river conservancy authorities. From December to February the Danube is generally at its lowest, and it is at its highest from April till June. One disadvantage must be noted, namely, that the southern bank is the commanding one for long reaches, and therefore Austro-Hungarian undertakings will have to be made mostly within sight and range of the enemy's bank; still as regards this the appearance of the Danube flotilla can ensure protection. Only one heavy bridge offers secure communication over the river, but bridging material is available in many places on the river itself, and besides this a sufficient store of material is available from the steamship companies. Materials can be brought up on the river itself, and the numerous islands, the "war islands" at Semlin, the islands at Pancsova, Semendria, and Gradiste, as well as those downstream from Bazias, appear favourable for the construction of a bridge. For a light military bridge, 9 to 20 bridging trains, and 10 to 25 hours preliminary work are necessary, but bridging operations are only possible in still weather. As regards the convoying of materials, it is to be observed that a convoy from Budapest to Orsova takes four days, and in the reverse direction eight to nine days.

From Semlin westwards, the Save forms the boundary. This river is 300 to 750 mètres wide, 2½ to 9 mètres deep, and slow moving and downstream from Samac, the Servian bank is the commanding one. The already considerable obstacle of this volume of water is appreciably strengthened by the character of the valley, which not only makes approach difficult in wet weather, but also makes it impossible in parts at high water. For the capacity of the Save as a transport line, similar conditions obtain as in the case of the Danube.

Conditions of Strategical Deployment on the Drina.

The area west of the Drina from Zvornik to the point where the Drina flows into the Save, contains any areas which could be taken into consideration for the assembling of large forces only in the lower Posavina—which is wooded and boggy in places—or in the valleys of the Drina and in the Spreckopolje: otherwise there are only small scattered groups of places, which are but little suited for the billeting of troops. As lines of strategical deployment there are two railways available, one by Esseg and Brcka, and the other by Brod, but both end two marches from the frontier. As a continuation the roads radiating from Brcka towards the important communication-junction Bjelina and the communications leading from Brcka and Dolna Tuzla against Zvornik could be utilized. To a limited extent the Drina—connecting with the Save—can be turned to use as a line of transport.

Further south there are no places of assembly of any magnitude on the frontier itself; the small basins of Vlasenica and Srebenica only come under consideration for the billeting of the advanced frontier detachments. The single large place of concentration is Sarajevo, which should afford room for three or four divisions within its surrounding ring of modern fortifications. It is however two to four days' march from the boundary. Besides this there are only very poor settlements, which could only be used for the billeting of small detachments. Somewhat more favourable conditions prevail in the valleys of the Drina at Visegrad and in the mountain country in the basins of Kotusica and Glasinac.

The small gauge railways from Brod to Sarajevo, Metkovic to Sarajevo, and Sarajevo to Visegrad lead into this zone; beyond these, only roads, which are certainly in excellent condition, come under consideration. The observation and security of the frontier is made easier by the Drina, which is 100 to 200 mètres wide, and in its lower reach requires *three to seven* bridging trains (of 64 mètres length) for its bridging. This river is difficult to cross, and the most important crossings are protected by fortifications. At Foca (Fotcha) there are three defensible barracks, at Visegrad one defensible barrack and two open batteries, at Zvornik one old fortress with subsidiary works. Further inland the places of assembly referred to before, Vlasenica, Srebenica, further on Gorazda, Rogatica, Hanpod, Romanja, and Praca, are protected in the form of fortified garrisons; Sarajevo, finally, is fortified as a base and *point d'appui* by a girdle of 18 kilomètres extent, consisting of defensible barracks and gun emplacements, and by an entrenched camp.

SERVIAN ZONES OF STRATEGICAL DEPLOYMENT AND OBJECTIVES.

We find in Western Servia near the frontier the following areas for the concentration of forces for the offensive movement across the Drina, as apparently planned, viz. :—(1), The plain on the Drina downstream from Loznica, which—though situated directly on the frontier—is well adapted as regards considerations of space, billets, and communication for large forces; (2), the basin of the upper Jardar Valley; and (3) Valjevo and Uzice-Pozega, each distant two or three marches from the frontier, though limited in area, with indifferent resources, and only relatively favourable conditions for billeting. It is important to note that between these areas of concentration and the frontier lies a range of hills difficult to pass, with few roads, and heavily wooded; this circumstance would greatly influence a forward movement to the Drina on the one hand and on the other an Austrian advance. The communications for an advance on the frontier are not unfavourable, especially as regards the area Janja-Loznica, into which three good lines of communication lead, radiating towards the Drina. Intercommunication, in the zones of concentration and communication with the country in rear, is by several lines of road which join in Valjevo, and make it thereby an important junction of communications and an intermediate objective for Austria. For crossing the Drina the Servian bridging material at hand at this time would hardly suffice, only two whole and five half bridging trains being available. It is not known however whether these have been since added to, and the procuring of material on the Drina and the Save can be stopped by Austria's Danube flotilla.

As Servian zones of concentration in the interior, the following come into consideration:—Kragujevac, Cacak, the valley basins on the Morava, and Nis. But the last-named areas are at such a distance from the frontier, that they can only be considered in the case of a defensive course of action being pursued from the very first, and this in no way would correspond with the objects sought by Servia.

The Nis-Belgrade Railway is at disposal as a line of strategic deployment against the Danube front. It is a normal gauge single track line of small capacity, with heavy curves and insufficient facilities for watering. When this is considered in connection with the insignificant peace traffic, which makes thorough-going practical instruction of *personnel* impossible, it depreciates the serviceability of the line on mobilization.

Servian Objectives.

As the Servian Army is too weak for an offensive move across the Danube-Save barrier, only Sarajevo can well be regarded as the objective of an offensive stroke, as the loss of this as chief town would particularly injure Austria-Hungary's prestige in the country, and would swell the insurrectionary forces. Irrespective of its resources and billeting accommodation, this zone is also of great importance in that the best communications from the country in rear meet here, viz., railways and roads by Brod, Mostar, and Bugojno, the latter joining up with the steamship route from Trieste and Fiume at Metkovic. For this reason reinforcements can easily be concentrated in this place. The important line of reinforcement could be cut by a raid on the line Brod-Doboj-Sarajevo. The most sensitive points of this line are the railway and road bridges at Doboj, Maglaj, Zepce, Zenica, and in addition the railway runs for the most part on the eastern bank, and the Bosna River offers no absolutely secure protection.

