THE ROYAL ENGINEERS JOURNAL.

Vol. XXIII No. 3. MARCH, 1916.

CONTENTS.

Abbreviated Notes on MILITARY ENGINEERING.

CONTENTS.

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Sixth Impression just published. Corrected to 1st January, 1916.

Price 6d. per Copy, Cash with Order.

SECRETARY, R.E. INSTITUTE, CHATHAM.

CONTENTS

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TELEPHONES.

By Sir William Slingo.

By the kind permission of the Council of the Institution of Post Office Electrical Engineers we are enabled to reproduce the following address on "Telephones" by the President of the Institution, Sir William Slingo:—

One of the most remarkable features in the history of modern electrical engineering is the extraordinary development of the telephone service throughout the world. In Great Britain the telephone service dates from 1879, when the first Exchange was established in London by the Edison Telephone Company. Other companies licensed by the Postmaster-General commenced operations in 1880, but several of the earliest exchanges in the provinces were established by the Post Office in 1881 and 1882.

The development of the local exchange systems subsequent to 1882 and up to 1900 was due to the enterprise of the companies which were ultimately absorbed by, and consolidated in, the National Telephone Company. The amalgamation of the various companies which was completed in 1890 represented a capitalization of over three millions sterling.

The telephone companies had operated each in its own territory, and there was practically nothing in the way of competition between them. They had erected a number of inter-city lines, but there was no long-distance service as we now know it until the Post Office commenced the construction of the backbone trunk lines in 1892. Most of these lines were completed and working in 1895. In 1896 the Post Office acquired by purchase the trunk lines owned by the National Telephone Company, and the nucleus of a comprehensive long-distance service covering the whole country was formed.

The efficiency of the backbone lines was of the highest grade. Copper conductors weighing 1,600 lbs. per loop mile were used for the longest and most important circuits; for example, the London-Glasgow, London-Leeds, Leeds-Glasgow, Leeds-Carlisle and Belfast-Dublin. Conductors weighing 1,200 lbs. per loop mile were used for the secondary circuits such as Cardiff-Birmingham-Newcastle, and Liverpool-Glasgow; while, for the shorter lines such as London-Ipswich and London-Brighton, conductors of 800 lbs. per mile of loop were erected. These backbone trunks were provided as nominal aerial lines throughout; *i.e.*, the amount of underground was kept as small as was considered possible.

Mention should be made of the London-Paris telephone service which was inaugurated in 1891. There were two circuits consisting of aerial lines of 1,600 lbs. per loop mile on the English side, and 1,200 lbs. per loop mile on the French side. The submarine section was a 4-core cable, each core consisting of 300 lbs. gutta percha and 160 lbs. copper per nautical mile.

The growth of the trunk system since 1896 has been rapid, but it is feared that in providing additional trunks and extended communications, the weight of copper in the aerial lines was for some years rather under-estimated. A more serious point was that the detrimental effect of leading-in points and underground sections was not fully appreciated, with the result that some of the plant erected in the years immediately following 1896 does not meet present-day standards; and this apart from any question of physical deterioration. Other causes have also operated to render line plant, provided many years ago, comparatively less efficient than it was when first erected, even though it may have been meanwhile properly maintained. Twenty or thirty years ago exchanges generally were of a very simple type, the cord circuits were void of complication and the subscriber did more work than now in effecting and clearing a call. The growth in size of local and other exchanges and the greater facilities now given the public, combined with a constantly increasing tendency to "speed up" the service, have involved the provision of very complex cord circuits in exchanges so as to provide for automatic calling and clearing by subscribers and the visual supervision of calls by operators. The loss in transmission efficiency consequent upon the introduction of complex cord circuits, of large multiples, of leading-in points and underground sections in trunk lines, has made it necessary in many cases to replace originally efficient light gauge wires by heavier conductors.

Viewed in the light of our present-day knowledge and experience, the trunk system formed in 1896 was defective in one important aspect from the engineering point of view. It was a framework or structure in which many of the members were out of proportion. Its members were not disposed in such a manner that each should meet its duty in accordance with sound engineering design, and this failing was due partly to (*a*) the fact that the system was an amalgamation of several smaller ones, each of which had been constructed without regard to the part it would play in a national network; (*b*) to the absence of that most important factor, scientific traffic data; and (*c*) to a certain extent, unscientific operating methods.

A scientific method of designing a telephone system has been developed and brought into use during recent years, and will be referred to later; but it may here be stated that such a task is not unlike the design of a lattice bridge, where the duty required from the several members varies with their position in the completed

design, and they have to be proportioned accordingly. The engineer requires full data of the loads to be borne before he can produce the completed design of his bridge; so also a telephone engineer must obtain full details of the volume and peak load of the traffic to be handled. He must also study the calling rates and the origin and destination of the traffic at the various centres.

One of the most important steps towards the co-ordination of the telephone system in the kingdom was the determination, in terms of miles of standard cable, of the limiting distance of telephonic speech transmission on various types of commercial telephone circuits. The study of the subject of telephone transmission has for many years been one of great theoretical interest, and the writings of Kelvin, Heaviside, and others, have done much to explain the factors that govern the range of possible speech, but it remained for the telephone engineer to apply the theoretical propositions to the practical conditions of commercial use, and in this connection the works of Pupin and Campbell have been of inestimable value.

It is quite possible for experts to carry on a conversation through a circuit having an equated length of 60 miles of standard cable; but the commercial limit of 46 such miles provides a factor of safety such as is common in all engineering design. It must, however, be understood that in order to speak successfully through a circuit which approaches this commercial limit it is absolutely essential that the apparatus shall be in good order, that each correspondent shall speak distinctly and close to the mouthpiece of the transmitter, and that both telephones shall be in apartments or silence cabinets into which extraneous noises do not penetrate. Business men, however, insist upon using a telephone stationed upon or near their tables, and their rooms are nearly always in noisy situations, so that the conditions for a 46-standard cable mile limit are seldom met with and the value of 35 miles of standard cable is now commonly used here and in most other countries as *the* commercial limit.

The general effort is towards an extension of the facilities afforded for one person to talk to another through a telephonic system, and the solution of the problems involved in arranging such facilities is and will be one of the most important duties of the telephone engineer.

The ideal system so far as we are concerned, would be that which would give one person in the British Isles facilities for conversation with any other; but the physical disposition of the area is such that it will be very difficult to provide such a system. Intercommunication between all parts of Great Britain and Ireland respectively would be particularly difficult because of the necessary submarine cable link between the islands.

Much has been done in the matter of improving telephone transmission by loading submarine and subterranean cables, and finality in design and improvement has not yet been reached. With the

combined results accruing from loading and the use of telephone repeaters, it is not too much to hope that in the future any one person in the British Isles will be able to speak to any other.

To what extent the ideal mentioned can be realized depends largely upon the demands of the public; or, in other words, upon financial considerations.

Since the British Post Office took control of long-distance telephone lines its policy has been to make every subscriber's connection a "long-distance station." This was no easy matter when the trunk lines were first acquired. At that time only a few important commercial centres were directly connected, and from these other scarcely less important towns were served. The large centres became overburdened and the number of switchings and lengths of line involved in effecting communication between subscribers on indirectly connected exchanges, were so great that there was serious waste of time on the long-distance links. As a first remedy traffic studies were made at the large centres, and direct lines provided between points where there was sufficient traffic to fill them. The service was generally quickened and better transmission obtained, with the result that trunk traffic grew. The result of this policy, however, was to produce a large number of pole routes carrying only a few wires. The annual cost per mile of a circuit decreases to some extent as the number of circuits on the route increases. A scheme was, therefore, sought for which would combine the advantages of the direct line policy as regards speed of service, with the economic advantages of multi-circuit routes.

The most promising scheme yet suggested and that at present followed is the splitting up of the British Isles into areas known as Zones. There are nine of these, having their telephonic centres, known as Zone Centres, in London, Bristol, Cardiff, Birmingham, Cambridge, Manchester, Leeds, Glasgow and Dublin respectively. These centres are, or will be, connected together by direct trunk lines of the highest obtainable transmission efficiency. From each zone centre trunks radiate to other secondary centres in the zone, known as "Controlling Exchanges," and from each controlling exchange trunks radiate to still smaller exchanges known as "Minor Exchanges." Junction circuits connect the minor exchanges with the local exchanges in their vicinity.

Such is the scheme for essentially long-distance traffic, but where the load warrants the provision of direct circuits between any two exchanges they are provided.

For purposes of design, rules have been framed which provide that the loop from the zone centre to the controlling exchange shall not exceed the equivalent of 4 miles of standard cable, and that from the zone centre to any subscriber in the zone shall not exceed the equivalent of 10 miles of standard cable plus the equivalent of a 300-ohm

loop (common battery). There are certain other reservations which need not be mentioned now.

It follows that for a maximum standard cable equivalent of 35 miles between subscribers in a long-distance connection the equivalent of the loop between the respective zone centres should not be higher than 15 miles. All the above values include wiring and apparatus losses.

It is quite possible to design circuits, and many exist, between the zone centres named, having much lower standard cable equivalents than 15 miles, but it is at present impossible, economically, to provide lines in one specific case; namely, lines from Dublin to other zone centres within the limit of 15 miles owing to the necessity of providing a submarine cable. The provision of a high-grade loaded cable across the Irish Sea between Nevin, North Wales, and Howth, near Dublin, has done much to improve London-Dublin communication, and when special land lines have been completed it is hoped to bring this, the most difficult zone to zone connection, below the equivalent of 20 miles of standard cable.

So far as circuits within a particular zone are concerned it is not in all cases possible to keep within the limit of 10 miles of standard cable between the zone centre and the local exchange. Some local exchanges in the more remote parts of the kingdom are about 200 statute miles distant from a zone centre, and to reach such centre there will be at least two exchange switchings involving loss of transmission efficiency. It would be necessary to erect very heavy copper aerial lines to bring such subscribers within the 10-mile range, and the amount of long-distance traffic from such remote and generally sparsely populated districts is insufficient to warrant the expense of providing heavy gauge lines. In these cases the nearest economic value to the 35-mile limit, but less than 46 miles of standard cable, is of necessity arranged for.

There can be no doubt that the more efficient the system or, in other words, the better the transmission, the greater will be the volume of telephone traffic. Further, the greater will be the financial return from any one circuit, since with poor transmission a conversation which takes, say three minutes, might otherwise be completed in two.

The reason for the existence of any telephone company, administration or undertaking as one pleases to call it, is that it has something to sell, namely, telephonic speech transmission; and the requirements of the buyer are that the transmission shall be good, the required connection made speedily and the cost reasonable. In fact the conditions are very much like those obtaining in a large store, the amount of business done depending largely upon the quality of the goods supplied, the ease with which they can be obtained and the price.

It is essential, therefore, for the telephone engineer in every operation he performs in connection with a circuit to bear in mind what the effect of that operation will be upon the transmission efficiency of the loop, since it is quite obvious that inferior transmission with its attendant inconveniences to the business man must result in a disinclination on the part of the subscriber to use the telephone. The better the transmission the greater will be the tendency of subscribers to use the service and the greater will be the revenue; but on the other hand the provision of high-grade circuits involves higher first cost and annual charges.

The relation between transmission efficiency and plant cost is of primary importance since, given satisfactory operating conditions, it is upon these two factors that the success or otherwise of the system depends. It is generally agreed in this country that telephone service between subscribers joined to exchanges in the same area or neighbourhood is satisfactory if the transmission is not worse than that through 20 miles of standard cable. Naturally two subscribers near one another expect to be able to converse with greater ease than two who are separated by long-distance connections, but these expectations are not always borne out by the facts, owing to long local lengths of unduly light-gauge line.

Transmission standards, as will have been gathered, cannot be regarded as being absolutely applicable in all cases. Whether the general rule can be applied will in each case depend upon the cost of attaining the standard and the revenue likely to result from its attainment. One important point must, however, always be borne in mind in fixing the standard cable equivalent of any circuit; namely, that faults and many other conditions will arise which will cause the efficiency to fall below that which would obtain if the circuit were perfect. There is no balancing factor, that is, nothing can happen to a specific circuit which will increase its efficiency beyond that obtained from the perfect condition. An allowance should therefore be made for what may be termed the "out of condition" state. And this is one of the factors in the determination of the 35 miles as against the 46 miles as the commercial equivalent.

The expenditure incurred annually in the provision and maintenance of telephone plant is very great; much of it in the erection of heavy-gauge copper wires with the object of securing high-transmission efficiency, and it devolves upon everyone concerned with the telephone service of the Post Office to see that the best financial results are obtained from the plant.

