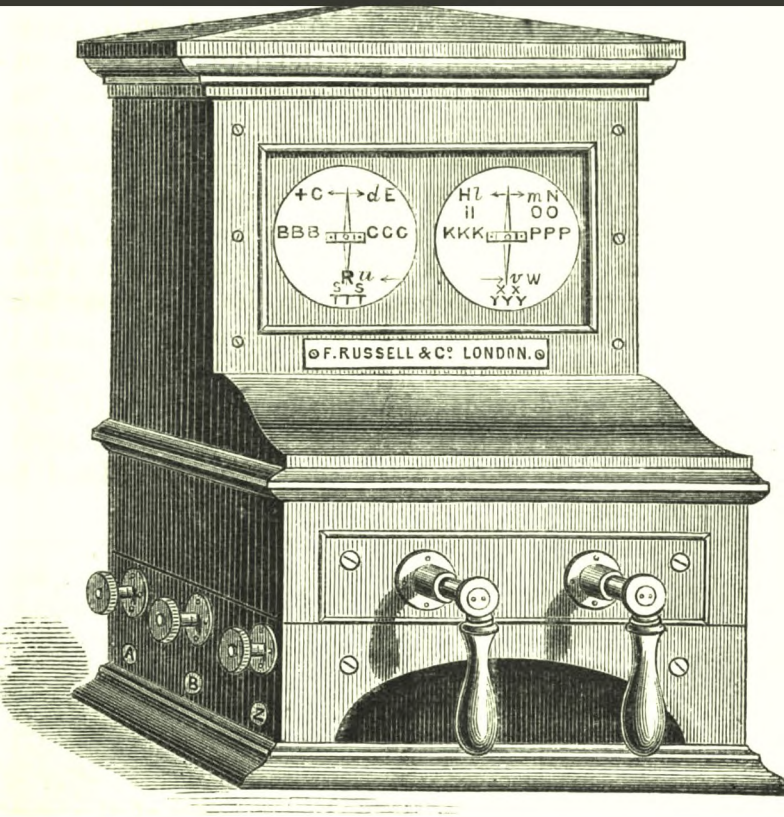

Handbook of the telegraph

R. Bond (of London.), W. McGregor

HANDBOOK OF

THE TELEGRAPH.

Being a Manual of Telegraphy,

TELEGRAPH CLERKS' REMEMBRANCER, AND GUIDE TO CANDIDATES FOR EMPLOYMENT IN THE TELEGRAPH SERVICE.

By R. BOND.

FOURTH EDITION, REVISED AND ENLARGED.

TO WHICH IS APPENDED

QUESTIONS ON MAGNETISM, ELECTRICITY, AND PRACTICAL TELEGRAPHY, FOR THE USE OF STUDENTS.

By W. McGREGOR.

FIRST ASSISTANT SUPERINTENDENT, INDIAN GOVERNMENT TELEGRAPHS.

With numerous Illustrations

LONDON:
LOCKWOOD & CO., 7, STATIONERS' HALL COURT
LUDGATE HILL
1873

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CITY ROAD.

TO

FRANK IVES SCUDAMORE, ESQ.,

TO WHOSE INDOMITABLE ENERGY IS DUE THE HONOUR OF ORGANIZING

THE POSTAL TELEGRAPH SYSTEM,

WHICH IS DESTINED TO RIVAL IN UTILITY AND IMPORTANCE

ITS SISTER-BRANCH OF THE PUBLIC SERVICE,

THE PENNY POST,

THE FOLLOWING PAGES ARE, BY PERMISSION, MOST RESPECTFULLY

INSCRIBED,

BY HIS MUCH OBLIGED AND MOST OBEDIENT SERVANT,

THE AUTHOR.

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QUESTIONS ON MAGNETISM, ELECTRICITY, AND TELEGRAPHY.

HANDBOOK OF THE TELEGRAPH.

INTRODUCTORY.