From this statement it is clear that Sarajevo can serve as main objective, somewhat in unison with a Montenegrin offensive, while the railway communications referred to can be considered as the secondary objective.

Conditions for an Offensive Move by Austria-Hungary.

Servia's network of communication is well laid out for any advance either across the Danube, or in a north and south direction, but as regards the lateral communications across the country, there is only one road running right through, a noteworthy fact when considering the supply of war material.

West of the Morava there are two to three means of communication fit for wheeled traffic, and which are important for concentrations of troops, leading from Valjevo and from Kragujevac into the basins of Cacak, Uzice-Pozega, Kraljevo-Krusevac in the south, and into the valleys of the Western Morava. From the Bosnian frontier several lines, fit for wheeled traffic, lead into the zones of concentration already referred to, but these lines are somewhat isolated in consequence of the nature of the mountains. By this converging of the communications from the northern as well as from the western front of the country, supreme importance is attached to the towns of Valjevo and Uzice, as well as to the Morava Valley, with Cacak, Kraljevo, and Krusevac as the foci of an Austro-Hungarian offensive conducted across the Danube and the Save. For the prosecution of an offensive across the Danube, the broad valley of the Morava is centrally situated and stretches right across containing one railway and two, or in places, three roads to Nis affording a very favourable line of advance. Nis is thus of particular strategic importance as an important junction of communications, from which the great connections with Belgrade, Sofia, and Kumanova, and the roads to Pristina and into the Timok Valley, can be commanded.

In the Timok district only two good communications, suitable for wheeled traffic, lead from the Danube to Zajecar.

On account of the system of communications and the geographical conditions already described, it may be supposed that in the case of a war between Austria-Hungary and Servia, the main Austrian force would be assembled in the lower Banat and deployed in the Morava Valley against Nis, and that, parallel with this action, separate and supplementary action would be pursued on lines through Belgrade, Sabac, Lozdica-Bijelina, Rogatica-Visegrad, with Kragujevac-Krusevac-Nis as the objective beyond Valjevo-Uzice.

A diversion by Turkey, for whose entry into the Servian and Montenegrin alliance Servia has striven so hard, is only conceivable against the last-named Austrian line of operation, to which the Turkish areas of concentration of Sjenica, Novibazar, and the Kosovopolje give favourable conditions. The union of Turkey with the Servian-Montenegrin alliance would however force Bulgaria to march on Adrianople, both on account of the obligations entered into with Austria-Hungary and also out of interest for her own preservation. The Servian fortifications on the Austro-Hungarian frontier are of no importance. For an Austro-Hungarian offensive it is worthy of notice that the resources of the country are insignificant, and that therefore an extensive system of supply is required, and this, owing to the military character of the population, renders strong measures for its security necessary.

The Position of the Herzegovina as an Area of Concentration against Montenegro.

The geographical peculiarities of the "Karst" (Eastern Alps), such as great poverty of resources, lack of water and fuel, lack of billeting accommodation, extremely unfavourable sanitary conditions, are particularly strongly developed in the Herzegovina and Dalmatia, as also in the Cernagora (Montenegro). These conditions render the subsistence of troops difficult, and necessitate an extensive system of supply which presupposes, on the one hand, a well-developed network of communications, and on the other—more especially in view of the proximity of an opponent prepared for immediate action—numerous strong points which serve for the defence of the frontier either as places of strategical deployment or as intermediate bases and points of support.

The military measures of the Austrian War Department had therefore in the first place to be directed to the construction of communications, and before all things to the construction of efficient communications with the Monarchy. This resulted in the laying down of the small gauge railway Brod-Sarajevo-Metkovic-Trebinje-Zelenika (Castelnuvo) and its branch lines, and in the improvement of the state of the harbours in Southern Dalmatia. So too the lines of road to Avtovac, Bilek, and Trebinje from the Narenta were constructed by utilizing natural low levels and joining up with the railway and the harbour of Metkovic, and these lines were connected up with each other, as well as with the best harbours, by the roads through Neum, Mostar, Slano, Nevesinje, Ragusa, and Avtovac. For pushing up forces direct from Sarajevo on the Drina into Eastern Herzegovina, a road, suitable for wheeled traffic from Sarajevo to Kalinovic, and the bridle path Foca-Cemernosattel-Gacko, were laid down over the Krblijina, Zargoje, and Morinje.

Austro-Hungarian Lines of Operation and Objectives.

Montenegro is divided geographically into two parts, one the Cernagora—with the regions on the Scutari Lake—and the other the Brda. The former territory embraces the most thickly inhabited and climatically most favourable parts of the Principality, and affords, though in a limited degree, almost the only means of subsistence for the defenders, while it alone possesses good communications with other countries, on whose matérial assistance Montenegro depends. The Brda is an extremely inhospitable country. Thus for an Austro-Hungarian offensive, only the Cernagora need be considered, and in particular the district of Niesic and the lower Zeta. Cettinje as the capital cannot become the objective, as it does not possess the importance ordinarily belonging to capitals. The frontiers of Montenegro only bear the character of obstacles along the Tara-Piva gorge—1,000 mètres deep and in the rocky mountain peaks of the Maglic—the Vlasulja, and the Lebronik, and in the Trebijncica gorge; in other parts the frontier is open, and from the ends of the Duga across the Orjèn towards Bar, it is formed for the most part of ridges of hills 200 to 500 mètres high. At Cattaro, and partly also along the Herzegovinian boundary, the border line runs on this side of the ridges, and thus affords the Montenegrins tactical advantages. The communications leading from the interior of the Monarchy to Montenegro, unite from Foca, Avtovac, Bilek, Trebinje, and the Krivosije in Niksic with those from Cattaro, Budua, and the coast of Spizza-Bar at Rijeka; both these junctions of communications therefore acquire the importance of objectives. They are the Montenegrin centres and are connected by a good road through Podgorica, which facilitates movement of troops by the defender.