With the object of obtaining these results it is essential that there should be the closest co-operation between the officers who are responsible for arranging the services with the subscribers, those who have to design and provide the plant, and those who control the working after the plant has been installed.

It may be stated at once that the more simple and systematized a telephone system is, the better is the prospect of providing for good transmission. Special services, that is, those not commonly catered for, invariably bring in complications which are detrimental to good service over the system as a whole. The officers who make arrangements with subscribers can assist greatly by discouraging subscribers in their demands for services which cannot be rendered except by the provision of special apparatus or by allowing for a low grade of transmission. A few of the subscribers' services which should be so discouraged are those involving connections to exchanges other than the one normally serving the area in which the subscribers' station is situated; demands for long extension lines to private branch exchanges, and for lengthy tie lines between private branch exchanges. In special cases where long tie lines are provided it should be stipulated that they be used for purely local purposes and that access to the general system of the country should not be obtained over them.

In a very large number of cases the subscribers who ask for such special arrangements do not realize the effect which is produced upon their own service. If it were a matter simply concerning the particular subscriber no great harm would result from providing him with whatever scheme he desired, provided he could speak over it, but when he has access to a common system not only is he himself badly served but so also is everyone with whom he is connected. Complaints result and much time of administrative and executive officers, both engineering and clerical, is subsequently occupied in dealing with correspondence. The cost of this is difficult to assess, but is without doubt considerable. It is, therefore, desirable that the traffic staff should carefully consider and, if need be, consult the engineers, as to the effect upon transmission which is likely to result from the provision of special arrangements.

The officers who are responsible for the working of the plant, also have many opportunities of assisting in obtaining the best results from it. One of the main points they should bear in mind is the proper selection of routes, with the object of reducing the number of switchings to a minimum. Another is to so supervise that listening-in by operators does not take place more frequently than is absolutely necessary for the proper control of calls. Some portion of a mile of standard cable is added to the equivalent of a circuit every time an operator bridges across it, and as will be shown later, a mile of standard cable may be a very costly item. Just as special arrangements in subscribers' circuits debase the general service so also do abnormal or uncommon provisions in exchange equipment, and traffic officers would greatly assist by not asking for devices and the provision of signals which complicate cord circuits. It is possible to design electrical circuits for telephone purposes which give

very admirable results in the matter of calling, supervisory, and clearing signals; in fact, the circuit can be made to do almost anything but think for the operator, but in general such beautiful arrangements are not helpful from a transmission point of view.

It is upon the engineer that the greatest responsibility for ensuring good transmission devolves. He has not only to provide the plant to meet the requirements, but on account of his special knowledge he must act as adviser to the other branches concerned in the working of the system.

Telephone plant, taken as a whole, is probably the most difficult plant of any to design, construct and maintain. Not only is the telephone itself one of the most sensitive instruments in existence, but the uses to which it is put by any one subscriber vary very considerably. The different parts of the system in the matter of connecting links change in relation to each other with almost every call. A subscriber on a private branch exchange extension may at one moment be connected to another person in the same building by a single local connection, and the next moment may be connected to a subscriber say 200 miles away, in which case there will be quite a large number of circuits joined in series, all of which on the completion of the conversation will be dissociated and possibly each part be again linked up in as many different chains as there are parts. A defect in any one of the parts affects the whole chain of connections.

So far as the lines themselves are concerned and assuming them to be of the proper gauge to give the required service, the matter of greatest importance is to keep them free from noise produced by inductive effects from neighbouring circuits. Quite a small amount of such noise on a circuit will produce as harmful an effect on the transmission efficiency as the insertion in the loop of several miles of standard cable. Interference of this kind can only be avoided by correct design and efficient maintenance.

Maintenance of open lines in this country is probably more difficult than in others, first on account of the general and variable humidity of the atmosphere, and secondly because the roads along which the lines are of necessity erected are very well wooded. These are what might be termed natural disadvantages. The first produces low insulation resistance due to deposition of moisture on supports and internal wiring, and the second a similar result due to wires touching trees. But, in addition, the system adopted for running the wires in revolving squares makes the maintenance of good and uniform regulation more difficult than it would be if the wires were run straight on the cut and cross-over system. Careful consideration has been given to the question as to whether the revolving system shall be abandoned in favour of straight spans with cross-over points. The latter certainly possesses the advantages of greater economy, more ready erection, quicker and easier inspection

and of somewhat higher transmission efficiency when superposed working is arranged. Low insulation and bad regulation of wires account for nearly all transmission troubles so far as maintenance of lines is concerned. It may be of interest to state here that I have had several trunks erected on the cut and cross-over system, and they are giving every satisfaction.

The most common defect from the design standpoint is the inclusion in the nominal open wire routes of comparatively short lengths of underground cable. Sometimes these lengths are inserted because the route passes through a town, in which case, by the way, the sections are generally long enough to be loaded. In the event of such underground sections being really unavoidable, arrangements should always be made for loading; but every effort must be made to avoid the insertion of underground sections in open routes and to remove those which are already in existence.

In other cases, however, the covered work is provided for the purpose of leading-in to a testing point. On the majority of main routes there is such a testing point about every 10 miles, and in many cases at even shorter distances. The idea of such frequent testing points is a very old one in this country, and most of them were established many years ago in the days when the telegraph held the field; the exponents of the system proclaim its merits from the point of view of rapid removal of faults due to abundant localization facilities, but it is feared they forget that what we have to sell is telephone transmission. With lines properly designed and constructed there should be no necessity to lead in at such frequent intervals for testing purposes. Quite apart from the loss in transmission efficiency produced by the wiring of testing points there is the very real danger of faulty connections on the test board or other such fitting. One such faulty connection, say an ill-fitting plug or link, not infrequently causes a loss in transmission of over 10 miles of standard cable. It is probable that the loss in money due to inferior transmission over these much-led-in trunks is greater than the loss which would be caused by a slightly longer time in clearing whatever faults may arise. Many of the faults which do occur could be prevented if the lines were systematically and conscientiously patrolled. This was the practice in well-organized districts before the transfer of the National Telephone Company's system to the State, but the subsequent rapid growth of the system and latterly the withdrawal of men for military duties have stopped all maintenance inspections and patrols, and lines are now only visited when faults have to be removed. It is to be hoped that on the conclusion of the War inspection work will be resumed on a systematic basis. I have, however, closed a large number of testing points on several main routes, with the result that there has been a considerable improvement in the transmission efficiency without any serious or appreciable counter results. The new system of maintenance testing

which has been inaugurated on the recommendation of the Maintenance Testing Committee, over which I had the honour to preside, has helped materially in the efforts to cut down the number of testing points.

It is a very common experience to hear engineers (who should know better) say that a particular operation performed on a circuit, such as the making of an additional leading-in point or the provision of some special device in a cord circuit, will only result in the loss of half a mile or so of standard cable. Do they ever consider that 1 mile of standard cable constitutes about $2\frac{1}{2}$ per cent. of the limit of what they are selling? Do they appreciate what is involved upon occasion in reducing the equivalent of a line by a mile of standard cable? To concentrate attention on this point, suppose a telephone circuit be required between London and Glasgow with a standard cable equivalent of 12. It could be provided by wires of 600 lbs. per mile weight, but suppose—and the supposition is not extravagant—that owing to underground sections, leading-in points, low-gauge open sections, apparatus losses and other factors, a loss of 3 miles of standard cable were to result; it would be necessary to erect wires of 800 lbs. weight per mile in order to neutralize this loss. The difference in cost at present prices would be over £8,100 or about £2,700 per mile of standard cable regained by the use of the heavier lines.

It will thus be quite clear that to diminish the equivalent of a line by even a mile of standard cable may mean the expenditure of thousands of pounds. It is unnecessary to labour this point further, but too great an emphasis cannot be laid on the fact that the equivalent mileage of standard cable which is introduced in exchange equipment and by irregular line construction represents a definite sinking of capital, since so much more copper has to be put in the line, or expenditure incurred in loading to compensate for the loss.

Cases do exist, however, in which it is physically and economically undesirable, if not impossible, to provide the necessary number of lines overhead; such include congested local telephone areas, junction routes between large exchanges and certain main routes between towns. In these cases underground work perforce has to be provided, and care should be exercised to arrange that all junction and main line cable routes are improved by loading.

The main cable routes are not intended primarily for long-distance work, but to provide for direct services; they have been laid between such towns as Glasgow-Edinburgh, Manchester-Liverpool, London-Birmingham, and are being completed between London-Liverpool and Birmingham-Liverpool. The number of circuits required to meet direct traffic between the respective places is so great that pole routes are out of the question.

It is worthy of special mention that the London-Liverpool cable, which is loaded for superimposed working has proved a marked success so far as the completed section London-Birmingham is con-

cerned. It is novel, inasmuch as it contains pairs made up of 200 and 300 lbs. per mile of single conductor respectively. It is the first time such heavy loaded underground wires have been provided in any country, and the success achieved is very creditable to the Department's engineers, who designed the cable and loading, as well as to the contractors who laid and jointed it. As an instance of the damage done to transmission by frequent leading-in of aerial lines and the inclusion of odd lengths of underground, it may at once be stated that the loaded loops in the London-Birmingham and London-Liverpool lengths are better than any of the nominal aerial lines of equivalent gauge between the respective places.

In any telephone administration the cost of the line plant is considerably greater than that of the internal plant; namely, the exchange and subscriber's apparatus. The difference in cost between a highly efficient line and one of lower efficiency is very considerable, whereas the difference in cost between a high-grade instrument, such as a transmitter, and one of lower grade is not very appreciable, being sometimes of the order of one penny. Although the penny may be multiplied many times on account of the number of instruments involved, it pays in the long run to obtain the better type, since a bad instrument may account for a loss as great as 10 miles of standard cable. The present system of obtaining apparatus from various manufacturers under open competition results in a general tendency to lower prices, but care has to be exercised to see that this is not accompanied by a corresponding decrease in efficiency and life. Any saving which may result from purchasing cheap and inefficient instruments, will very soon be absorbed by increased maintenance charges.

It was mentioned earlier that the telephone system now controlled by the British Post Office has been formed by the amalgamation of many different concerns. It is, therefore, only to be expected that there are many varieties of plant in use. This is particularly true of exchange and subscribers' apparatus. The different designs of equipment in use are not, however, wholly due to the above-mentioned amalgamation, they are to a large extent due to the fact that the Post Office is not a manufacturing concern, but draws upon at least five contractors for internal plant. Each of these contractors has a special system to offer, and from sheer necessity of getting the equipment to meet urgent requirements consequent upon growth, widely different types of apparatus have had to be accepted. There are at present the following systems in use:—

Magneto.
Magneto Call Key.
Common Battery Signalling.
Common Battery Nos. 1, 9, 10 and 12.
Trunk, Lamp Signalling.
„ Non-lamp „

The types of apparatus employed differ with each system, and no two manufacturers provide the same system in the same way. Notable cases are the Trunk Exchanges and the Common Battery No. 1 Boards. In the case of the latter there are five distinct patterns, one special to each manufacturer.

Apart from the question of differences in apparatus design, the battery powers employed vary with the different contractors. Some use 22 volts, others 40. All these variations from one cause or another tend towards producing inefficiency in the service.

As regards cost, since a different pattern relay, key, condenser, etc., is required in the various systems and for the different designs of board included in any one system, there is a serious multiplication of stock items and a larger floating stock than would be necessary were standardization carried further. Many items differing in design perform the same functions and there is no clear reason why the best should not be selected and standardized; all contractors being afterwards required to reproduce the standard; nor does there appear to be any need for the voltage to differ in different places. It should be possible to select the best voltage and standardize it with the apparatus.

Healthy competition is of course desirable, but it should be competition in producing the same type of article. It may be argued that to bind all manufacturers by drawing and specification to the production of standard items of plant which, when combined, make up a particular type of exchange board, would stifle development; but this argument, although of some weight in the early or transition days, is at the present moment untrue. Any manufacturer or other person might at any time submit improvements, and these should be the subject of careful study. If the thing submitted proves to be indeed an improvement it would be necessary to consider whether its cost would warrant its being made the standard throughout the country in connection with subsequent works. Obviously the standard pattern must be carefully determined, and it would have to be a radical improvement which would justify an alteration or scrapping of the displaced piece of apparatus. I am bold enough to think the time for standardization has arrived, and some time ago took the initial steps towards securing it. I may further point out that in addition to special apparatus provision consequent upon the use of so many systems, and so many designs, there are special circuit arrangements peculiar to each system and very complex junction circuits have to be devised to enable one design to work in with another—even between exchanges of the same general type. All these complications, and particularly those associated with private branch exchanges, result in considerable losses in transmission efficiency.