CANDIDATES for the vocation of telegraph clerks should be capable of writing a free and distinct hand, of spelling correctly, and, as correspondence will form a portion of their duties, of adapting their communications to grammatical formulæ; a slight acquaintance with arithmetic is also essential. Higher attainments than these are not actually indispensable to the ordinary clerk, although they may realise to their possessor advantages which the less accomplished would scarcely have reason to expect or hope for. An "instrument clerk" may be quite competent to telegraph or receive a dispatch in a foreign language, and yet not understand a single word of it; but, as the Continent and many other parts of the globe are intersected by the telegraph, clerks and other officials must of necessity be located in foreign countries, and to those who are privileged with such stations, the qualifications of a linguist will form an important element in moulding the eventualities of their career. That foreign situations are generally more lucrative than appointments in this country, is an admitted fact, and when they are at disposal, it is obvious to whom the preference would be accorded, unless favouritism or interest interpose; and such contingencies as those can scarcely be expected in the Postal Telegraph Office service. Besides, there are foreign departments, attached to which are numerous *employés*, in the chief offices, to which clerks who are conversant with the language of other countries may be drafted.

Although allusion has been made to the favourable circumstances under which the accomplished scholar identifies himself with the telegraph service, it must not be construed that the official who is destitute of such acquirements should

consider his position to be stationary, as, on the contrary, his course may be a progressive one. Constant practice enables him to signal, *i. e.* to send and receive messages, and to write with celerity; and if he applies himself to his duties as assiduously as is expected of him, and determines upon becoming acquainted with the why and the wherefore, he may not only render himself a proficient instrument clerk, correspondent, and accountant, but also attain to a thorough knowledge of the principles of electricity, which operates so surprisingly, and with such exquisite accuracy, in exchanging thoughts, although conceived in different climes and hundreds of miles apart, with the rapidity of lightning,* hence annihilating distance and concentrating time, conveying tidings of the movements of an army, the rise and fall of dynasties, or the desires of a peasant, with like facility and marvellous speed. If the acquisition of a knowledge of the mysteries of this wonderful agent be the clerk's ambition and aim, opportunity will aid the will in demonstration of the fact that the zenith of his aspirations is within his flight, and perhaps assist in distinguishing him as an illustration of the truthfulness of the poet's sentiments—

> "There is a tide in the affairs of men,
> Which, taken at the flood, leads on to fortune."

In the telegraph management there is a feature that is especially commendable. We allude to the solicitude for the development of the mental faculties, as evinced by the establishment of a free library of good, useful, and entertaining works, treating on all subjects, which are at the disposal of the clerk, who has generally an abundance of time to devote to the mind's culture. The means, therefore, of enriching himself in knowledge are within his reach, a literary repast is spread, and he is invited to partake of it. The various grades

* Professor Gould found the velocity of the electric wave in the Atlantic cable to be between 7,000 and 8,000 miles per second, differing somewhat when the circuit was composed of the two cables, and when the earth formed a part of the circuit. Telegraph wires placed in the air on poles conduct the electric wave with about double the above velocity, and the curious fact has been discovered that the rapidity of transmission increases with the distance of the wire from the earth. Wires buried in the ground transmit as slowly as the submarine cables; wires on short poles with a velocity of some 12,000 miles per second, and those on long poles at the rate of 16,000 to 20,000 miles per second.

in the correspondence department, and the higher positions in the engineering department, shine forth in the prospective as stimulants to exertion, as rewards to diligence, perseverance, and adherence to the regulations laid down for his guidance.