An Austrian offensive would have to reckon not with a most extremely tenacious opponent, extremely adept in defence, but also with the difficult peculiarities of the country. According to former experiences of war, this opponent can only be overcome when his country is occupied piece by piece, and so each new move of this mobile opponent in the rear of invading corps is checked. Beside strong garrisons and extensive use of fortification, mobile reserves would have to look after the security of the communications and nip in the bud every attempted concentration of the enemy.

Montenegrin Areas of Strategical Deployment.

Montenegro can concentrate her forces in the depression of the Zeta Valley and in the small areas of concentration lying along the frontier in the middle of the desolate rocky alpine tract, namely, Grahovo, Bukovica, Cettinje, Rijeka, Virpazar, and in the coastal plain of Bar (Antivari).

From here communications lead across the mountain ridges, forming the boundary through the Dugafurchen, then by Trepca Grahova Cettinje (road and bridle path), Maini Sutomore, which could partly be made fit for wheeled traffic.

A Montenegrin offensive with Mostar as objective, as well as co-operation with Servia across the Sandjak of Novibazar, or Foca-Kalinovik, is sorely prejudiced by lack of means of reinforcement. An offensive against Spizza would offer much the better chances, as this line of operation is of little length, and some resources are to be had on the coast. In an undertaking against Spizza, Montenegro would have to reckon on a counterstroke by the Austro-Hungarian fleet.

Montenegro has to reckon with a concentric invasion by Austria-Hungary's forces, and as the Austrian force would be increased by 100,000 men, the Principality has practically no chance of assuming the offensive. All the fortresses on the Herzegovinian frontier, such as Bilek, Trebinje, Gacko-Avtovac, Kalinovic-Trnovo, have been furnished lately with garrisons up to a total of 10,000 men, and with a large supply of war material.

It is worth while expressly emphasizing at this point the fact that Austria-Hungary has no intention whatever of moving out from her waiting position; the military measures taken are only measures of prevention. A great Power of the standing of the Austro-Hungarian monarchy could not allow matters to come to such a point as to expose herself to defeat by such small States as Servia and Montenegro.

That Turkey would take up arms against Austria can only be regarded as very improbable. A move by Turkey is only conceivable from the Kosovo, and from the Sandjak of Novibazar, but as observed at the commencement, the Austro-Hungarian War Department has taken sufficient precautions even for this certainly improbable eventuality.

E. G. WACE.

HUNGARY
BANAT
SYRMIEN
POSAVINA
BOSNIA
HERZEGOVINA
SERVIA
NOVIBAZAR
MONTENEGRO
BRDA
KOSOVO
TURKEY
R. Danube
R. Save
R. Morava
R. Drina
R. Zeta
R. Tara
Temesvar
Esseg
Neusatz
Slankamen
Pancsova
Semlin
Belgrade
Weisskirchen
Bazias
Gradiste
Orsova
Semendria
Sabac
Brcka
Bijelina
Janja
Lesnica
Loznica
Zvornik
Valjevo
Brod
Doboj
Maglaj
Tuzla
Zepce
Zenica
Bugojno
Vlasenica
Srebrenica
Kragujevac
Sarajevo
Rogatica
Praca
Visegrad
Uzice
Pozega
Cacak
Kraljevo
Krusevac
Zajecar
Timok
Nis
Trnovo
Gorazda
Kalinovik
Foca
Mostar
Nevesinje
Cemerno
Gacko
Avtovac
Metkovic
Neum
Sjenica
Novibazar
Bukovica
Duga Pass
Bilek
Niksic
R. Trebinjcica
Trebinje
Slano
Ragusa
Castelnuovo
Ielenika
Cattaro
Cetinje
Bukovica
Podgorica
Rijeka
Skutari Sea
Budua
Virpazar
Spizza
Antivari
Pristina
Kosovo Polje
Kumanovo
18° 19° 20° 21° 22° 23°
45° 44° 43° 42°
Scale 3600000 or 1·03 Inches to 48 Miles
Miles 10 5 0 10 20 30 40 50 60 70 80 90 100 Miles

NOTICES OF MAGAZINES.

Bollettino della Societa Aeronautica Italiana.

December, 1908.

The first article is a continuation on the subject of the winds in Italy, and deals with the south and western corner. These compilations are of very great use to those making a study of the subject, but are of no special interest to others.

In the second article there are a few notes on aeroplanes, dirigible balloons, and light motors; also an excellent outline drawing of the German military balloon—"Dirigible Gross-Basenach." This is described in the last copy. The photographs of the motors are of little value, being merely as seen from the outside.

The third article gives the rules for the Monaco Meeting, 24th January to 24th March, 1909. This meeting is only for heavier-than-air machines, which can be started in any way preferred. The course to be run seems a dangerous one over the sea, from the Mole at Monaco to Cape Martin and back, a distance of about 6 miles. The course must be run three times on three different days. Any number of trials may be made, and the prize will be given calculated on the basis of the least time in completing the course during the three best trials.

1st prize	£3,000
2nd "	£1,000
3rd "	£400
Entrance	£4

Note is made of the following prizes open to aviators:—

The "Ruinart" prize open to the 1st of January, 1910—£500. To be run only on Saturdays and Sundays, crossing the Channel either from England to France or *vice versâ*.

The "Gordon-Bennett" Cup of £500, and three prizes amounting to £1,000 for aeroplanes probably on a circular course.

Nice has arranged for a meeting in which the prizes amount to £2,000.

The fourth article has a good description of the Wright Brothers' machine, which is of course well known now.

In the fifth article calculations of the resistance of ogival-headed dirigible balloons. Numerous experiments made in the United States by the French authorities demonstrate that the "coefficient of shape" is proportional to the mean value of the sine of the angle which the tangent at the extremity of the projectile forms with its axis.

The exact shape of the head of the projectile appears to be of less importance than the proper formation of that portion which is in rear of the greatest diameter.

The sixth is a useful article with photos on the construction of a cannon for use against balloons. The author says that the cannons already in the Service are quite insufficient. It will be necessary to have a number of special cannons at favourable points, bridges, harbours, docks, etc., and also to have movable armament on automobiles. He is of opinion that to reconnoitre accurately from a dirigible balloon you should not be more than 10 kilomètres off, or more than 5,000′ high. He lays down the following conditions which govern the construction of a special cannon:—

It must have unlimited power of traversing horizontally and vertically, and can be mounted on a pivot on a fixed base or on a wheeled carriage.