Maintenance is also rendered very difficult. The number of

diagrams of connections with which the maintenance hands have to be familiar in order to deal with faults, is so great as to involve actual strain on all grades of the staff. It is almost too much to expect any of the men to know thoroughly more than a small proportion of the total number of different circuits. This must seriously react upon the speed with which faults are cleared and the general working of the whole service. Added to this the men required to do the work of fault clearance must be of a higher type than would be necessary if the number of different designs were reduced, and it becomes increasingly difficult to arrange for interchangeability in the staff.

One or two different types of exchange must always exist in any telephone system to meet the differing volumes and types of traffic, but there is every reason to urge that the same type of exchange board should always be of the same constitution as regards the design and use of its parts.

It is, therefore, proposed in the near future to fix upon a standard voltage for manual exchanges, to standardize the circuit diagrams and to specify the items to be used. It will take some considerable time and probably involve the expenditure of large sums of money, but such standardization of equipment is one of the main avenues along which general improvement in the telephone service may be sought.

THE ELECTRIC LOCOMOTIVE.

THE following is an abstract of a paper read at the Institution of Civil Engineers by Frederick William Carter, M.A., A.M.INST.C.E.

The electric locomotive for use on main-line railways has already reached a high state of development in countries where conditions are favourable to electrical operation; the number of distinct types that have been developed is large, and it is somewhat difficult to classify them simply and satisfactorily; development has taken place along two lines, one based on tramway experience, and the other on steam-locomotive practice. Electric locomotives, suitably controlled, are capable of making very efficient use of their adhesive weight for developing draw-bar pull, and on this account electrical operation often shows to advantage where gradients are long and steep. Where such conditions prevail the question of the return of energy to the source, by using the motors regeneratively, becomes of interest.

Electric locomotives admit of a primary division into two groups, namely, those in which the axles are driven independently, and those in which they are coupled and driven collectively. With a few exceptions these two groups correspond with the continuous-current and the alternating-current systems of operation respectively, and have their origin in limitations of motor design. With the exception of the Pennsylvania Railroad locomotives, all important side-rod locomotives have been designed for alternating-current systems. With the exception of the Norfolk and Western locomotives, all driving through jack shafts have been designed to use single-phase commutator motors; with the exception of the later Lötschberg locomotives, all driving through Scotch yokes employ polyphase motors. Two methods are used for driving the axles independently, namely, the geared and the gearless; unless the driving is arranged to be effected through a spring-supported quill, both methods add to the dead weight carried by the axle; the amount of the additional weight is of interest from its bearing on the maintenance of the parts. Collective driving through side rods assumes several forms, but all result in considerable strains in the structure. Where the locomotive is driven by motors of uniform torque the main driving forces cause alternating stresses of low frequency in the structure, but where the driving torque is impulsive the resultant frequency becomes comparable with the natural frequencies of vibration of some of the parts, and at certain speeds

destructive vibrations are liable to be set up from resonance between the frequency of the main driving torque and the natural frequency of vibration of some part or parts; vibrations of smaller intensity and varying with the adjustment arise from indeterminateness in the application of the driving forces, and such vibrations are also met with in steam locomotives. The polyphase locomotive from its constant speed characteristics is less likely to be affected with vibration troubles than others.

The classification of locomotives according to wheel arrangement has been adopted from steam practice, but hardly affords the same insight as to the type as in the case of the steam locomotive. Electric locomotives have not always been designed with due regard to the question of stability of the rolling motion of the wheels, and some run less smoothly than is desirable on this account. The tilting of the rails and the coning of the wheels causes the progression by pure rolling to assume a sinuous nature, and on the stability or instability of this motion depends the question whether the nosing effect tends to die down or to increase to the limits permitted by the wheel flanges. It can readily be shown that a locomotive carried on a rigid wheel base is in some circumstances unstable and may accordingly be expected to develop a nosing tendency if run at high speed; the same is true when the locomotive is divided into units each carried on a rigid wheel base; guiding wheels elastically centred to align with the main wheels tend, however, to stabilize the motion.

There are few available records of tractive-resistance tests on locomotive-drawn electric trains, but among the most complete are those taken by the General Electric Company in connection with the endurance test on the first New York Central and Hudson River Railroad locomotives. These were made on trains of two different types of passenger vehicle, and are of importance in showing very conclusively that, for a particular type of coach, the additional tractive resistance per additional coach is a function of the speed and is independent of the number of coaches, provided this is greater than two; the additional tractive resistance per additional coach was found to be a straight-line function of the speed within the limits of the tests. The effective locomotive resistance when running with train was found to be smaller than that of the locomotive running alone.

CORPS ARCHÆOLOGIA.

ROYAL ENGINEERS IN IRELAND DURING THE 18TH CENTURY.

MAJOR J. J. CROOKS, of 35, Brighton Road, Rathgar, Dublin, has been good enough to forward to us the following Memorials, and cutting from the Dublin *Evening Telegraph*, dealing with the status of the Royal Engineers in Ireland during the 18th Century, which will prove of great interest to our readers.

First is a copy of the Memorial of Major James Ferrier, R.E., dated 23rd November, 1789, which reads as follows :—

To the King's most Excellent Majesty.

The Memorial of Major James Ferrier, Engineer,

Most humbly sheweth

That your Memorialist, serving by your Majesty's permission in the Armies of the Queen of Portugal, was by your Majesty's command sent for in the beginning of 1779 by Sir John Irwine, then Comdr.-in-Chief of your Army in Ireland, to come and serve in that Kingdom, with the solemn and specific Promise in your Majesty's Name, that on his Arrival in that Country he should be immediately put upon the Irish Establt. as Major of Engineers, and with that Rank in the Army.

That, in consequence, your Memorialist abandon'd immediately very high Rank and flattering Prospects in Portugal, and on his Arrival in Ireland found, that Directions had been sent to Sir John Irwine to offer your Memorialist only the Rank of Captain of Engineers on the Irish Estabt., which Offer your Memorialist respectfully declined, in consideration of the Promise already made to him, which had engag'd him to quit the Service of Portugal; but it being then time of War and the Army in the field, your Memorialist at the same time offered his Service to the Comdr.-in-Chief as a Volunteer wherever wanted, which offer was readily accepted.

That, upon the Representation of the above Circumstances to your Majesty by the said Comdr.-in-Chief, Your Majesty was at that time graciously pleas'd to honor your Memorialist with the Rank of Major in the Army, and to signify your Pleasure to the Ld. Lt. of Ireland, by Lord Weymouth then S. of State, that your Memorialt. should be employ'd and paid as Major of Engineers, as he has continued to be ever since.

That, most of the above related Circumstances apper authentically in a letter written by Sir John Irwine to your Memort., which letter is now in the hands of Evan Napeau, Und. Sec. of State.

That, your Memt. has never discontinued his respectful Representations to the different Chief Governors sent to Ireland of the solemn Promise made to your Memt., in your Majesty's Name, requesting to be put on the Estabt. of the Engineers there in consequence, and has always received friendly assurance of the Same from each, particularly from the present Chief Governor both when formerly Viceroy of Ireland, and more especially during his present Administration.

That now at the moment when your Memt. had every reasonable expectation of Promotion from the assurances of the Chief Govr., and of the present Comdr.-in-Chief of your Army there, as well as from the consideration of his having been long at the Head of the List of Majors of your Majesty's Army, and from his having serv'd your Majesty's Crown with zeal and honour ever since the beginning of 1758, to his utter confusion and astonishment, he finds himself by every late Regulation of the Corps of Irish Engineers reduc'd to the Rank and pay of Captain in the same Corps, which appointmt. he respectfully declined near eleven years ago.

That, under the violent Pressure of such extraordinary and unexpected Circumstances and the palpable impossibility of acting as Captain after having been employ'd by your Majesty's direct authority for near eleven years as Major of Engineers, certain of the honourable testimony of all the Superiors under whom he ever served, and brought without his knowledge into a Situation he firmly believes unexampl'd and unprecedented in all the Armies which ever yet existed; your Memorlt. with the most humble and respectful confidence presumes to throw himself and his Situation at your Majesty's feet, imploring from Your Majesty's goodness that Degree of immediate Redress and Relief which the uncommon Circumstances of his Situation so evidently require, and which is so Consistent with your Majesty's well known Principles of Justice Liberality and Protection continually exercis'd towards all the Officers of your Majesty's Army.

And your Memorialist as in Duty bound shall ever pray etc. etc. etc.

J. FERRIER.

Dungarvan in Ireland, Novr. 23rd, 1789.

Then follows a copy of the Memorial of Lieut. Alexander Taylor, dated 20th November, 1789.

To the King's Most Excellent Majesty.

The Memorial of Lieut. Alexander Taylor

Most Humbly Sheweth

That in the year 1781 your Memorialist then a Lieut. in the 81st Regt. of Foot, was apptd. an Extra Engineer by Warrant and employed under Col. Vallancy in Fortifying Cork Harbour, and has been since employed in assisting to make the Military Survey of this Kingdom under said Col. Vallancy.

That at the conclusion of the War when the other Extra Engineers were struck off, the Govt. thought it necessary to continue your Memorialist on the list of Engineers.

That Yr. Memt. has declined many civil Employments of greater profit, than the pay of Extra Engineer, from a motive of attaching himself to the service of the Ordnance only, in hopes of preferment therein, and that from his Services he had assurance both from the Master-General and the Govt. of this Country, of succeeding to the Rank of Captain, in case of a vacancy, which was then expected.

That in the late alteration in the Engineers of this Country, the Marq. of Buckingham has promoted Lt. Brown from the 27th Foot to be Cap' Lt. over Your Memorialist's head, tho' he was a Lieut. of not two years standing, and Your Memt. has held that Rank twelve years; Your Memorialt. can have the strongest recommendations for his propriety of conduct, abilities, and diligence in Yr. Maj.'s Service, from his C.Os. both in the Infantry and Engineers, and most humbly prays Your Majesty will be graciously pleased to take his case into consideration, and promote him to the Rank of Captain over Cap' Lieut. Brown, which is most humbly submitted.

ALEXR. TAYLOR.

Dublin, Novr. 20th, 1789.

Separate to Ld. Lieut.

That Yr. Memt. has been greatly injured by a late alteration in the Engineers of Ireland.

In conclusion we have a "cutting" from the *Dublin Evening Telegraph* of 4th December, 1915, dealing with the Work by General Vallancy, LL.D.

DUBLIN 100 YEARS AGO.

(FROM THE "FREEMAN'S JOURNAL," DECEMBER 4TH, 1815).

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To add to the interest of this admired Work it is intended to subjoin an Appendix, consisting of such miscellaneous scraps as may be found at all connected with its subject. Gentlemen possessing such are respectfully invited to forward same (authenticated) to the Publisher as soon as possible.

When sufficient Subscribers come forward the Work shall go to Press.

MEMOIR.

LT.-GEN. CHARLES AUGUSTUS GOODFELLOW, V.C., COLONEL COMMANDANT, ROYAL (BOMBAY) ENGINEERS.

By the death of General Goodfellow at Leamington on the 1st September, 1915, the Corps loses the services of a most distinguished officer whose relations with the old Indian Corps of Engineers were of the most intimate nature.

In the annals of the history of the Corps of Royal Engineers the fact is unique of the grandfather, the father, and two sons having all attained the rank of Colonel Commandant.

The grandfather of the late Charles Augustus Goodfellow was General Samuel Goodfellow who entered the service of the Honourable East India Company's Engineers in 1797. He served at the Siege of Seringapatam in 1799 and in Egypt in 1801, and in the Mahratta War in 1803. He was afterwards for many years Chief Engineer in Bombay. His appointment as Colonel dated from 1829 and as Lieut.-Colonel Commandant from 1825. He was promoted Lieut.-General in 1851, and died in London in 1861.

General William Barclay Goodfellow, the father of Charles Augustus, was the son of General Samuel Goodfellow. He obtained a cadetship at Addiscombe in 1822 and was appointed Ensign in the Bombay Engineers in 1824. He served at Kolapore in 1827, and filled many posts as Executive and Superintending Engineer in the Bombay Presidency. He was appointed Colonel Commandant in 1854. In 1865 he left India, and in 1877 was promoted to General. It is a remarkable and unique fact that for several years the names of the Generals, Samuel and William Barclay—father and son—stood next to one another in the *Army Lists*. The latter General resided at Torquay until his death in 1892.