The juvenility of many of the clerks denotes a freshness to business—a recent withdrawal from school to take part in the active concerns of life: youths of fourteen are deemed eligible for the post, and sharp, intelligent lads sometimes enter the service even at an earlier age, and the employment seems so congenial to their taste, that, unlike other tasks, it is viewed by them with the pleasurable emotion of an agreeable pastime; nor does this feeling abate, it grows with their age, and, as a consequence, they frequently out-distance those whose induction dates at a later period of life, and hence earn for themselves the reputation of first-class readers. Some of these clerks, with whom the author is acquainted, have been known to receive two hundred and forty words, on the double instrument, within three minutes.*

Female clerks are also comprised in the telegraph staff, and they certainly manifest an adaptability for the calling. They are daily holding converse with the remote, by the "wonder-working wire," which

> "Marks how bold Invention's flight
> Makes the widest realms unite;"

and their cheerful demeanour stamps it as a delightful occupation—one, too, which inspires them with a lofty idea of the part they play; and the confident air assumed by the more expert, when influencing the rapid transition of the needles, expresses as explicitly as looks or mien can do—

> "Speak the word, and think the thought,
> Quick 'tis as with lightning caught,
> Over, under, lands or seas,
> To the far Antipodes.
> Now o'er cities thronged with men,
> Forest now, or lonely glen;
> Now where busy Commerce broods,
> Now in wildest solitudes;
> Now where Christian temples stand,
> Now afar in pagan land.

* We are informed, as somewhat remarkable, that in 1849 eleven dispatches were sent for the *Times*, at the rate of nearly seventeen words per minute!

Here again as soon as gone,
Making all the earth as one.
Moscow speaks at twelve o'clock,
London reads ere noon the shock,—
Seems it not a feat sublime?
Intellect hath conquered Time!
Sing who will of Orphean lyre,
Our's the wonder-working wire!"

The spectator's interest is naturally enlisted; a train of thought and reasoning ensues. The poor needlewoman found an able advocate in Hood, and in the influential pens of other writers; benevolence pitied and relieved. The artificial flower-makers have had their sympathizers; and doubtless others of the gentler sex, who derive their subsistence from the toil and labour of their own hands, have endured, and still experience, privations which are unknown, or known but to the few besides. And why such distress in this land of wealth? why exists this cause for pity? Contrast the two great sections (male and female) of the population numerically with each other; compare the vocations, innumerable and various, which are assigned to the lesser with the few to the greater, and the cause is obvious. Open to women a wider and more diversified field of operation; accord to them a less dependent position than that which they now occupy, and we may augur well for the result.

The telegraph exhibits the perceptive and concentrative faculty of females to equal advantage with that of their brethren of the guild; they catch the movements of the needle, and interpret them, with surprising avidity; and the success of the experiment in employing them is suggestive of the inference that it may be extended, until the telegraph service becomes universally popular as an avocation for women. Unfortunately, employment for this section of the community is, as before observed, limited to few branches, the engagement in most of which is viewed with repugnance by many, who deem it detractive from caste, and degrading to position; hence, many a mind, many a hand, which might contribute to the prosperity of themselves, a household, a nation, is inactive, useless, and reliant upon the energies of the sterner sex to a greater extent than is compatible with the possession of self-reliant capabilities; therefore the discovery of a new source that is likely, in however small a ratio, to inspire emulation, to arouse dormant energies, and

to call latent intellect into life and action, must be a matter of congratulation to the right thinking.

The employment of females, as telegraphic clerks, originated with the telegraph companies on the ground of economy; and the postal telegraph establishment, combining that principle with other advantages, has considerably enlarged upon the idea; indeed, the popularity of the scheme with the postal telegraph authorities, may be inferred from the fact that the number of female clerks, employed in the district and branch offices in London, exceeds that of the males by 50 per cent.; hence the total cost of the staff therein employed, and which consists as under, viz:—

Female clerks 295 Male do 197	..	..	..	..	492
Messengers	..	..	..	..	..	848
				Total		1,340

does not exceed £35 16*s.* 9*d.* per head.

The remarks of Mr. Scudamore, which appear in his Report to the Postmaster-General, may be interesting to those who advocate a more general employment in suitable vocations for females.