Photos are given of the 6·5-cm. Krupp cannon, which is ingeniously situated so that the wheels can be placed with their axles pointing to the trail of the cannon, allowing very rapid traverse of the whole machine. Special arrangements must be made for the recoil.

The damage to a balloon can be either perforation of the outer envelope, leading to large escape of gas, or possibly ignition of the gaseous mass. Damage may also be done to the motors, to the screw, to the controlling planes, and other fragile parts, and also to the ballonnets of the semi-rigid and non-rigid systems. The maximum damage will be done if the shell bursts inside the balloon, for the envelope will be rent to ribbons and the remains will crash to the ground.

The author further suggests that some chemical substance might be carried in the extremity of the projectile itself which would ignite the hydrogen on contact.

Observation being of the greatest importance, accurate observation instruments must be used. Mechanical aids to calculation are of the first importance, in order to correct the ranges while the balloon is well within range.

The Krupp gun throws a projectile which leaves a trail of smoke behind it, and this makes the trajectory easy to observe. It weighs as much as an ordinary field gun.

There is also a special supplement devoted to spherical sporting balloons, but this is of no particular interest.

'J.E.C.'

Internationale Revue über die gesamten Armeen und Flotten.

The Defence of Coasts and Harbours according to the Teachings of the Russo-Japanese War.—Capt. Bracht, of the Prussian Foot Artillery, has published a series of interesting articles on this subject in recent numbers of the *Militär Wochenblatt*, basing his observations chiefly on a paper on coast armament by M. Treidler in the *Russian Artillery Journal*. The following extract is interesting:—

"As is proved by the history of maritime wars, especially during the last 50 years, the defence of coast fortresses possesses a much greater importance from the point of view of the results of the campaign, than the defence of those situated in the interior. The loss of a maritime fortress often decides the fate of the whole campaign, as was the case at Sebastopol, Charlestown, Alexandria, and Port Arthur. Now the defence of such fortresses as these rests almost entirely on the action of the coast artillery, which has to perform the following tasks:—

1. To prevent the hostile fleet from gaining possession of the fortress by main force, *i.e.*, from forcing the entrance of the harbour after having reduced to silence the coast batteries of the defence.

2. To afford an assured refuge to its own fleet in the event of the enemy obtaining command of the sea.

3. To prevent the enemy's fleet from bombarding at a long range the stores, magazines, docks, etc., of the fortress.

4. To prevent the hostile fleet from basing itself on neighbouring harbours, either for operations at sea or for disembarking troops, and thus to render a blockade of the fortress from the land side impossible."

The author considers that though existing coast defences are generally sufficiently powerful to repel the attacks of an enemy's fleet, still they are rarely pushed sufficiently far out to prevent the effective bombardment of the place from ranges of 9,000 to 11,000 mètres (say $5\frac{1}{2}$ to 7 miles). It must not be forgotten that the range of naval ordnance is constantly increasing, and consequently coast batteries should be sited even further away from the nucleus than present conditions make absolutely essential.

The works should be arranged in two lines; the outer line—the object of which is to prevent the hostile fleet from penetrating by force into the harbour—should be armed with guns of large calibre and of long range so as to keep hostile vessels at a distance. Heavy mortars will find their place in the second line.

The part played by coast artillery does not depend solely on the targets presented to it, but also on the effect which is produced by the projectiles which are selected and on their destructive power. It was proved at Port Arthur—and at Tsushima – that vessels are put out of action and even sunk, not merely by projectiles which pierce the armoured belt, but also by other projectiles which strike the vessel above the water line; that is to say in general by those projectiles which destroy or damage the weakly protected or unprotected portions of the superstructure. The essential requirements of this superstructure are that it should be able to resist water which may penetrate by holes pierced above the water line, and that it should not readily catch fire. We shall see further on, that the most effective means of reducing battleships is by setting them on fire.

Before the Russo-Japanese War there were two opposing schools of thought regarding the methods that should be adopted in order to destroy armoured vessels. The one, basing its opinions on the experiments carried out against the *Belleisle*, maintained that the armoured belt must be pierced, at or below the water line, by the aid of an armour-piercing shell provided with a small bursting charge; the other held that the greatest effect would be obtained by the use of long shell provided with large bursting charges, which would be directed against the superstructure, and which would not be intended to pierce the belt or damage the engines and boilers. The English adhered to the opinions of the first of these schools, whilst the French and Russians concurred with the second. Nevertheless during the war the Russians used armour-piercing shell with small guncotton bursting charges exploded by percussion fuzes, the action of which was so much retarded and so insensitive that frequently they failed to burst even after passing through light armour.

On the other hand, the Japanese vessels were provided with high-explosive shell of large capacity, the weight of the charge amounting to 9·5 per cent. of the total weight of the shell, and with very sensitive fuzes, which were not retarded.

The experiments carried out against the *Belleisle* in 1900 led all nations—except Russia—to adopt lyddite or mélinite shell.

The lessons to be drawn from the battle of the 28th July, 1904, off Port Arthur are that the injuries caused by shell, the fuzes of which are not retarded, are the most dangerous, because :—(1), It is very difficult to close the holes made by them in the sides of a vessel, as these holes are of large dimensions and their edges are turned in towards the inside of the vessel. Thus the water enters in very large quantities when the ship rolls and when the hole is situated a little above the water line; (2), the damage caused to the interior of the structure is necessarily greater, because not only the fragments of the projectile, but also pieces of the side of the ship—sometimes 10 square feet in area—were violently projected into the interior with their rivets, bolts, etc. It appeared that only a very small part of the force of the explosion was expended along the side of the hull, by far the greater portion taking effect on the interior. Another lesson is that it is necessary to employ projectiles which injure the motive power of the vessel, *e.g.*, projectiles which riddle the funnels, rather than shell, which after having pierced the belt can damage the interior of the vessel.