Charles Augustus Goodfellow, the subject of this memoir, was born at Poona on the 27th November, 1836. In 1853 he obtained a cadetship at Addiscombe on the recommendation of his grandfather, Lieut.-General Samuel Goodfellow, and was appointed Second Lieutenant in the Bombay Engineers in June, 1855. His elder brother, General William West Goodfellow, C.B., was also a very distinguished officer of the same Corps and served in Persia in 1856–57, and in Abyssinia

in 1867–68, receiving the medals for these campaigns. He became General in 1891 and Colonel Commandant in 1897. At Addiscombe Charles Augustus was noted for his skill and proficiency in athletics, being a good cricketer and football player. He was in the same term with Colonel Charles Henry Luard, Major-General Joseph Bonus, and Colonel George Scott Hills who served in the Indian Mutiny, Bhootan, and Afghanistan. Charles Augustus was renowned for his skill in boxing. On one occasion there was a large fair at Chatham at which several Royal Engineer officers were present. At that time much ill-feeling existed between the officers and men of the Corps and certain roughs who came from Rochester and the neighbourhood and who took every opportunity of insulting them by opprobrious epithets, etc. One of these, within the largest tent at the fair, produced a string of woollen rolls made up like sausages, with which, while walking about the tent, he struck any men of the Corps whom he happened to meet. A regular *mêlée* and free fight ensued, in which Charles Augustus took an active part much to the detriment of those who were unlucky enough to come in contact with him. Some of the men of the Corps who were outside the booth at the time, hearing that the officers were in difficulties, rushed in and cleared the tent of the disturbers of the peace.

Charles Goodfellow arrived in India in 1857, the year of the outbreak of the Indian Mutiny. He served with the Central India Field Force in 1857–58 and was present at the Siege and Capture of Ratgarh, the capture of Garrakota, and the Siege and Storm of Jhansi.

At the storming of Jhansi, Lieuts. Dick and Meiklejohn, of the Bombay Engineers, were killed and Lieut. J. Bonus was wounded. In 1859 he was Assistant Field Engineer with the Okamundel and Kattywar Field Force.

General Goodfellow was awarded the V.C. for gallant conduct at the attack on the Fort of Beyt on the 6th October, 1859. This was the last V.C. of the Indian Mutiny. It was given for uniform gallant behaviour through the war, and more especially at Beyt (Western India) on the above-mentioned date, when under a shower of lead he bore off a wounded soldier from under the walls of the fort.

The Siege of Jhansi was undertaken under such difficulties, and the besieging force met with such opposition that it may not be out of place to refer to some details which are related in the excellent *History of Madras Engineers* by Colonel H. M. Vibart, R.E.

"At midnight on the 19th March, 1858, the force under General Sir Hugh Rose marched to Chuckampore (15 miles), 8 miles from Jhansi, and on the 20th a strong detachment from the 2nd Brigade advanced by a forced march of 25 miles, and placed picquets on all the chief roads round Jhansi.

"Tantia Topee was reported to have left Jhansi for the purpose of bringing down a large army from Calpee—chiefly Gwalior contingent."

On the 22nd Jhansi was invested by the cavalry. The following extracts are taken from Sir Hugh Rose's despatch :—

"The great strength of the fort, natural as well as artificial, and its extent, entitled it to a place among fortresses. It stands on an elevated rock rising out of a plain, and commands the city and surrounding country. It is built of excellent and most massive masonry. The fort is difficult to breach because composed of granite.

"The fort was extensive and elaborate; outworks of the same solid construction, with front and flanking embrasures for artillery fire and loopholes of which in some places there were five tiers for musketry. Guns placed on the high towers of the fort commanded the country all round. One tower called the White Turret, has been raised lately and armed with heavy ordnance. The fortress is surrounded by the city of Jhansi on all sides except the west, and part of the south. The steepness of the rock protects the west, the fortified city wall with bastions springing from the south face. The mound was fortified by a strong circular bastion for five guns, round part of which was drawn a ditch 12 ft. deep, and 15 ft. broad of solid masonry.

"The city of Jhansi is about 4 miles and a-half in circumference, and is surrounded by a fortified and massive wall from 6 to 12 ft. thick, and varying in height from 18 to 30 ft., with numerous flanking bastions armed as batteries with ordnance and loopholes with a banquette for infantry. To the south are the ruined cantonments and residences of the English. Temples with their gardens, one, the Tokun Bagh, the scene of the massacre of our countrymen, and two rocky ridges; the eastmost called 'Kapoo Tekri,' both important positions, facing and threatening the south face of the city wall and fort."

"I established seven flying camps of cavalry as an investing force round Jhansi.

"The attack on Jhansi offered serious difficulties. There were no means of breaching the fort except from the south, but the south was flanked by the fortified city wall and mound just described."

"The rocky ridge was excellent for a breaching battery, except that it was too far off, 640 yards, and that the fire from it would have been oblique. The mound enfiladed two walls of the city, and commanded the whole of the south quarter of it including the palace.

"It was evident that the capture of the mound was the first most important operation, because it ensured in all probability that of the south of the city, and of the palace, affording also the means of constructing by approaches an advanced breaching battery.

"The desideratum therefore, was to concentrate a heavy fire on the mound and on the south face of the city, in order to drive the enemy out of them and facilitate their capture; to breach the wall close to the mound, and to dismantle the enemy's defences which protected the mound and opposed an attack.

"This was effected, firstly, by occupying and placing batteries on a rocky knoll (the right attack). Secondly, on the rocky ridge there was the left attack.

"By the evening of the 24th, there were four batteries on the right attack.

"A remarkable feature in the defence was, that the enemy had no posts outside the city.

"Sir Robert Hamilton estimated the number of the garrison at 10,000 Vilaitees and 1,500 sepoys, of whom 400 were cavalry; and the number of guns in city and fort at thirty or forty.

"The manner in which the rebels served their guns, repaired their defences, and reopened fire from batteries and guns repeatedly shut up, was remarkable. The women were seen working in the batteries and carrying ammunition.

"The Garden battery was fought under the black flag of the Fakeers. Everything indicated a general and determined resistance. This was not surprising, as the inhabitants, from the Ranee downwards, were more or less concerned in the murder or plunder of the English."

The despatch of Sir Hugh Rose dated 30th April, 1868, describes in complete detail the operations previous to the assault.

"On the 2nd April orders were given to storm on the morning of the 3rd. The breach was stormed by the left attack, while the right attack escaladed. A feint was made on the west face. About 3 a.m. the storming parties advanced. Right attack (escalading party)—Madras and Bombay Sappers, 3rd Europeans, and Hydrabad Infantry. Left attack—Royal Engineers, 86th and 25th N.I.

"The moon was very bright, and the escalading party had to march 200 yards through a heavy fire. The Sappers with the ladders in three places. Three of the ladders broke. Lieuts. Dick, Meiklejohn, and Bonus[o] of the Bombay Engineers led the way. Lieut. Dick was bayoneted and shot dead, Lieut. Bonus was hurled down, Lieut. Meiklejohn was cut to pieces, and Lieut. Fox, Madras Sappers, was shot through the neck; but the British pushed on and gained a footing from eight ladders.

"The left attack carried the breach. Street fighting took place in every quarter from wall to palace. Near some stables was found the British flag which had been presented to the grandfather of the Ranee by the British Government for faithful service, and which was hoisted on the top of the palace."

"Street fighting still went on; the rebels fought like tigers, and the bayoneting went on until sunset.

"On the 5th, Lieut. Baigrie, 3rd Europeans, went to the Fort gate, found it open, went on from gate to gate, and found himself in possession of the Fort of Jhansi. The Ranee had fled in the night. Our cavalry went in pursuit and cut up 200. Street fighting still continued.

"On the 6th the last desperate body was disposed of in the Lal Bagh. After four days' hard fighting, Jhansi was ours. The casualties on our side amounted to upwards of 300; of the enemy some 3,000 must have been killed. Forty guns were found in the fort.

[o] Afterwards Major-General.

"The father of the Ranee and the Jhansi paymaster were captured by a zemindar, 12 miles to the west, and brought in on the 18th. Both were hanged next day, near the nullah where the massacres had taken place."

Sir Hugh Rose in his despatch says:

"It will be a gratification to the relatives of Lieuts. Meiklejohn and Dick, of the Bombay Engineers, to know that these two young men had gained my esteem by the intelligence and coolness which they evinced as Engineer officers during the siege. I should have recommended both for promotion, if they had not died in their country's cause, for conspicuous gallantry in leading the way up two scaling ladders."

The Sappers' Mess before the battle of the Betwa had eight members; it was now reduced to two.

Lieut. Prendergast* wounded in cavalry charge on 1st April.

Lieut. Fox wounded in storm, by bullet in neck.

Lieuts. Meiklejohn and Dick killed.

Lieuts. Goodfellow and Gordon escaped unhurt.

Lieut. Goodfellow was mentioned in despatches, *London Gazette*, 17th July, 1858, and received the Indian Mutiny Medal with clasp.

At the close of the Indian Mutiny Lieut. Goodfellow in December, 1858, was appointed Acting Adjutant to the Corps of Sappers and Miners and was employed on the Bombay Harbour Defences. As Executive Engineer he acted temporarily at Sholapure from 16th April, 1860. In January, 1862, he was promoted 3rd Class Executive Engineer and placed in charge of the Dewar and Brora Division of the Agra Road. In March, 1862, he was again appointed Executive Engineer at Sholapore, and also at Kanara in October, 1863. He was promoted Captain on the 2nd September, 1864, and was Executive Engineer 2nd Class in charge of Bombay Defences. In September, 1867, he was placed on special duty with the Abyssinian Expedition under the command of Lieut.-General Sir Robert Napier—afterwards Lord Napier of Magdala. During the operations he was employed on the coast in the disembarkation of the troops and other engineering works.

The following is extracted from the account of the Abyssinian Expedition given in General Porter's *History of the Corps of Royal Engineers*:—

"The first step taken was the despatch of a reconnoitring party from Bombay, consisting of five officers, one of whom was Lieut.-Colonel St. Clair Wilkins, R.E., to select the best point on the coast to form the base. This after careful inspection of all the possible places, was decided to be at the village of Loola, in Annesley Bay. Here the water supply of

* Afterwards General Sir Harry Prendergast, Colonel Commandant, R.E.

the river Haddass promised very fairly, and although the shelving nature of the beach rendered much labour necessary in the formation of piers, no better site could be discovered.

"The first step to be undertaken was the construction of these piers, and from the nature of the beach they had to be of considerable length. No stone was available in the vicinity, the plain being covered with brushwood. Fascines were therefore made use of for the first pier to form retaining walls as a temporary measure, whilst native boats were engaged to bring stones from the opposite side of the bay.

"These when procured, were built into walls outside the fascines, thus giving a character of greater permanency to the piers, which were run out for a distance of 900 ft. into the sea, and even then only gave a depth of 5 ft. at low water. A second pier of similar dimensions was afterwards constructed on piles, the materials for which were brought from Bombay.

"The troops forming the Expeditionary Force arrived by degrees, the advanced brigade landing in November, 1867, and the Headquarters early in January. The Engineer Staff consisted of Lieut.-Colonel St. Clair Wilkins with Capt. C. Goodfellow as his Brigade-Major. There was one company of Royal Engineers (the 10th) under the command of Major Pritchard, R.E. Of Indian sappers there were three Madras Companies, and four Bombay Companies. The Madras Sappers were under the command of Major H. N. D. Prendergast, R.E., and the Bombay Sappers under Capt. Macdonell. Altogether 30 officers of Royal Engineers were engaged in the Expedition."

For his services in the Abyssinian Campaign Capt. Goodfellow was promoted to be Brevet Major and received the Abyssinian Medal. On his return from Abyssinia he was appointed Executive Engineer at Dharwar, Poona District. He was promoted to 1st Grade on the 24th January, 1877, while in charge of the Poona and Kirkee District and at Kanara in July, 1881. In July, 1877, he received brevet promotion to Lieut.-Colonel, and in July, 1881, to Colonel. In May, 1884, he was appointed Superintending Engineer of the Southern Division, and in September, 1887, he was made Chief Engineer for Irrigation and Officiating Superintending Engineer, Central Division. In August, 1888, Colonel Goodfellow was appointed Chief Engineer, 1st Class of the Southern Division. His subsequent promotions were to Major-General, 15th March, 1889, Lieut.-General, 1st April, 1892, and Colonel Commandant, R.E., 2nd February, 1898. General Goodfellow was also Colonel of the 3rd Bombay Sappers and Miners.

After leaving India, he first lived at Sevenoaks, and subsequently, for some years at Leamington, Warwickshire, where his death took place on the 1st of September last.