"Mr. Chetwynd," he observes, "and I are of opinion that at a future time, when we have had some further experience of a female staff, and when circumstances will enable that department to provide for the accommodation of a larger number of female clerks, it will be well to entrust to them a large part of the work of the telegraph account and telegraph message branches, and to effect a corresponding reduction in the numbers of the male clerks."

Adverting to the time of the transfer of the telegraphs to the Government: "The Electric and United Kingdom Telegraph Companies had, in their chief offices in London, a female staff for day and a male staff for night duty."

In Liverpool a like arrangement was in operation in the Electric Company's establishment.

In Dublin, the Magnetic Company had a male, and the Electric Company had a female staff; but the Postal Telegraph establishment, immediately upon coming into power, commenced, and continue, to employ clerks of both sexes, and the result has been gratifying to all concerned. It was

considered a hazardous experiment, but Mr. Scudamore's assurance is, that he has never had cause to regret it. "I am," says that gentleman, "satisfied that, where large numbers of persons are employed, with full work and fair supervision, the admixture of the sexes involves no risk, but is, on the contrary, highly beneficial. It raises the tone of the male staff, by confining them, during many hours of the day, to a decency of conversation and demeanour which is not always to be found where men alone are employed; and further, it is a matter of experience that the male clerks are more willing to help the female clerks with their work than to help each other; on many occasions pressure of business is met, and difficulty overcome, through this willingness and cordial co-operation."

The pay of female entrants is 8*s*. per week. Mr. Scudamore expresses an opinion that this might be deemed low; but their services are not of much value until they have been employed for two or three months; besides which, properly qualified probationers do not object to that rate of pay. We have been informed of some of the advantages of employing females, but the probability of the number of female telegraphists preponderating is thus argued. "The good accountant, the good linguist, the good salesman, the good mechanic, the good artisan, have many markets for their wares, but the good telegraphist has, and will have, but one market, and the effect of this will be that women, to whom but few fields of labour are open, will be more ready than men to qualify themselves as telegraphists."

Females are not employed on night or Sunday duty in the London postal telegraph offices.

The talented chief of the postal telegraph system, whose largeness of heart and noble sentiment is exemplified in his able and successful advocacy of female claims to legitimate employment, has made allusion to a curious property of the telegraph, and recorded an incident in connection therewith, of so extraordinary and interesting a nature as to seem to justify our reproducing his statements for the information and delectation of those whom they may concern.

"When two offices are in direct telegraphic communication, the clerks in both of them are practically in one office. The whole world is the country of the telegraphist. Sitting at one end of a wire, no matter what its length, he converses

as easily with the clerk at the other end as if he were in the same room with him. Strange as it may seem, he knows, by the way in which the clerk at the other end of the wire does his work, whether he is passionate or sulky, cheerful or dull, sanguine or phlegmatic, ill-natured or good-natured. He soon forms an acquaintance with him, chats with him in the intervals of work, and becomes as much his companion as if he were working face to face.

"It is a fact, that a clerk in London, who was engaged on a wire to Berlin, formed an acquaintance with, and an attachment for a female clerk, who worked on the same wire in Berlin, that he made a proposal of marriage to her, and she accepted him without having seen him. They were married, and the marriage which resulted from their electric affinities is supposed to have turned out as well as those in which the senses are more apparently concerned."

Applications for clerkships and for admission into the service should be made to the Postmaster of the district, and the prospect of their favourable reception is enhanced by their being accompanied by testimonials emanating from the last employer of the candidate, or (if he has not had a previous engagement) from the head of the establishment in which he was educated, and from one or two other respectable parties to whom he is known. He is then supplied with a printed sheet, similar to the *Form of Application* below, comprising a series of interrogations, which must be replied to in the order in which they occur.

FORM OF APPLICATION.

Christian and Surname of Candidate.

Residence.

Age last birthday.

Nature of last Employment.

Address of last Employer.

Reason for leaving last Employment.

Salary received.

Salary now expected.

Names and Addresses of Referees.