The Battle of Tsushima demonstrated in an even more striking manner the superiority of high-explosive to armour-piercing shell. The *Oslabia*, *Souvarow*, *Borodino*, and *Alexander III.* were put out of action and sunk, because the high-explosive shell destroyed everything above the water line. The torpedo boats did not give the *coup de grâce* until after the above-mentioned vessels had been destroyed by gun fire. Eye-witnesses declare that at Tsushima the Russian battleships were wrapped in a dense shroud of flame and smoke, caused by the fires which had broken out on board them.

The Battle of Tsushima has proved anew that the active power of a vessel, or of a fleet, as well as that of every coast battery, depends not on its armour, parapets, or traverses, but solely on the power of its fire, which is dependent not merely on the calibre, range, and rapidity of fire of the guns, but also on the destructive force of its shell, measured not only by their momentum, but by the explosive energy of their bursting charges.

It was not the superior speed of the Japanese ships, nor their armoured protection, nor the excessive loading of the Russian vessels, nor even the superiority of the Japanese in *personnel*, *matériel* and number of guns of medium calibre, which decided the naval battles in Asia, but solely the torpedo shell with large bursting charges, which was opposed only by armour-piercing shell, and shell with small bursting charges.

The bombardment of the harbour of Port Arthur showed that the efficacy of naval as well as of coast artillery does not depend on its power of discharging the maximum weight of metal in a given time, but on its being able to discharge projectiles provided with very large bursting charges of very powerful explosives.

The following important conclusions regarding the armament of coast defences may be deduced from the events of the war:—(1), The principal projectile should be the high-explosive shell; (2), the proportion of common shell need not be great; (3), armour-piercing shell should be done away with; (4), the armament may be divided into three classes, heavy, medium, and light. Mortars may be employed in the second line; (5), all long-range guns should be provided with telescopic sights; (6), medium and light guns should be quick-firers.

History shows us that the majority of maritime fortresses have fallen before an attack from the land side. If the neighbouring bays and harbours had been commanded by high-angle fire batteries—established under cover from the observation of the enemy—the hostile fleet would have been unable to have entered them, and the contest between this fleet and the batteries would have offered no prospect of success to the former. It is not sufficient to close these bays by means of mines, as was proved at Dalny. It is absolutely indispensable to construct batteries in order to deny them to the enemy, and the best armament for them consists of mortars or howitzers having an all-round arc of fire, supplemented by gun batteries where the ground is suitable. The 28-cm. (11") howitzer is a suitable weapon, and may be installed at a distance of 2½ to 5 miles from the bay or harbour that is to be defended. It will suffice to shelter these howitzers in stores or sheds close to the place where they will be required. The sheds should be connected with the batteries by lines of rail, so that the pieces may be mounted very rapidly. All the batteries of the fortress should be connected in the same manner. The trucks used on these lines should have a carrying capacity of 30 tons.

Maritime fortresses must be protected on the land side by chains of detached forts, provided with bombproofs capable of keeping out the shells of the 11" howitzer. They must be armed with howitzers firing high-explosive shell and shrapnel, and should be sited—not on commanding points—but in places where they are completely screened from hostile view.

All the harbours close to a maritime fortress should be defended by at least one battery, which may be armed either with obsolete guns or with guns taken from the ships of war. Such batteries will often prevent any attempt at a landing, and no landing is possible unless a harbour is available. The guns and ammunition may, if necessary, be stored in the fortress itself, and the batteries may be constructed by the engineers during their annual periods of training.

The internal communications of a coast fortress are of primary importance, and must include a complete system of telephones, telegraphs, and railways, connecting every portion of the defence. Wireless telegraphy should be installed.

Preparations must be made in peace time for an active defence. The ill-success of the Russians both at Sebastopol and Port Arthur was due chiefly to the passive character of the defence of those places.

'M.'

JOURNAL DES SCIENCES MILITAIRES.

December 15th, 1908.

The discussion on the reorganization of the infantry and artillery is continued. Opinions are very diverse, and a great deal of the matter is either repetition or of little interest. The following are some of the opinions expressed:—

The 1905 law diminishes the peace strength of the army by 45,000. A battalion over 1,000 strong is unmanageable. If corporals are done away with it will be necessary to endow the senior soldier in each squad with authority to keep order in the room, as the sergeants who are in command of squads will not live in the barrack rooms. An officer should be attached to the colonel to look after official correspondence.

The most difficult question to solve seems to be how the frontier can be effectively guarded during the critical period from September to January, *i.e.*, while the recruits are not fit to take their places in the ranks. Another difficulty is how to officer the reserves when called up.

Cyclist battalions are recommended.

Turning to the artillery, it is said to be impossible for one man to command 6-gun batteries under fire, and if it is necessary to have 6 guns therefore they should be subdivided into 3-gun sections. The proposal to cut down the cavalry so as to increase the number of horses available for the artillery, is met by suggesting the extensive adoption of motor transport for artillery parks. Another correspondent summarizes the arguments in favour of 4-gun batteries, as (i.) after seven years' experience the artillery have become well acquainted with them, (ii.) they are quite large enough for one man to look after.

The German 1908 War Budget is subjected to detailed examination. An experimental company is to be added to the balloon battalion at Berlin. Civilian workmen are displacing military in the storehouses, setting free 500 men for field service. £40,000 is to be spent on motor wagons. A debate was held in the Reichstag on the advisability of reducing the cavalry service to two years. Arguments in favour of it were that cavalry and horse artillery were well enough trained in one year, otherwise the one-year volunteers ought to be entirely done away with; the critical state of the French cavalry was due to not taking measures to ensure the re-engagement of enough men. The answer was that the presence of men in their third year was essential for training horses, patrolling, and providing enough N.C.O.'s.

A further instalment of "Souvenirs of Casablanca" gives an account of a cavalry fight on February 18th, 1908.

January 1st, 1909.

The discussion on infantry and artillery organization is continued, and the "Combat of Rfakha" in Morocco is concluded by the account of the pursuit and bivouac. The author of the "Decisive Attack" sums up his conclusions as follows:—(1). No attack is possible until such a superiority of fire has been gained that the hostile artillery and infantry are incapable of acting on the chosen zone of attack. (2). The most favourable zone of attack is that in which, owing to the configuration of the ground, the assailant can bring into action more guns and rifles than the defender. (3). Perfect combination between infantry and artillery is necessary. (4). The attack should be in three lines—(*a*), a line of skirmishers and supports to maintain fire superiority and to deliver the assault; (*b*), a line of columns in closer formation, so as to relieve the first line on the captured position, to follow up the success, and to support the threatened flank against hostile counter-attacks; (*c*), a general reserve. (5). The bulk of the cavalry should maintain close connection with the threatened flank, act against counter-attacks by enfilade fire, and lose no chance of transforming into a rout any wavering on the part of the enemy.