The qualities shown by the late General Goodfellow when on active service characterized his whole life, for he was ever thinking of others; but his reserve and dislike of publicity were such that his

many charitable acts are known only to those who participated in them. He was a most devout Catholic and a splendid and upright soldier. His life was a fine example of an individual living for others. He was thoroughly good and kind, and was always ready to devote his time and money to any charitable work. The Charity Organization Society, the Royal Midland Counties Home for Incurables, the Waifs and Strays Society are a few amongst the many public institutions in which he was interested, but his loss will be more acutely felt by those who received the benefit of the innumerable acts of kindness and charity of which his life was made up. To the St. Peter's Boy Scouts he was a real and true friend, and the wounded soldiers at "Holmdene" have in various ways found in him a thoughtful neighbour. His thoughtfulness too was always put into practice; in fact Lieut.-General Goodfellow was a thorough believer in the power of deeds.

Charles Goodfellow was a "thorough sportsman" in the best sense of the term. A first-class shot, with either rifle or gun, he used to spend a considerable portion of his leave, or furlough, in fishing or big game shooting.

His favourite grounds for the latter were the jungles of S. Kanara, south of Bombay. Here he shot a large number of tigers, bison, and other game in the course of his visits spread over a period of several years.

He was an intimate friend of the late Colonel Peyton, the Chief Forest Officer in Kanara, who had shot more tigers than any other sportsman in Southern India.

On one occasion Charles Goodfellow shot a rogue elephant in the Kanara jungles, after patiently tracking it for the best part of two days.

He was also a keen fisherman and spent the best portion of two of his furloughs in salmon fishing in places as far apart as Newfoundland and Tasmania.

Of late years he was unable to do much walking and he usually drove to St. Peter's Church to attend Mass. He and Mrs. Goodfellow found accommodation in their carriage for the wounded Catholic soldiers at "Holmdene." No one was more respected than General Goodfellow, and his death will be a loss in precept as well as example to the community at large.

The fullest possible military honours befitting alike his high rank and valorous career were accorded at the funeral of General Goodfellow which took place at Leamington Cemetery on Saturday, September 4th. That morning at 10 o'clock a Mass of Requiem was said, the Rev. Hamilton Macdonald, M.A., R.N.—a nephew of the General—Naval Chaplain at Portsmouth, being the Celebrant, and the Cantors, the Rev. Fathers McCarthy and McDonnell. Although all the troops in Warwick and Leamington were turned out—

between 300 and 400 men—the muster would in peace times have been increased to 1,000. The remains of the gallant General were conveyed the previous evening to St. Peter's (Roman Catholic) Church and received at the West Door by the clergy in procession, the Very Rev. Canon Barry, D.D., officiating. The ritual prayers were recited and the body remained for the night in front of the altar rails. On the coffin—which was covered with the Union Jack—were placed General Goodfellow's sword, belt, and medals. These were the Victoria Cross, the Abyssinian Medal, and the Indian Mutiny Medal. The plate on the coffin bore the following inscription :—

CHARLES AUGUSTUS GOODFELLOW.
DIED
1ST SEPTEMBER, 1915,
IN HIS 80TH YEAR.
R.I.P.

NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

No. 11.—*November*, 1915.

PERMANENT FORTIFICATIONS AND MODERN ARTILLERY.

It is pointed out in this article that the relative ease with which the Germans made themselves masters of Liège, Namur, Maubeuge and Antwerp at the commencement of the War has destroyed the faith of more than one soldier in the efficacy of fortresses. It might be urged that the places named were, more or less, taken by surprise, their rearmament had not been completed, their garrisons had not been raised to war establishment, briefly that everything favoured the attackers. However, the more recent experience in Poland, where the defence of the fortresses crumpled up almost as rapidly as that of the strongholds of Belgium, seems to suggest that the reasons enumerated above are not the only ones accountable for the comparatively poor resistance offered, in the instances referred to, by the garrisons of fortresses. It is true that examples can be quoted where the results have been of an opposite kind; Przemysl held out for months against the Russians; the Allies spent vain efforts against the Dardanelles position for yet a longer period; finally Belfort, Epinal, Toul, and Verdun have defied all the efforts of the Germans since the beginning of the War, and to-day they stand practically intact, not a stone having been disturbed nor a gun dismounted by hostile artillery fire. Nevertheless, a very general impression prevails that fortresses have not fulfilled the *rôle* expected of them. The experiences of the War in relation to permanent fortifications have been freely discussed in the military Press, and an attempt has been made to account for the apparent failure in this branch of the military art and to discover the remedy which must be applied to reinstate permanent fortifications into favour again.

It is stated that the *Revue* article is based on the ideas contained in articles which have appeared in the *Kriegstechnische Zeitung*, the *Jährbucher für die deutsche Armee und Marine*, and the *Rivista di Artiglieria e Genio*.

The principal cause of the failure of Belgian and other fortresses to play the *rôle* for which they were intended is attributed, in the articles referred to, to the introduction of the modern howitzers and mortars of large calibre, such as the Austrian 12-in. and the German 16·5-in. howitzers. It is claimed that Przemysl only held out as long as it did, because the Russians were not in possession of any artillery as powerful

as that just referred to. Prior to the Russo-Japanese War, guns of the calibre referred to were only mounted on fixed carriages in coast defences and on battleships. The coast defence and battleship heavy artillery was intended rather to pierce armour plates than to produce any considerable explosive effects. The Germans and the Austrians, with their calculating temperament and being devoid of all false notions regarding idealism and pacificity, set to work to go one better than the rest of the world and quietly evolved the one, the 16·5-in., and the other, the 12-in. howitzer. The former of these weapons, it is said, can project a 2,000-lb. shell with accuracy up to a range of 8¾ miles.

Doubts are expressed, however, with regard to the accuracy of the fire of these weapons at the extreme range mentioned; and it is stated that the illustrations of the effects alleged to have been obtained by the 16·5-in. howitzer have been reproduced for the edification of the public rather than for the information of engineers and artillerymen. However, what is certain is that the projectiles from the 16·5-in. howitzer fired at some of the Belgian forts penetrated 11 ft. 5½ in. into concrete; thus in the contest between artillery and armour plates, as things stand at present, the former is the victor. This state of things will assuredly lead to new developments in relation to permanent fortifications. The 16·5-in. howitzer is practically the heaviest weapon possessing sufficient mobility for use as a siege piece, although more than a half-century ago a 35·5-in. mortar, capable of projecting a 3,300-lb. projectile, was constructed in Great Britain. A weapon which can penetrate 11½ ft. of concrete can, of course, be employed to batter down a masonry parapet or wall possessing three to four times the thickness; questions of time and quantity of ammunition alone are involved. Therefore, no reasonable limit can be fixed upon, as being essential, in the thickness of the mass to be employed to give protection to the guns and the garrison of a work. It is no longer a question of opposing force by force, some other means must be found to meet the new situation.

The great disadvantage of a fort is its immobility which compels it to remain a stationary target for the enemy's fire; it can neither be moved from a very hot corner nor can it, at times, even reply to the enemy's fire—this was often so in the case of the Belgian forts. It is thought that a greater dispersion of the elements of defence works and a measure of mobility in the armament of such works will be sought after, in the future, by those responsible for the preparation of schemes in connection with permanent fortifications.

The armoured cupola has so far by no means come up to expectations; an Italian Engineer officer, however, recently put forward the design for such a cupola intended to resist the projectiles from the Austrian 12-in. howitzers. Its characteristic is an armoured apron jutting forward for several yards under the earthen parapet. In this type of work the cupola and its concrete foundation are, so to speak, isolated and protected against explosions in immediate proximity thereto. The thickness of the armour plating is based on the requirements for resisting a direct hit. Nevertheless, it is thought that the cupola will yield the place to a mobile weapon, provided with a comparatively light shield. Forts

will continue to lose in importance. An isolated *fort d'arrêt* will probably be entirely a thing of the past, except in mountainous regions; such a work has no chance at all against the modern heavy howitzers of the 16·5-in. type which can be placed in selected positions at a suitable range therefrom.

The fortifications on the Austro-Italian frontier are said to have been designed in accordance with the latest ideas on the subject; so far they have fulfilled the object for which they were provided.

In connection with the Dardanelles Campaign, Turkish mobile batteries have been referred to from time to time, batteries which the Allies have not been able to locate or put out of action. In this case also, it would appear that the Germans and their Allies have studied the situation so thoroughly that as soon as the defects in their defensive arrangements have been discovered they have simultaneously ascertained the most effective remedy. Thus it may be that the works of the Karst and at the Dardanelles may be the forerunners of the fortifications of the future; they embody the principle of smaller and less conspicuous targets and of more mobility for the guns.

It is thought that, in connection with the defence of entrenched camps, detached forts will still be utilized, but that modifications will be introduced in their design. In order to deal with the heavy guns of the attackers, the defenders will require artillery which is heavier still and possesses a longer range than that of the attackers; this artillery, on account of the weight of the individual piece, will necessarily have little mobility and must therefore be placed in forts. Guns of smaller calibre will be placed in the intervals and given the maximum mobility. Therefore, it will become necessary to provide numerous gun emplacements between the forts; the armament for the intervals will be provided with armoured shields and will be moved from place to place, either by mechanical transport along covered ways or along military railways.

The *Revue* has reproduced a diagram illustrating the project for a fort of the future, which was published in the *Kriegstechnische Zeitung* a short while back. The contributor of this design remains anonymous; he lays down the following four conditions as those which must be fulfilled by all *points d'appui* :—

1. They must provide the most effective fire against the enemy during the stages of the close attack.
2. They must support the neighbouring works by bringing the intervals under artillery fire; such artillery to be well protected and defiladed from frontal fire.
3. They must render the point absolutely secure against an assault.
4. They must have internal dispositions so arranged that in the event of an enemy succeeding in penetrating into it, he will find no cover nor be able to maintain his position therein.

The fort in question is shown as having three lines of defence. The advanced line consists of an infantry parapet, immediately in rear of

which are placed, at 100-yard intervals, armoured blockhouses intended to serve as the base for the active defence and to provide an observation line from which the attempts of the enemy to destroy or pass over the line of obstacles may be prevented. The line of obstacles consists of wire entanglement, about 100 yards deep; it is proposed to charge the wire with high-tension electricity. This entanglement is placed partly on a glacis slope in rear of the infantry parapet referred to above and partly in a V-shaped ditch which is provided with a concrete counterscarp. At 50-yard intervals along the top of this counterscarp are prepared positions, protected with armour plates, intended for the defence of the glacis. The counterscarp is provided with loopholed galleries, from which fire can be brought to bear on any of the enemy who may penetrate into the ditch of the fort, caponiers also being provided near each flank from which the ground along the foot of the counterscarp can be raked with rifle and machine-gun fire. The principal defensive position in the fort is situated some 70 to 80 yards in rear of the counterscarp and consists of an enormous mass of concrete, the top of which is studded with a great number of cupolas for the protection of the machine guns and light fieldpieces intended for use when the enemy has reached within close range of the fort. In rear of the cupolas, just mentioned, and on the flanks of the fort are further masses of concrete upon which are placed additional cupolas for the fieldpieces and machine guns intended for the defence of the intervals and support of the adjacent forts.

The gorge of the fort is shown as completely closed by a continuous concrete mass with cupolas distributed along the top thereof; entrance to the fort being gained by means of subterranean passages at the flanks. Wire entanglement, about 20 yards deep, is placed along the flanks and rear of the fort.

Capt. Tacconi, of the Italian Engineers, has recently prepared a design for a *fort d'arrêt* suitable for a mountainous region. It is said to be up to date; a description of this fort appeared in the *Rivista di Artiglieria e Genio* for April, 1915. A brief description of this fort, with a plan, is given in the number of the *Revue* under review. It is pointed out that in a mountainous region the thickness of armour and concrete which can be employed in the construction of forts is limited by questions of cost and transport.

In regions of this kind the forts are often placed behind the crest of some dominating feature providing protection against direct and flank fire. Sites of forts at great altitudes have two defects; mists frequently obscure the field of fire, and snow, at times, interrupts the communications thereto, cutting off supplies of all kinds. These defects are, however, more apparent than real; for with indirect fire, as long as the target can be seen from an observation post, it is of no consequence if the guns themselves are enveloped in a mist. Indeed a mist, at times, may prove to be advantageous as a screen to mask the gun positions. Difficulties in bringing up supplies can further be overcome by attention to details of organization and by the exercise of foresight.

Dominating sites for forts have at all times possessed advantages;

the value of such sites has increased in recent times, since the greater the altitude at which a fort is situated the less able are the enemy to derive advantage from captive balloons and other aircraft for observation and attack purposes.