Signature of Candidate.

The other side of the sheet is headed "Exercises from Dictation." Underneath this he is supposed to write as the clerk in charge of the station in the town he may be a resident of, or other appointed person, may dictate; but more generally he has to transcribe a paragraph from a newspaper or book, as, for example:—

"We are told that woman's mission is a domestic one, that her character and position do not admit of her taking a part in the decision of public questions; that politics are beyond her sphere. But this raises the question—Who shall say what her sphere is? Amongst the Pawnees and Sioux it is that of a beast of burden; she has to carry the baggage, to drag home fuel from the woods, and to do everything that is menial and laborious. In slave countries it is within woman's sphere to work side by side with man, under the lash of the task-master. Clerkships, cashierships, and other responsible business situations are comprised in her sphere in modern France; whilst, on the other hand, the sphere of the Turkish or Egyptian lady extends scarcely an inch beyond the walls of the harem."

Or—

"Hark! the warning needles click,
Hither, thither—clear and quick,
Swiftly swinging to and fro,
Tidings from afar they show.
While the patient watcher reads,
As the rapid movement leads,
He who guides their speaking play
Stands a thousand miles away.
Eloquent though all unheard,
Swiftly speeds the secret word;
Light or dark, or foul or fair,
Still a message prompt to bear."

Or—

"So it falls out
That what we have, we prize not to the worth
While we enjoy it; but being lack'd and lost,
Why then we reck the value; then we find
The virtue that possession would not show us
While it was ours."

In addition to this, the candidate may probably have to undergo a colloquial examination in orthography and geography, which is generally conducted by the Postmaster of the district, or clerk in charge of the office of his *locale*. If it be deemed and reported upon by the examining party as satisfactory, he commences his instructions forthwith, and remains on probation for a stated period. If at the expiration of that time he be capable of sending and receiving a stated number of words per minute, he is finally installed as

clerk. Mr. Scudamore observes that, if a clerk be of any value, he should be capable of receiving twenty to twenty-five words per minute. A male or female with a good and accurate sight, a steady hand, and average intelligence, may learn to work the single needle instrument fairly well in from eight to ten weeks, and become thoroughly proficient in four months.

Security.

Security or guarantee of fidelity and trust has not to be given to the Postmaster by clerks whose duties are restricted to the working of telegraphic instruments, but in the event of money passing through their hands, for which the Postmaster is accountable, the regulations in respect of Post Office counter clerks will be made to apply.

Messengers may be appointed by the Postmaster. As good conduct entitles the messenger to promotion to the rank of junior clerk, they may have to submit to a similar examination to that of the clerk, and to supply answers, &c., as demanded in the foregoing form of application. Each of the officials is, upon the occasion of undertaking office, furnished with a book containing certain instructions for his guidance in the receipt, delivery, and transmission of messages, &c.

Secrecy.

The most scrupulous secrecy must be observed in regard to all telegrams. The Postmaster-General directs that no information whatever be given, except with the authority of the secretary, as to the contents of any message which may have passed through any postal telegraph office, and he desires that any and every applicant for such information, even though he be the sender or the addressee of the message in question, may be referred to the Secretary of the General Post Office for such answer to his application as under the circumstances it may be right to give.

It is not difficult to conceive the object of imposing conditions of secrecy; the disclosure of a telegram might endanger the position and solvency, and ruin for ever the prospects of the parties whom it concerns. It might defeat the ends of justice, frustrate projects of utility, and operate otherwise perniciously on the individual and the nation. The necessity of keeping faith with the public is therefore of

moment. The Post Office authorities are thus impressed; hence Acts of Parliament authorise the infliction of imprisonment on those of the staff who improperly reveal a message. So desirous are they of preserving the inviolability of secrets entrusted to them, that even their clerks, when not on duty, are prohibited from entering the instrument room, and are enjoined not to hold communication with the public when on duty, save as respects the telegrams having reference to them. Forfeiture of confidence and their situation, and fine also, attend the discovery of the revelation of a communication to a fellow-servant. Like penalties also await the offender who permits any other than those who are deputed by the secretary to examine dispatches or registers, unless it be in the discharge of his duty. There are other irregularities which might be productive of mischievous, indeed, in some cases, ruinous results; and the Postmaster-General is necessarily obliged to employ measures to deter the commission of them. Instances of carelessness, insubordination, &c., are visited by salutary punishment.