A final article on the infantry machine gun considers the tactics which it should employ. Machine guns can never take the place of the living element and intelligence inherent in infantry, and the flat trajectory prevents their being fired over the heads of their own men, as can be done when using artillery. Their only chance of reaching the firing line in attack is due to the slowness of its movements. In the attack machine guns will be used to strengthen important points which have already been seized by the infantry, and which may be used as rallying points in case of a repulse. When the attack is successful, they will hurry forward to the conquered position to join in the fire which will be brought to bear on the flying enemy.

On the defensive, with the ranges measured, machine guns will be most effective. They will be most useful on false fronts in advance of the true line, and on the real front will be used either to search the openings of the roads along which the enemy is advancing or to occupy the salients of the position, and to sweep dead ground. But they should be kept under cover from fire till wanted, so as to prevent their premature destruction by the hostile artillery. They add considerably to powers of resistance of the advanced guard, and will have to join in the sacrifices made by cavalry and artillery when acting as rear guard to beaten infantry. In night fighting machine guns—laid by day on important points—will be far more effective than random rifle fire would be.

In attacking a position defended by machine guns artillery must endeavour to knock them out, or in any case to raise such a cloud of dust and smoke before them as to render aimed fire impossible. The infantry may then advance in safety provided the space just in front of the machine gun is left empty in case of random fire being opened.

In the *Military Month* is an account of a new model of the present field gun. The weight is reduced from 4,000 lbs. to 3,400 lbs. The force of recoil opens the breech and ejects the empty cartridge case, and the action of loading shuts the breech. Five men can work it, in place of six, and the shield is larger.

January 15th, 1909.

An article on the intellectual instruction of infantry officers opens by emphasizing the necessity for careful preparation for war. The German regulation that "The main strength of an army lies in its constant preparation" is quoted. It is most desirable to have unity of doctrine, as in the case of the Germans at Spicheren, where three generals followed each other in the command, and yet all pursued the same course. At Sedan, on the other hand, the three French commanders held widely differing ideas.

The commander must see clearly the end in view when he undertakes any operation, and direct all his strength to attaining it. The object of Mistchenko's famous cavalry raid on Yinkow was to destroy the Japanese magazines. Why then did he drag an enormous convoy with him and waste time in attacking villages whose capture was unnecessary?

In issuing orders, no more than the objects to be attained should be given. It is the duty of the subordinates to find the means.

To only half obey an order is a worse offence than to disobey, as it makes a commander imagine his orders are being carried out. The conduct of de Failly in 1870 is instanced. Owing to his supineness in carrying out perfectly clear orders he first of all caused the defeat at Froeschwiller, and then was surprised and had his corps practically put out of action at Beaumont.

Initiative is particularly necessary with modern extensions. It does not suddenly spring into existence on the battlefield, but must be cultivated in peace time. It becomes independence when a subordinate acts for his own advantage and not for that of the whole, and such acts should be put down. Indiscipline is voluntary, and in war time is a crime. Solidarity is the fourth military virtue, which sets in action all the others. It consists in an unselfish devotion to attain the common end and was strongly marked both in the Germans in 1870, and also in the Japanese; in Napoleon's armies it was rather weak. Dragomiroff sums it up in the remark "Perish, but save your brother."

A company of cyclists was employed during the divisional manœuvres of the 20th Corps in 1907. Details of three days' work are given. The chief conclusion arrived at is that, without cavalry, cyclists are practically useless. They are poor scouts as most of their attention is occupied by their machines, especially when riding against a head wind or on a bad road. The numbers of a cyclist company are so small for a detached force as to make any detachment—even for security—very serious. Flank protection is difficult. If a detachment is sent out to follow a parallel road a mile or two off it seriously weakens the main body; and if an infantry flank guard is used, the advantage of pace is lost. On the whole cyclists are quite useless as cavalry substitutes; without cavalry they cannot avoid a dangerous dispersion. Their use seems to be as supports for cavalry, thus enabling the latter to remain mounted and seize opportunities which would be lost if some of the squadrons were in the firing line.

A Russian fieldworks manual has just been issued. Infantry are to be capable of simple works and of working telephones. A certain number of infantry officers and men are attached to sapper companies in summer for instruction. Great attention is paid to the concealment of trenches.

The manual is in three parts, for soldiers, N.C.O.'s, and officers. Only the first two parts have so far appeared. The part for the men is free of all figures and superfluous details; simple diagrams show the common forms of trench for fire when standing, kneeling, and lying down. Numerous traverses are necessary to protect against H.E. shell fire and enfilade; bombproofs, covered communication trenches, and shelter for reserves are also mentioned. Trenches behind the firing line may be necessary for use while a bombardment is taking place.

The N.C.O.'s manual gives more detailed descriptions of the trenches, and draws attention to siting of trenches so to avoid dead ground. Very low parapets not exceeding 18″ are shown. A berm half-way up the interior slope of trenches is provided, so as to facilitate the delivery of counter-attacks. Head cover is suggested. Obstacles are to be 50 to 75 paces in front of the trenches.

Redoubts of higher profile are to be established on important points. Protected look-outs, bombproofs, and machine-gun emplacements are to be prepared. Numerous traverses are required inside to localize the effects of shell bursts.

Latrines, inclined entrances for supports, and special shelters for reserves are to be provided.

H. L. WOODHOUSE.

LE BULLETIN.

November 30th, 1908.