Capt. Tacconi's design of a *mountain fort d'arrêt* provides for the principal armament being placed in cupolas, spaced at intervals of 40 yards; these gun positions being connected together by a tunnel in the solid rock and at a suitable depth below the natural surface of the ground, say 18 to 20 ft. to the soffit of the arch over the tunnel. The armour plates of the cupola being little liable to be directly hit by a shell are only of a sufficient thickness to keep out rifle bullets and shrapnel splinters. Ammunition magazines and repair shops are also tunnelled out in the solid rock. The shelters for the garrison consist of bomb-proof casemates, and masonry barricades are also provided to guard against the descent of an avalanche of snow or of loosened rock on to the fort.

Accommodation for the garrison, it is recommended, should usually be placed on the flanks of the gun position, where the men can be made most comfortable and the requirements of hygiene can be best met. Any dead ground, which cannot be swept by the fire of the principal forts, should be brought under fire, either from an auxiliary work specially provided for the purpose, or by special armament installed for the purpose in the adjacent forts, or by mobile defensible artillery.

It is recognized that neither of the examples quoted above can be considered the final solution of the problem; they only give a rough idea of the lines on which the future development of permanent fortifications may probably be successfully worked out. The object should be to provide in ordinary undulating country dispersion and mobility for the armament, and in mountainous country, command and defilade against direct fire.

The opinion is expressed that, except in marshy and mountainous country, the days of small detached forts is past and gone; the present difficulties in transport of heavy artillery are likely to be overcome. It is therefore surmised that the siege artillery of the future will possess a range exceeding that of the German 16·5-in. howitzer, *i.e.*, $8\frac{3}{4}$ miles. The 15-in. and 16-in. guns hitherto employed exclusively in coast defence works and on battleships have a useful range exceeding $12\frac{1}{2}$ miles. The mysterious weapon with which the Germans have occasionally bombarded Dunkirk during the present war has a range exceeding 23 miles. Small entrenched camps will stand no chance against the siege artillery of the future and in cases where the works are placed on a perimeter, the greatest diameter of which does not exceed 9 to 12 miles, the artillery of the attack may be able to fire, from one and the same position, on the front parapet of some of the forts and on the gorge of others protecting the same centre. For this reason, entrenched camps and fortified centres must in future cover an exceedingly great area and will require enormous garrisons; this will bring about a more intimate relation between the field armies and the garrisons of fortified centres.

The Serbian Soldier.

This is an illustrated article by R. A. Reiss, who has spent a year with the Serbian Army whilst in the field; he does not pretend to discuss the strategy of the Serbian Army, but only records his personal observations on King Peter's soldiers, as he has found them on the battlefield, in bombarded towns and in camps and billets.

The Serbian Army is recruited on a popular basis and is thoroughly permeated with the democratic ideas which prevail to so large an extent in the Balkan State contiguous to Austria and Montenegro. In the reign of the Obrenovitchs, who were vassals of Austro-Hungary, the Serbian Army was impotent, badly led and ill-armed; the advent of the Karageorgevitchs, descendant of a peasant family of Schoumadia, brought about an entire change in the situation. Democratic government was substituted for the rule by placemen sent by Vienna. Thanks to the efforts of King Peter and his minister, Pachitch, miracles were worked in transforming the Serbian Army into a military machine of considerable value. It is due in a large measure to the foresight of the Serbian Premier that Serbia met with so much success in the late Balkan War and that she has been so long able to hold her own in the present war against the powerful combination directed against her. The organization adopted for the Serbian Army has drawn into the ranks practically every man capable of bearing arms; unfortunately a part of the second ban and the whole of the third ban had not been, at the beginning of the War, provided with uniforms or a proper military equipment; they still wore their civilian clothes, with a policeman's cap. Belts, rifles, bayonets and ammunition pouches were alone issued to them; this was the excuse utilized by Austro-Hungarians for calling them *comitadjis* or *franc-tireurs* and for treating them as franc-tireurs whenever these unfortunate Serbian soldiers fell into their hands. Three successive wars have caused a very considerable drain on the manhood of the nation and on the material reserves of the little State.

By the autumn of 1914, the greater number of the soldiers had worn out their uniforms and were obliged to resort to civilian clothes; nevertheless, the officers and the men in the ranks still bore themselves with soldierly pride, recalling the memory of the glorious soldiers of the days of the French Revolution who fought in rags. The eight months of rest, from January to August, 1915, not only allowed the Serbian soldiers to recuperate in health, but also permitted Great Britain and Russia to provide them with uniforms, great coats and rifles; it must not be forgotten that the Austrians in their flight during the autumn of 1914 abandoned large quantities of military overcoats, pantaloons, etc., which fell into the hands of the Serbians and were a perfect godsend to them. At the time of writing all volunteers and many of the third ban had been supplied with uniforms; the outfits served out were of various descriptions and gave the Serbian Army a motley appearance.

The Serbian soldier is highly disciplined; his discipline is not of an automaton order, but rather one making due allowance for the use of intellectual faculties. Off duty an officer treats his men as comrades

rather than as subordinates; the soldier often makes the supreme sacrifice on behalf of his officer. The Serbian soldier is proud, without being vain; those of high degree as well as those of low degree are proud to acknowledge that Serbia is a land of peasants.

The Serbian soldier is inquisitive; he wants to enquire into everything. Extreme politeness is shown to strangers, but they are bombarded with pointed questions with a view of eliciting the nature of the particular business in which the stranger may then be engaged. It is not mistrust but curiosity which prompts the questionings.

The Serbian soldiers often possess poetical talent; they are also extraordinarily courageous. The display of courage is noticeable not only on the battlefield, but also in hospitals; soldiers' limbs have often been amputated without the aid of any anæsthetic, yet not a sound has escaped their lips.

The Serbian soldier dislikes nothing more than a retreat; indeed he prefers to make a foolish sacrifice of his life rather than retire from a position. The melancholic disposition of the Slav race is ingrained in the soldier of King Peter's Army; not that he cannot be gay, indeed he can be boisterously so, but when on pleasure bent he carries with him a tinge of sadness. The old soldier of 60 summers and more, belonging to the third ban, is as much to the front as the young soldier in his teens.

Many instances can be given of deeds of valour performed in this war which rank with the heroism of antiquity. The details are related of the manner in which a young soldier named Birtchanine, belonging to a well-known family of Soŭvodagne, met his death in the autumn of 1914, after performing numerous heroic acts, for which he was decorated with the gold medal for valour. About the same time young Birtchanine's great-grandfather was killed by the Austrians because he refused to act as a guide to them.

The Serbian Army possesses a special category of combatants, the well-known *comitadjis* or volunteers, who have been a source of terror to the soldiers of the Emperor Francis Joseph; to-day the *comitadjis* are under military discipline, although they have not been drafted into the regiments of the Serbian Army. The volunteers, who form the *comitadjis*, are young fellows ready to undertake any peculiarly hazardous enterprise and to lay down their lives in a patriotic cause; their spirit will not tolerate the restraint imposed by service in a regiment. They are commanded by officers who are called "*voivodes*."

Those who know the Serbian soldier best ardently hope that he will come victorious out of the present struggle.

A XVII. CENTURY DOCTOR OF VEVEY AS MILITARY WRITER.

Gamaliel de la Tour.

Swiss medical men, it would appear, have in past ages often made a name for themselves outside their own profession; one member of this profession, Gamaliel de la Tour, however, seems alone to have taken any interest in purely military matters, and he acquired, in the XVII.

century, a reputation as a military writer which has come down to the present time. A few disconnected notes relating to this man's family history, dating from 1404, are given. The date of Gamaliel de la Tour's birth is unknown, but it is on record that he was a student at Montpelier in 1611, and sat for the degree of a Doctor of Medicine on the 26th May, 1615. The doctor does not appear to have had any taste for his profession, so he turned his attention to the military sciences. He wrote two works, both published in 1634, entitled *Abbregé de la discipline militaire et des trois principales actions de la guerre* and *Principes et Fondemonts de l'Art Militaire. Concernant l'Exercise des Armes prattiqué en Hollande, etc.;* they are both exceedingly rare. The first of these works was dedicated "à tous vrays Protecteurs, Colonels, Capitaines, Amateurs de l'Art Militaire." In the first pages of the book, the author counsels the soldier to be on his guard against being overtaken by fear. Apart from the religious strain in which the work is written its contents are very similar to those of the modern Swiss *Instruction sur la service en campagne*. The first part of this *Abbregé* deals with the various branches of the service; the second part deals with the *actions principales de la guerre*. The three *actions principales* are briefly referred to in the following terms:—To house troops is the most difficult, to march is the most painful and to fight is the most desperate and full of peril." The contents of *Les principes et fondements de l'art militaire* are practically the same as that of the present Swiss *Règlement d'exercice pour l'infanterie;* it deals with drill, the manual exercise, etc.

In his *principes*, de la Tour devotes considerable attention to tactics under the title "La Démonstration de l'Exercise concernant la faction ou la manière de se défendre et attaquer son ennemi." Religion also occupies a prominent position in this work; the work contains three prayers, namely for the morning, the evening and the day of battle.

The two works referred to appear to have met with much success, when first published, and were translated into German. G. de la Tour was also the author of a work entitled *Réconciliation et amiable décision des controverses*, published in 1644. It has not been possible for the author of the *Revue* article to inspect a copy of this work and it is therefore not possible to give any indication of the subject of which it treats.

Notes and News.

Portugal.—A special correspondent refers to the operations conducted by the Portuguese troops in Angola against the native levies led by German agents. The Portuguese Governor and Commander-in-Chief did not commence operations against these native levies, who had invaded the Portuguese colony at Naulila and at other points of the frontier, until the reinforcements demanded by him had arrived in the territory under his jurisdiction. Therefore, when he did make a move all the military advantages were on his side and he defeated the natives signally, inflicting very heavy losses on them.

The Portuguese are now engaged in the reoccupation and with the pacification of the frontier region of Angola over which they have recently

restored their authority. It is reported that a *modus vivendi* has been established between the British and Portuguese Governments as regards the restoration of order in the frontier zones on the two sides of the boundary separating British from Portuguese territory. The part of the country which was in dispute between the Portuguese and German Governments is to be neutralized and to be governed by a mixed Commission composed of members appointed by the Portuguese and the South African Union Governments.

SUPPLEMENT.

The European War.

The examination of the communiqués relating to the present War is continued in the *Supplement* issued with the *Revue* for November, 1915 (for previous notices *vide R.E. Journal* for June, September, December, 1915, and January and February, 1916).

The *Supplement* issued with the previous number of the *Revue* concluded with an account of the bombardment of Dunkirk; the story is picked up at this point in the number under review, and the history of events is completed down to the end of the year 1914.

La Manœuvre.

There was no change in the general situation during the early days of May, 1915. Attacks and counter-attacks producing no very apparent results were announced by both sides in their communiqués. Two exceptionally severe actions were alone referred to in French and Belgian telegrams, the German General Headquarters maintaining silence in relation thereto.

A French communiqué dated 11 p.m., 5th May, 1915, stated that, on the previous evening, French troops had carried a German trench and that the French line had been advanced as far as Lizerne-Hetsas, resulting in the capture of these places. It was announced that the Germans had not counter-attacked; this announcement was premature, for a French communiqué dated 3 p.m. of the 6th May, 1915, adds: "We have easily repulsed, to the north of Ypres, a night attack delivered from the direction of Steenstraat."

The second of the actions referred to began on the night of 11th—12th May, 1915, and was continued during the next few days. Prior to the commencement of this action the German artillery had bombarded the whole of the Belgian front from the east of Dixmude to the sea. To the north of Dixmude the German bombardment was particularly active in the region of the bridgehead established by the Belgians on the right bank of the Yser. Three German battalions made a vigorous attack on this bridgehead on the night of the 11th—12th May. The Belgians drove them back, and at the same time took a number of prisoners. Simultaneously, a Belgian division won some ground to the south of this locality. The Germans returned to the charge on the night of the 12th—13th May, but only to be again driven back.

These were only preliminary skirmishes; the real effort to recapture the position was begun by the Germans on the 16th May. The French and German telegrams of the 16th, 17th and 18th May relating to this affair are reproduced in the *Supplement*. In the German account of the fighting of the 17th May, contrary to precedent, an unqualified admission is made by the Germans that they had abandoned their advanced positions near Steenstraat and Hetsas; no attempt is made to explain away the retirement by suggesting that the positions abandoned had no longer the same value as when first occupied; nor is there anything to quarrel with in the silence maintained in relation to the four counter-attacks delivered by them.