Punishment is certainly not a pleasing theme to dilate upon, nor is it by any means calculated to attract votaries to any standard; still, no matter what name it assumes, it is recognised in every establishment as a stern necessity, one which the evil only, not the good, have cause to fear; and nowhere more than in the telegraph office does a divergence from the path of duty justify its institution, although it must be conceded that its opposite often proves a more powerful instrument towards accomplishing similar results. In every phase of life, in the commercial and mercantile world, the trading emporium, the office, and concerns in general, public and otherwise, the basis of usage affecting the *employé* enunciates a conformity of the views of the employer with this principle—pecuniary advantage and improved position are made a consideration; and thus it is with the telegraph service—certain and sometimes speedy promotion recompense the energies of the disciplinarian; the messenger ascends the official incline, he becomes a clerk; the clerk glides on, step by step, from grade to grade, and

"Hope is swallowed in the vast reward."

We will not hazard an opinion as to the consistency of public companies in respect to their officers,—we will not

pretend to divine as to whether it be reconcilable with their conscience or otherwise, to advocate the poet's sentiments—

> "Let none presume
> To wear an undeserved dignity.
> Oh, that estates, degrees, and offices
> Were not derived corruptly! that clear honours
> Were purchased by the merit of the wearer!
> How many then should cover that stand bare!
> How many be commanded that command!"

Whether such lofty ideas actuate in the disposition of preferments is not our province to investigate; but it must be observed that whatever be the effect, the governing bodies encourage the operation of effectual means for the discovery of superior talent. Unlike many who are engaged in official capacity, the telegraph clerk is occasionally subjected to a test of skill. In the case of a Queen's speech, a government proclamation, or a foreign message of importance, a premium is generally awarded to the sender and receiver who accomplishes the task within the least space of time; a pre-eminence is thus assigned to them, and their abilities are prominently brought under the cognisance of the proper authority.

Holidays are granted annually to the postal telegraph officials, the term of leave being generally in accordance with the position of the official. For example:—To superintending officers, one calendar month; to telegraph clerks who are not superintending officers, but who are liable for night and Sunday duty, three weeks; to female telegraph clerks, and those male clerks who are exempt from night and Sunday duty—also messengers, two weeks.

Like other Government offices the postal telegraph clerk has in perspective the reward of fidelity. As duty calls forth his energies, as he devotes the vigour of life to the incumbencies of office, it is with the consolatory knowledge that in his declining years he may legitimately demand a pension, and release from the cares and responsibilities of business pursuits.

When, in 1870, the telegraphs became the property of the Government, the greater number of the telegraph companies' officers and clerks were drafted into the service of the Postmaster-General, whilst others were placed in the immediate receipt of a superannuation allowance, the section of the Act relating thereto, providing that "every

officer and clerk of any telegraph company, the undertaking of which was purchased by the Government," who has not been less than five years in the service of telegraph companies, and in the receipt of a yearly salary, or who has not been less than seven years in the service of telegraph companies, and is in receipt of a remuneration at a rate of not less than £50 per annum, shall, if he receives no offer of an appointment by the Postmaster-General in the telegraphic department of equal value to the appointment held by him under any company, receive during his life from the Postmaster-General, by way of compensation for the loss of his office from the time at which the Government takes possession of the company's telegraph, an annuity, payable half-yearly, equal, if he shall have been in the service of the telegraph companies twenty years, to two-thirds of the annual emolument derived by him from his office; and with respect to any such person who has been in such service less than twenty years, the said annuity shall be diminished at the rate of one-twentieth for every year less than twenty years during which he has been in such service. Such officers and clerks as enter into the service of the Postmaster-General, shall be entitled to count their past years of continuous service with the telegraph companies as years passed in the civil service of the Crown; and all such officers and clerks upon their appointment, shall be deemed to be, to all intents and purposes, officers and clerks in the permanent civil service of the Crown, and shall be entitled to the same, but no other privileges.