INTERNATIONAL LAW.—*Russo-Japanese War (continued).—Siege of Port Arthur (continued).*—An interesting note on suspension of hostilities for the removal of dead. It appears that up to the beginning of December, 1904, no armistice had been sought or granted for the purpose of removing the dead in the neighbourhood of the permanent forts. Their number must have been considerable, as Colonel de Grandprey says that the fourth general assault on November 26th cost the Japanese 12,000 men. The first advances were made by the Russians in the counterscarp galleries of N. Kikouan, which had been subjected to four assaults lasting six hours. Arrangements were made, apparently without consulting superior authority, for a suspension of hostilities on December 2nd at this fort. The Japanese dead were brought out by the Russians and placed about 15 yards in advance of the trenches. The relations of the two sides during this scene are said to have been most cordial, although a few miles to the west a furious battle was raging for the possession of

203-Mètre Hill, captured three days later. Afterwards the matter of concluding local armistices was left to divisional commanders.

The text of the capitulation of Port Arthur is given; the most noteworthy provisions were those including Government officials in the number of prisoners of war (due to the semi-military status of Russian officials), and giving permission to the officers of the garrison to wear their swords; this was apparently incorrectly rendered into English, and should have read "retain" instead of "wear." Subsequent confusion was caused by the Russians maintaining their right to wear their swords in Japan.

FIELD SERVICE REGULATIONS, GERMAN ARMY.—*Reconnaissance.*—There is little of note under this heading. The regulations seem to favour the use of infantry officers' patrols—for artillery officers' patrols are the rule.

December 15th, 1908.

INTERNATIONAL LAW.—*Russo-Japanese War (continued).*—Further remarks on the siege and capitulation of Port Arthur deal with the question of the civil population (non-combatant); at the time of the capitulation there were 6,000 Russian inhabitants, and 55 of other nationalities in the town. Their property was respected, and they were free to leave the fortress. As however the majority of them desired to go, the arrangements made to despatch them by junk from Pigeon Bay at their own expense were found impracticable. The Japanese then undertook to provide them with free railway and steamboat passage, at first from Chang-Ling-tse *viâ* Dalny to Cheefoo, and later on from Port Arthur itself. From January 20th an emigrant train left Port Arthur daily for Dalny and Cheefoo. When all arrangements had been made for placing the fortress in a state of defence against the Baltic Fleet, it was decided to send away all remaining foreigners.

The article concludes with a note on martial law. This was never generally proclaimed by the Japanese, partly to avoid giving offence to a neutral power, partly because of the difficulties in applying it to various cases. All illegal acts on the part of the inhabitants were dealt with on their merits. However much there is to be said for this decision, it cannot be denied that the proclamation of martial law has a moral effect in itself which tends to prevent the occurrence of such acts. A list of the principal offences dealt with include tampering with payment vouchers, making trenches, and trafficking in opium. As regards courts-martial, it is noted that the fundamental difference is that in the field the accused is presumed guilty, and the burden of refutation rests on him.

December 31st, 1908.

GERMAN FIELD SERVICE REGULATIONS.—Under "Protection" it is laid down that outposts in contact with the enemy are responsible that this contact is not lost—even if the enemy alters his position by retiring by night for instance. This seems to be demanding a good deal from infantry outposts. On the march outposts are furnished on halting, without further orders, by the advanced or rear guard.

FOREIGN MILITARY INTELLIGENCE.—It is interesting to compare German recruiting statistics, 1907, with those for France given in *Bulletin* of November 30th:—

Unfit for military service ...	Germany	2·85 per cent.	
	France	19 ,,	
		No.	Per cent.
Unable to read or write ...	Germany	39	or 0·025
	(Prussian cont. of 151,900)		
	France	11,062	or 3·53

France.—Infantry and cavalry regiments are to be at once supplied with machine guns (four per regiment).

'E.R.'

REVUE DU GÉNIE MILITAIRE.

December, 1908.

THE BALLOON AT CASABLANCA.—A balloon section for service in Morocco was formed in August, 1907, and arrived at Casablanca on the 7th September. At the time the French had no reliable information as to the position of the Moorish forces in the neighbourhood. On the 10th September the observers in the balloon discovered a Moorish camp of 640 tents at Taddert, some 10 kilomètres from Casablanca. They were also able to report that there were no other camps within a radius of 15 kilomètres. Acting on this information, the French moved out on the 11th September and destroyed the Moorish camp. After this ascents were only made at night, so as to avoid warning the enemy. On the 15th September the balloon discovered a camp of 700 tents at Sidi-Brahim, and on the 21st September the French destroyed this camp also. The ascents were made with great difficulty owing to the heavy wind. The balloon was out of action from the 14th October to the 8th November, as all the gas had been used and the fresh supply had been delayed by floods in the south of France. On the 11th November a new camp of 300 large tents was discovered at Sidi-Aissa, at a distance of 27 kilomètres, and it was ascertained that this was the only camp within a radius of 35 kilomètres. Night observations were now useless, as the distances were too great to observe the Moors' camp fires. About this time a number of ascents were made to try to locate Abdul Aziz's last army—under the command of Bagdadi—which was expected to enter the zone of operations, but it was defeated and dispersed some 50 kilomètres from Casablanca. The section also provided a signal balloon which was sent up as required. On the march the signal balloon was kept fully inflated, the rope being made fast to a mule. In January, 1908, the balloon supplied the first information that the transport *Nive* had run ashore some 9 kilomètres from Casablanca. The balloon section attempted to send a line on board by means of kites, but without success. At a later date the balloon section accompanied several mobile columns. The conditions under which it was compelled to work were disadvantageous, as the columns never halted long enough to permit of proper observations being taken. Some officers objected to the presence of the balloon, because, they complained, it warned the Moors of the approach of the column. But it is doubtful whether the appearance of the balloon gave them any information which they did not already possess.

AERIAL PHOTOGRAPHY.—A description of an apparatus used for taking photographs from a kite. The camera can be turned to any required vertical or horizontal angle without bringing the kite down. This is effected by electrical apparatus. A series of eight exposures can be made. The plates are placed one behind another at the back of the camera, and after each exposure is made the exposed plate falls face downwards into the bottom of the camera.

J. E. E. CRASTER.

REVUE MILITAIRE DES ARMÉES ÉTRANGÈRES.

December, 1908.

The article on the military use of skis is continued.