The situation here dealt with is by no means similar to that on the Aisne where, for example, silence concerning the German counter-offensive gave a quite different impression regarding the nature of the battle as compared with the true facts of the situation; it amounted then to an equivocation. At Steenstraat, the question whether counter-attacks had taken place or not was immaterial; everyone, whether in Germany or elsewhere, would understand that retreat had not been ordered until every measure taken to avoid it had failed of its purpose. Finally, had an excuse been invented the circumstances invoked to justify the retreat must have been of a nature as would carry conviction. Realizing the hazardous position in which it was placed by the Franco-Belgian manœuvre, the German detachment wisely broke off the engagement. This being the first direct admission on the part of the Germans of a repulse, it becomes necessary to account for this departure from past practice. The progress of events may give some clue to the reasons which may have prompted the breaking away from the traditional methods adopted hitherto.

Dampness and fogs interfered with the operations of the belligerents during the period 18th—20th May; even the cannonade of the artillery slackened. Some engagements took place on the 18th May; the Berlin telegrams represented that the results obtained had been favourable to the German arms, but they were referred to in the Paris announcements as two abortive attacks by the Germans which had been held up by the fire from the French trenches. Nothing of consequence occurred on the 19th and 20th May. Activity was resumed during the night of 20th—21st May; there is a complete contradiction in the two accounts relating to this affair. On the 21st May Berlin announced: "The French coloured troops attacked our positions east of the canal during the night. The fight still continues." The French version of the affair is directly the opposite. The Germans had taken the initiative in attacking, but the fight had been brought to a standstill by the French resistance. French telegrams dealing with the situation are reproduced in the *Supplement*.

In view of the fact that the two versions of this affair are in direct conflict, it is necessary to consider which of the two sides had the most pressing motive to make public or to hide the results of the fighting in this region. The matter is hardly debateable, and it goes without saying that the victor would desire to give the greatest publicity to his success,

whilst the vanquished would make an equal effort to hide his failure. It is not at all likely that the German General Headquarters would have maintained silence had victory been to the German troops. There were reasons, moreover, why the German General Headquarters should maintain a discreet silence regarding the check; one check at Steenstraat had been admitted four days earlier, and there was a danger that the admission of a second check, so soon afterwards, might lead the public to believe that the German front north of Ypres was compromised. This might have proved unfortunate, in view of the very different results expected to follow from the accounts of the piercing of the Allied front in this region on the previous 22nd April. The dissimulation in regard to the final stage of the engagement, in view of the admission that the French had, on this occasion, assumed the initiative and attacked may be thus explained; by maintaining silence in regard to the check, the German public might be induced to persuade itself that "no news is good news" in war as in peace. The enemy had attempted to attack, he had been checked; the fighting continued. What more easy than to maintain silence on the subject for the next few days; the German public should thereupon, without hesitation, conclude that the attack had been finally repulsed. On the other hand, if an announcement were made that German troops had resumed the initiative, it would be impossible to maintain silence as to the results attained; silence in such a case might easily be construed by the public into a reverse.

The second motive for dissimulation lay in the fact that the Germans still desired to regain the passage across the canal. To represent the *rôles* reversed had a double advantage: the situation described indicated that one side had decided to stand purely on the defensive; that this defensive attitude had been imposed forcibly on that side by his adversary. On the German side motives of self-interest dictated that the real situation should be masked. So far as the French accounts are concerned, no apparent advantage would have been gained by representing the French success as arising out of a German counter-attack rather than as the issue of some deliberate operations undertaken on the initiative of the French General Staff. On the contrary, the success would have had a deeper significance had it resulted from deep-laid plans rather than as a consequence of an engagement brought on by the enemy. Moreover, from the point of view of maintaining public confidence, it was desirable to make it clear that the initiative lay with the French.

Calm now reigned on the French front, properly so called; according to the communiqués of the German General Headquarters, up to the 29th May. There was indeed some fighting in the region about Wieltje and Hooge on the 24th *idem*, but this was of interest rather to the British troops. The engagements near Steenstraat seemed to have come to an end. The Germans had withdrawn from the bridgehead on the west bank of the Canal, but had maintained their position on the opposite bank. The engagement of the 29th May brought about no change in the situation.

A Berlin communiqué of the 30th *idem* stated that, after a preparatory

artillery bombardment extending over a period of six hours, a French attack was launched against the German positions at Houdt-Ferme., *i.e.* the positions in close proximity to the Canal. The losses suffered by the French being exceedingly heavy and the attackers driven back by the Germans, the latter had no choice but to attempt to hold on to the position won by them by the gas attack on the 22nd April—with the exception, of course, of the bridgehead at Steenstraat recently lost. Elsewhere the German troops had been able to hold on to the whole of the positions won by the gas attack aforesaid.

The French account gives a widely different representation of the situation. According to this account, after the affair of the night of 20th—21st May, calm reigned during the two succeeding days. During the night of 22nd—23rd May the Germans returned to the charge at several points between the sea and Arras. The first of these attacks was made to the north of Ypres—to the east of the Canal—but it could not be pushed home. Other attempts were made against the Allies' front between Steenstraat and Ypres during many of the days following; asphyxiating gases were employed, but to no successful purpose.

A new period of stillness prevailed from the 14th to 25th May, but on the 26th *idem*, the Belgian troops repulsed two German attacks to the north and south of Dixmude; on the 27th *idem* an intermittent artillery fight was in progress along the canal front, and three days later the evening communiqué announced that the French troops had carried the whole of the German trenches on Hill 17, in the neighbourhood of Pilkem; they took about 50 Germans prisoners, captured 3 machine guns and repulsed a counter-attack which followed.

Since then, the actual situation, as definitely known to exist, has been found to correspond with that referred to in the French account. The practice of denying reverses is again met with in the telegrams of the German General Headquarters and therefore the admission of the retreat at Steenstraat must be regarded as a single and modest exception to the general rule. It may even be that it is not so much an admission of a check, which should be read into the German communiqué, as indirect praise for the German troops in a tight corner. In another form, it is a repetition of the procedure adopted in regard to the situation at Neuve Chapelle.

Summary and Conclusion.

The positions which the Germans held at the end of May, 1915, were no longer on the line they had succeeded in reaching on the 22nd April. A salient still existed at Ypres, but a salient possessing a less rounded apex. In place of the pronounced semicircle Steenstraat-Langhemarck-Broodseinde-Zwartelen, the salient was formed by a crooked line joining Pilkem-Wieltje-Hooge. The average distance between the positions held by the Allies after and before the gas attack was approximately a couple of thousand yards.

The main incidents of the action may be summarized in the following terms:—German surprise gas attack succeeds on the front Steenstraat-

Ypres-Stalden occupied by the French. Latter retire from the Ypres-Stalden Railway to the Canal and at Steenstraat behind the Canal. The British troops on the line north of Ypres from Langhemarck to Broodseinde are obliged to conform to the French movement; they take up a fresh position on the line Pilkem-St. Julien-Broodseinde.

These incidents occurred during the period 22nd April to 1st May, 1915.

Deliberate retreat of the British troops; their front is carried back to positions south of the line Pilkem-Wieltje-Hooge. This movement is completed between the 1st and 4th May. British troops forced to retire on Ypres, they succeed in occupying a line slightly in rear of that last mentioned. This double move occurred between the 8th and 26th May.

A French counter-offensive takes place; the Germans are forced to cross to the east of the Canal; the French left, where it connects up with the British front, is carried forward on to the line Streenstraat-south of Pilkem-Hooge. Period 20th to 30th May.

The changes in the fronts occupied at various dates, as indicated above, seem to justify conclusions being drawn similar in all respects to those formed in relation to the engagements in the Champagne. The Germans had won a local tactical advantage which they had been able to maintain, during five weeks of fighting, on the greater part of the front attacked, but not along the whole of it. Some loss of ground won had taken place, on the right wing, where the Germans had been unable to retain the passage over the Canal.

However, although a tactical success was gained the operations really resulted in something of the nature of a strategical reverse. It is pretty certain that the Germans did not undertake this enterprise with the sole wish to push back the front of the Allies just a tiny little bit. They could not have intended merely to smooth out the Ypres salient. The least that they aimed at was to get possession of the Canal and with it to capture Ypres, wherein lay the principal point of passage across the Canal, and if they did not expect absolutely to lay bare their enemy's line of communications, they at least hoped to constitute a serious menace thereto by getting hold of good bridgeheads which would provide good jumping-off grounds for the next step forward; this programme represents probably the minimum which the Germans had set out to accomplish.

The execution of the German plans possessed the advantage that the attacks were convergent; they have drawn attention to this themselves. Recapitulating the results of this action in their official telegram of the 10th May, the Germans claimed that the Allied front which had previously had a length of about 15½ miles and a depth of 5½ miles was after the 4th May reduced to a length of about 8 miles and a depth of 3 miles. It is further stated: "The present positions are still more exposed to the cross-fire of the German Army." This could only mean that it had not been possible to maintain the former front under this cross-fire, it would prove to be still less possible to do so in the more restricted front. The German hopes betray their intentions.

In order to make sure of success the German General Headquarters did not hesitate to plan the surprise gas attack. This was dangerous. The methods adopted by the chiefs of the German Army in conducting the present war have, too often, done noticeable damage to the character of their army in the eyes of the world; it is not so much the acts themselves as the code of ethics implied by resort to such acts which is largely responsible for this. Those acts are no longer due to occasional errors of judgment, but represent the consequences of a deeply considered plan based on design. The use of poisonous gases has been a part of this reprehensible system. The whole German code rests on the three following maxims of the present-day materialistic philosophy to which the German people cling with tenacity: *necessity knows no law; might is right; the end justifies the means;* or in other words, the attainment of success removes the stain of the most diabolical deeds done to procure the same.

The plan on which the war communiqués are framed also represents an illustration of the last maxim, as do the use of poisonous gases, false accusations alleged against Belgium in order to justify the violation of her neutrality, the alleged shipping of munitions on the *Lusitania* to justify her destruction by a torpedo attack, the firing on German troops alleged against the civil population of Louvain, Senlis and other places as an excuse for pillage and incendiarism. The same idea runs through all these incidents, in spite of the difference in their nature. The use of asphyxiant gases has been held to be particularly serious, really in view of the fact that the insidious treachery involved therein, having been conceived, worked out and practised by the military authorities, conflicts with the code of loyalty which has been honourably associated from time immemorial with the career of arms. This act of the Germans is nothing less than a Jarnac Stroke, yet for many centuries past they had proudly maintained a reputation for honourable conduct. It is tolerably certain that the Germans only resorted to this foul trick in the certainty that their efforts would meet with success and a decisive victory would procure them absolution in respect of the dishonourable means by which the same was obtained.

All the above facts point to a strategic reverse; no doubt, in one respect, one of smaller importance, owing to the magnitude of the operations and the numbers engaged, than the reverses of October and November, 1914, but, on the whole, of greater importance than these latter perhaps, since no better strategic results were obtained than on the previous occasions referred to, in spite of the novelty of the measures adopted to secure success. The second Battle of Ypres represents the end of the German Campaign of 1914 on the Western front; it was the final offensive effort which constitutes the first chapter of the War. This chapter now ends and the last page is turned over at the record of a definite check. The strategic plans develop; the Austro-German General Staff have decided that the decisive offensive must be attempted on a different front.

The German "Manœuvre Morale."

Seemingly the second Battle of Ypres caused the German Press Service momentarily to rouse itself from the torpor to which it had succumbed: the various phases of the battle were faithfully recorded by it. As a precautionary measure a reference was made to the asphyxiating gas question. At the time that orders were issued for the use of poisonous gases against the Allies, the German General Headquarters published an official communiqué. The public were informed that the British Commander-in-Chief had complained in his reports of the use made, from the time of the capture of Hill 60, of poisonous gases by the Germans in contravention of the laws of war recognized by civilized nations. The communiqué continues: "As the official communiqués have already made known, the enemy have made use of this means of war for some months past. They seem to think that practices which are permissible to them are not so to us. This view has, in the present war, no longer the charm of novelty, and we do not intend, by any manner of means, to have any share therein. But we well understand our enemy's attitude, specially so, when we realize that the German developments in the field of chemistry have naturally put us in a position to make far more efficacious use of these novel methods than can our enemy." This communiqué also deals with the provisions of the Hague Conference of the 29th July, 1899, and points out that it was only projectiles, the *sole* object of which was to liberate poisonous gases, that were forbidden and that the Germans were not using any projectiles of such a kind. It was further claimed that although the German gases were more disagreeable than those used by the Allies, they were not so dangerous; they were only capable of producing more powerful effects.