When the Post Office authorities determine on the transfer of a clerk to another station, he must comply, unless there are peculiar reasons for his continuing where he may then be. Such removals are of course unattended with expense to the clerk.

Clerks are supposed to devote the whole of their time to the service; or, in other words, they must not during their term of office engage in any other vocation.

Many of the railway companies have in operation over their lines telegraphs of their own, or wires which are worked by their own servants, generally lads, who are under the supervision of the station superintendents. Their appointment is generally vested in the railway company's telegraph superintendent, subject, however, in most cases, to the approval of

the board of railway directors. The duties of these clerks are confined to the telegraphing the times of arrival and departure of trains, and the transmission of messages on railway business only. The course of examination consists of reading and spelling. After passing that ordeal they commence their instructions upon the instrument; and when they are competent to send and receive a message their pay begins, generally at about seven shillings per week, which is subject to an advance until it reaches its maximum, when, if their conduct warrants it, and they should have profited by the spare time and opportunities that present themselves in qualifying themselves for the post of booking or goods clerk, the recommendation of their superintendent will be conducive to their appointment as such.

The denomination of officials in the postal telegraph offices includes messengers, counter clerks, instrument clerks, inspectors, superintendents, and engineers, on whom devolves the supervision of the engineering department in the district.

At minor offices the duties of the counter and instrument are combined.

The commencing pay of the clerk varies from eight shillings in the case of females, and twelve shillings and upwards in the case of males per week.

Schools of Telegraphy.

Connected with the Postal Telegraph Establishment, a London School of Telegraphy was instituted in Cannon Street in May, 1870, between which date and May, 1872, it was attended by 1,011 learners—648 of these were females and 363 were males. 504 of the females and 270 males attained to a proficiency which enabled them to obtain employment as instrument clerks in postal telegraph offices; 61 females and 35 males were at the latter date undergoing tuition, 43 females and 41 males retired from the school, and 40 females and 17 males, only, failed to pass the necessary examination. The following Report of the school superintendent will explain the primary cause of the unsuccessful pupils not satisfactorily acquitting themselves at their examination. "Failure," he observes, "is far oftener due to educational unfitness than to want of dexterity in operation. It is rare that we send away a person of good educational

attainments. I should perhaps say it is rare we ever have to do so, for mental deficiency is generally at the bottom of telegraphic inaptitude. Unquestionably the failures would be fewer if the average educational attainments of the pupils were higher." The conduct of the school for males devolves upon a superintendent, who is assisted by a deputy and instructor. The matron in charge of the school for females is assisted by a deputy and three instructresses. The schools are fitted up with telegraphic instruments, which are so disposed that those in communication with each other are situated in opposite parts of the room, and the learners are taught to forward, receive, and write out messages which are prepared for the purpose, and, in fact, both in regard to signalling and conforming to regulations, are made practically conversant with the actual business of a telegraph office. The limit of age at which persons are admitted into the school is between 14 and 18 years, a preference being accorded to ages varying between 15 and 17 years. Candidates for admission into the school are required to give proof of their educational attainments by—

Writing from dictation.

Copying a statistical table, and demonstrating their knowledge of the geography of the United Kingdom, and their knowledge of the four fundamental rules of arithmetic.

Examinations are held every fortnight, and admission thereupon made into the school in the ratio of 8 males to 12 females.

A probationary examination of the pupils takes place at the expiration of one month after the date of joining the school.