In Germany the ski is used by the 18 rifle battalions and by certain infantry regiments garrisoned in mountainous regions. The number of trained men per rifle battalion varies; only 12 pairs of skis are provided per battalion. The officers and N.C.O.'s—who are expected to teach their men—are recommended to buy *Der Skilauf* (a book on ski-ing), as no military textbook on the subject is published. In the Black Forest and the Vosges, the troops are allowed to take part in the competitions organized by the "Ski-Club Schwarzenwald" and the "Ski-Club Vosgien," which include reconnaissance and long-distance races.

In Austria about 20 to 50 men per brigade or division are trained by a lieutenant. In 1908 a special ski course for officers was instituted with the object of training good instructors. The course lasted five weeks, the last six days being devoted to a march in high altitudes. The best ski-runner in Austria—M. Zdarsky—was attached to the director of the course, as technical adviser.

Military competitions are organized regimentally for soldiers, and officers and N.C.O.'s are allowed to take part in the annual competition of the "Touristen-Club." In Italy each Alpine company must have three trained ski-runners (*sciatori*), who are specially trained (1), in scouting; (2), as orderlies; (3), in the occupation of advanced positions; (4), in protective duties. Hitherto the skis have been of Swiss make, but they are now being made regimentally. A cup was founded in 1907 to be competed for annually. The winners of 1908 travelled over the 10 kilomètres, with a difference in level of 700 mètres, in 1 hour 45 minutes. They wore uniform and were in marching order.

In Switzerland the training is very complete, and annual courses are organized which last from 8 to 10 days. The course is partly tactical and partly technical. In 1907—1908, 316 officers and N.C.O.'s were trained, and a grant of 20,000 francs was made for this purpose. All mountain troops would, in case of mobilization, be provided with skis; actually however only four battalions are equipped with 20 pairs of skis, 20 pairs of rackets, and 20 pairs of "snow planks" each.

An annual competition is held at Engelberg. The competitors are divided in two classes—(1), 9 officers; (2), 14 N.C.O.'s and men. The course is 4 kilomètres long, with a difference in level of 300 mètres. During the race the officers have to fire six rounds at a kneeling figure 40 mètres away, and the N.C.O.'s and men eight rounds at standing figure 200 mètres distant. The best times for 1908 were:—Officers, 46 minutes; N.C.O.'s, 44 minutes.

In the United States and Japan there are no regular exercises, but in the former case practice was carried out by the cavalry at Yellowstone National Park in 1907, and, in the latter, in the Island of Yezo during the winter 1904—1905.

Details of the skis and of the various courses are appended to the article.

A mobile search-light detachment in Holland consists of one wagon for the projector and one for the dynamo and motor. The motor is a petrol 9—12-B.H.P. engine and carries petrol for 10 hours. It can drive the back wheels of the wagon. The projector is 26 million c.p. strong and requires 45 volts. The light is ready for use 15 minutes after taking up a position.

The subject of military ballooning in Germany is continued from the October number.

German dirigible balloons can be divided in three classes.

(1). The non-rigid (*umstarr*) or Parseval system, in which the shape of the balloon is maintained by the internal gas pressure.

(2). The semi-rigid (*halb-starr*) or Gross system, in which the gas bag is fixed to a light metal platform, from which the car is suspended.

(3). The rigid (*starr*) or Zeppelin system, in which the gas bag is stretched over a metal skeleton shape, and which is filled with several smaller gas bags.

These systems have their various advantages and disadvantages. The first is the simplest to transport as the balloon is easily emptied and carried in a small number of carts. It can land anywhere and dead weight is reduced for a minimum.

The rigidity of the Zeppelin type greatly facilitates its steering, but increases its dead weight and the difficulty of transporting the balloon when empty. Moreover if assailed by a tempest whilst on the ground the balloon rapidly becomes unmanageable. It also can only land on water. The Gross system can land anywhere, and although less easily portable than the Parseval type it has none of the inherent defects of the Zeppelin.

The Parseval balloon was first thought of in 1901 by Major von Parseval, and was intended to be a dirigible balloon for use in the field, capable of attaining a height of 2,000 mètres, and of carrying three persons for 10 hours. The first successful trial took place in 1906. The balloon had attained its object. It was bought in October, 1906, for £6,500, by the "Motorluftschiff-Studien Gesellshaft," which perfected it.

The peculiarities of the system are :—

(1). The presence inside the main gas bag of two smaller ones, which are filled with air as required, and thus serve to elevate, depress, or keep the balloon level.

(2). The suspension of the car, which allows of its sides always remaining vertical.

(3). The use of a *non-rigid* propeller, which only becomes taut when the propeller is revolving.

The following are the data of the second Parseval balloon :—

(1). Lifting force = 3,800 kilogrammes.

(2). Capacity of air bags = 1,200 cubic mètres.

(3). Weight of gas bag = 750 kilogrammes.

(4). Weight of motor, propeller, etc. = 1,300 kilogrammes.

(5). Weight of water, benzine, and oil = 400 kilogrammes.

(6). Weight of ropes, guide ropes, and odd fittings = 400 kilogrammes.

Thus 800 kilogrammes remain for passengers and ballast. All the journeys were made with five to six passengers. After a final trial run on the 28th of November, 1908, the Parseval balloon was bought by the military authorities.

In 1905, owing largely to the success of the French dirigible, "Lebaudy II.," the German Government resolved to undertake privately the construction of an airship. Major Gross, Commandant of the "Luftschiffer-Batallion," was charged with its construction.

The history of the first flights of this type and the German arguments against the accusation of having copied the "Lebaudy" are given at length in the article. It is finally stated, as a result of experience, that wireless messages can be received, but not sent from a dirigible airship.—(*To be continued*).

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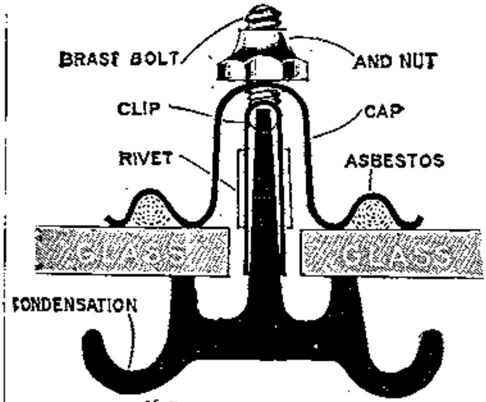

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