According to the custom adopted when public opinion had to be educated an official telegram was sent out on the following day, *i.e.*, at the same time as the German announcement of the victory won by means of the gas attack, reiterating the views contained in the communiqué referred to above.

Neutrals were able to learn that the German Press attached considerable importance to the great success at Langhemarck-Ypres. A report emanating from Amsterdam expressed the opinion that the German advance on the Yser Canal had produced great consternation in Great Britain. This advance occurred just at the time that Mr. Lloyd George had announced that Great Britain had troops in the field sixfold as great as at the beginning of the War and the British success claimed at Hill 60 had led the public to expect that the German lines would be pierced shortly. The point at which the Germans had crossed the Canal was very important, being at the junction of five routes. British and French wounded were alleged to have expressed the opinion that the battle was one of the most violent in the course of the War.

Reports of this kind continued to be published for some days; those from Amsterdam were always in the forefront. The *Allgemeen Handelsblad*, it was announced by the German Press Service, had stated that

the Germans had not awaited the thrust of the Allies promised for the spring, but had themselves made the first offensive stroke by a particularly vigorous attack on Ypres; although they had not succeeded in breaking the French lines, nevertheless they had pushed the Allies' front well back. The *Daily Chronicle* was also quoted to have enlarged upon the character of the German victory.

At the same time, it was necessary that reference to the question of the use of asphyxiating gas should not be overlooked. The conservative section of the German public still had scruples in regard to the misuse of this means in war. Once again it is to Holland that Germany turns for an approving nod. The *Allgemeen Handelsblad* was reported to have expressed the opinion that it was an extraordinary thing to reproach the Germans for having used poisonous gases. According to this paper, war was a terrible scourge and the real question was whether it was not preferable to expel the defenders from the trenches by the use of suffocating gases rather than to blow them to atoms by shell fire. As to the protest of the British Commander-in-Chief, a subject of the former Orange Free State, it was alleged, had written to say that the British had used poisonous gases during the Boer War, and when the Boers complained of this a reply was sent to the effect that this method of conducting war was evidence of the might of Great Britain and that the Boers should be happy to become members of so clever a nation.

The *Nieuwe van der Dag* was also quoted and the paper was represented as holding the view that too much noise was being made concerning the use of poisonous gases, since there was little difference between the use, by the French, of "turpinite" with its poisonous fumes and the use of asphyxiating gases by the Germans.

As a matter of fact, the noise made by the Germans about the gas question was merely trickery; this was known at Amsterdam. The *Tidj* in reviewing the situation wrote: "If the telegrams from the two camps are read with care, one forms the opinion that the Allies find it difficult to admit their defeats."

It has even been suggested that the idea of using asphyxiating gases was, after all, borrowed by the Germans from the British. Lord Dundonald put it forward on several occasions between 1812 and 1846; his proposals were examined by a commission, but rejected, although the efficacy of the method was admitted. Lord Dundonald is said to have advocated the use of gas against Sebastopol, but at that time the execution of his plans appeared impracticable.

The Battle of Ypres was fought at a time when Sir John French felt that he was no longer able to await the French counter-offensive and had, in consequence, ordered the withdrawal of his troops which were, as explained earlier, in too exposed a position. The withdrawal was affected and the battle continued on the new line, but the Germans gained no further ground, and did not achieve the results hoped for as a consequence of the forcing of a passage across the Canal. It thus became difficult to maintain the tone adopted in telegrams since the 23rd April. The official telegrams refer to the bombardments of Poperinghe and Dunkirk, and the German Press Service provides the

embellishments. This situation disturbed the peace of mind of the military correspondent of the *Daily Mail*. The Western Allies realizing the unfavourable position of their troops at Ypres attempted to regain the ground lost, but the Germans, who had arrived on the east of Lizerne, were only some 7 miles from Poperinghe; their heavy guns however had a range of $8\frac{3}{4}$ miles at least. The Germans were thus able to bring their guns into action at long range. Poperinghe had been reduced to ruins, but the British ambulances had been able to remove the wounded from the town. Without doubt, the British continued to be disturbed by the course of events. The Rotterdam newspapers published reports of an address given by the Bishop of London in which the heavy British losses and the deficiencies in munitions at the Front were referred to.

In Germany the outlook was considered widely different. The bombardment of Dunkirk loomed larger in the public imagination than that of Poperinghe. The position of the French and British Armies was represented, at the same time, to be precarious, and neutrals were asked to score up points in favour of the German Army. Such was the theme of the German telegrams for several days.

Important results were claimed in respect of the air raid by two Taubes on Dunkirk, just before the bombardment, when 100 casualties were caused by the 19 bombs dropped on the town. Much damage was claimed to have been done to the harbour, etc., by the bombardment itself; many British subjects were said to have been killed and wounded; the civilian population, it was stated, were flying from the town in motor cars panic-stricken, thinking that the Germans had been able to establish their siege batteries within range of Dunkirk.

The *Daily News* account of the effects produced by the bombardment are referred to in the *Supplement*, and the views of the military correspondent of the *Times*, regarding the menace to England which would arise in the event of the Germans breaking through to Dunkirk and Calais, are quoted.

In a general way, the news that Dunkirk had been effectively bombarded at a range of, at least, 24 miles undoubtedly created a deep impression. The first information published in France, which spoke of a naval bombardment, shows that the French were unaware that the Germans had a gun capable of dropping a shell into Dunkirk from the front occupied by them. The Italian papers were also much impressed by the power of the German heavy artillery; the German Press Service made the most of the Italian comments on the subject. Similarly, the most was also made of articles which appeared in the *Daily Express*, *Daily Chronicle* and the *Daily Mail* on the fighting at Ypres, and the use which was made of their views helped to confirm the opinion held in Germany that the stars in their courses were favourable to the success of the German arms.

It was about this time that the counter-offensive was assumed on the part of the French; followed somewhat later by the British forces making good their junction with the French troops.

The high hopes which the Germans had had of piercing the Ypres

salient were doomed to disappointment, and the *manœuvre morale* had to come to the rescue to cover the German retreat. A Berlin report of the 27th May, 1915, said to be derived from a "reliable source," referred to the favourable impression caused by the situation on the western front; it created not only a reassuring influence, but was also satisfactory. At Ypres slow but sure progress was being made.

The telegraph could, however, afford to let the subject drop. Other events of first-rate importance now monopolized attention; the Battle of Arras began to be seen in its true perspective and the victory in Western Galicia to make its consequences felt. Italy had entered into war against Austria. The accounts relating to the operations round Ypres became of subsidiary importance.

Conclusions on the Western Campaign of 1914.

The German *manœuvre morale* in connection with the second Battle of Ypres was artistic. It adhered closely to the accounts set out in the communiqués, connecting up the episodes of the battle, brightening up the successes, putting a cloak over the slackening off in the operations by expanding accounts of the bombarding of Dunkirk, just at the time when the failure to attain the end in view had become perceptible, helping to throw a veil over the delicate incident connected with the repulse of the offensive stroke at Steenstraat, in rear of the obstacle which it had been hoped to move out of the way, educating the minds of those who might have scruples regarding the use of poisonous gases. More art was shown than at the beginning of the War when the German Press Service set about its work without any refinement and with a confidence born of the conviction that force could intimidate those of every degree and every clime. Reverses had taught their lesson. Not only was the general mechanism of the institution completely changed, as was seen in connection with the *manœuvre des Flandres*: not only did German General Headquarters shift on to the Auxiliary Press Service the responsibility for its own acts; but its demeanour toned down. However, the methods remained the same as at the beginning; neither the German people nor neutrals could be brought to believe that German troops had ever met with a reverse or could ever meet with one. Reverses had always been categorically denied, except in a few isolated cases in which a pure and simple denial was distinctly impossible. It was only in the spring of 1915 that a modification in procedure in this respect took place. Up to this time, the denials had become more and more irreconcilable as the danger of demoralization from the longer duration of the campaign increased. This shows up in relation to the reports covering the period of the engagements in the Champagne, and of those in the Meuse and Moselle region. The instance of Hill 60 is also characteristic. When flat denials became too outrageous, then the plan of toning them down on the lines of the formula adopted in connection with the Battle of Neuve Chapelle was brought into use, *i.e.*, an absurd victory for the enemy; or that brought into use when the offensive on the Yser was checked, *i.e.*, failure covered by "bluff"—

the bombardment of Dunkirk. An admission properly speaking only occurred as a *manœuvre*, for example as in the retreat across the canal at Steenstraat.

Naturally, irreconcilable denials of reverses were accompanied by claims of success of an incomplete or doubtful character. For example, the deliberate breaking off of an engagement as at Steenstraat is never admitted in the enemy's favour.

Nor was there any essential change in the methods of the French Press Service. A slight change had indeed taken place; from the spring of 1915, there was a greater disinclination to admit reverses than at the beginning of the War. Psychologically this appears logical. Self-confidence had been increasing since the Battle of the Marne and the battles in Flanders; there was now no doubt that sooner or later the enemy would be defeated.

From the German point of view, the second Battle of Ypres ended the campaign of 1914. The *manœuvre morale* on the Western front occupies the period August, 1914, to May, 1915, and the tragedy may be divided into six acts.

La Manœuvre de la Meuse.

The German General Headquarters were confident of an early victory. In this they were disappointed. Germany is the elect among nations and its military chiefs are infallible. It is not necessary for the Press Service to await victories before announcing them; the telegraph anticipates events; the labours of the General Headquarters can bring nothing but success.

The French, on the other hand, were less sure of immediate victory. They had high hopes of ultimate success founded on confidence in a good army, on the assistance of loyal Allies, on a just cause superior to that of the Germans. It was known that the enemy was powerful and that on the last occasion France was at grips with him, he had been the upper dog. The tone and expression of the communiqués were therefore framed in a low key; the alternative of want of success at the start off was not ruled out.

La Manœuvre de la Marne.

The German General Headquarters was still imbued with the idea that it could not err. It had but to complete the victory already more than half won. The principles governing the Press Service remained as heretofore. However, since the actual situation failed to respond to preconceived ideas, and the view prevailed that decisive results would follow shortly, the German General Headquarters, in awaiting more prosperous times, resorted to equivocation and dissimulation.

On the French side, hopes grew stronger; but reverses were too recent and the exercise of prudence was necessary. The principles which governed the Press Service were those of expectancy of favours to come.

La Manœuvre de l'Aisne et de la Somme.

The German General Headquarters had met with defeat and an extension of time was required to allow for the victories which were yet to come. The resort to equivocation was more marked and the picture of the operations was out of perspective. However, the German General Headquarters declined direct responsibility for the dissimulation; the tone of its communiqués was pitched in a lower key than in the beginning; the Official Press Service of the civil administration became the tool of the military authorities.

On the French side, hope continued to increase in strength, but there were no signs of undue jubilation. Victory was slower in coming than had been expected. The Press Service maintained its former tone.

La Manœuvre des Flandres.

The German General Headquarters began to realize that the early German victories were likely to prove fruitless. There was a still further resort to equivocation; it being supposed that France was already beaten, it was the turn of Great Britain to be crushed. The German General Headquarters shook off from its shoulders still more of the responsibility for the dissimulation. The Official Press Service of the civil administration worked hand in hand with the German General Headquarters and became a mere auxiliary to it, but without any apparent connection with it. Soon there ceased to be military correspondents at the German General Headquarters.

On the French side, there was no longer doubt of a victory, which was further thought to be now near hand. The communiqués referred to the defeat of the enemy in more categorical terms; they raised encouraging hopes regarding the future.

The Winter Campaign.

On both sides, the danger that the lull in the operations during the winter might affect the *morale* of the civil population was fully appreciated. In Germany, the hopes of final victory were postponed; however, territory had been conquered; it was necessary to take all precautions lest the same might be lost. In the communiqués, denials of reverses took place on an exaggerated scale and equivocation and dissimulation were resorted to even in relation to operations of secondary importance. In France, events did not march as rapidly as hoped for; the offensive strokes led to no conclusive results; in the communiqués, the effects of the reverses were toned down, and the periodical reports were framed with a view to creating a more telling effect on the *morale* of the people

The Second Battle of Ypres.

The German General Headquarters made a supreme effort to snatch a victory on the Western front. Experience had taught the Press

Service to exercise more reticence; it was more sparing with its announcements, but there was no modification in its fundamental methods.

The French Press Service took steps to check an undue spirit of optimism—this had only grown up in the winter; it showed a slightly more pronounced tendency to minimize the importance of those events which were in the nature of temporary reverses. With this exception, its methods remained unaltered.

This number of the *Supplement* concludes with a Table of Contents.

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