Candidates for the school have to undergo a medical examination, the principal object thereof being to guard against defective vision and hearing.

A school of telegraphy for males is also attached to the Dublin General Post Office.

Depôts of instruction are likewise organized at the posts named below:—

	Learners Accommodated.
North Wales District—	
Birmingham	12
Chester	4
Shrewsbury	4

	Learners Accommodated.
South Wales District—	
Cardiff	10
Gloucester	8
Newport	8
Swansea	4
Hereford	5
Western District—	
Exeter	8
Plymouth	8
Southern District—	
Portsmouth	3
Southampton	12
South-eastern District—	
Brighton	4
Ashford	3
Maidstone	3
Tunbridge Wells	3
Dover	3
Eastern District—	
Norwich	10
North Midland District—	
Derby	16
Hull	8
North District—	
Lancaster	4
York	10
North-western District—	
Leeds	10
Preston	6
South Midland District—	
Bedford	2
Coventry	2
Leamington	2
Northampton	4
Oxford	4
Worcester	3
Bristol	24
Edinburgh	35
Glasgow	10
Liverpool	12
Manchester	50

In the provinces, where a learner can in one minute send fifteen and receive ten words on the Sounder or the single needle instruments, or send ten and receive fifteen words on the printing instruments, he is eligible for admission into the instrument room—if there are vacancies—the wages being at the rate of five shillings per week; *and there*, whilst perfecting his qualifications as a manipulator, he is engaged

in such employment as will make him conversant with the duties which devolve upon a fully qualified clerk.

The Messenger.

This official's stipend is regulated by circumstances, the minimum amount per week being five shillings. In some cases he is paid by fixed wages, and in others at a certain rate per message. His duties are, to deliver messages to within the radius of a mile free of charge, and beyond that distance at the following rates:—

	s.	*d.*
Not exceeding 1 mile	0	6
1, and not exceeding 2 miles	1	0
2, „ 3 „	1	6

When circumstances render necessary the employment of a fly, cab, or other conveyance to expedite delivery, these charges are duplicated. These receipts are not, of course, applied by him, but handed over to the recognised officer. He has an opportunity, and is indeed enjoined, to make himself acquainted with the telegraph; and when he is deemed competent, is promoted to the rank of junior clerk, and has equal chances of advancement with those who commenced in the latter capacity. The ages of the messengers vary from ten years upwards. When the messenger is remunerated by a rate per message he will receive with each message a numbered messenger's ticket. Employment is afforded to 5,440 telegraph messengers in the United Kingdom. Of these, upwards of 970 in London and 2,010 in the provinces are supplied with uniform.

Messenger's Ticket.

POST OFFICE TELEGRAPHS.

No. of Message_____

No. of Messenger_____

Date_____187

The Clearing House.

In this branch of the Postal Telegraph system (the officials connected with which are exclusively females) are examined, at least one day's telegrams, in every month of each postal and railway office in the United Kingdom, the object being to discover indistinct writing, inaccuracies, delays in transmission and delivery, as well as other instances of neglect of rules, in order that remedial measures may be had recourse to.

The Counter Clerk.

The duty of the counter clerk is to receive messages or telegrams from the public, and to transfer them to the instrument clerk for transmission. The charges have to be computed and payment obtained by him, he accounting to his Postmaster for all moneys he may receive on behalf of the Postmaster-General. He has also to enclose the received telegrams in properly addressed envelopes, and to see to their despatch by the messenger.

Instrument Clerks,

As the name implies, have to attend to the instrument for the purpose of transmitting and receiving messages. Instrument clerks are not allowed to leave the instrument room unless sanction for doing so be first obtained from their superior officer.

As an incentive to the clerk to make himself conversant with the principles of electricity and the construction of telegraphic instruments, and, in fact, to become an efficient telegraph engineer as well as a manipulator, the sum of £2,000 is divided annually in gratuities amongst those who are capable of passing the necessary examination to entitle them to rank in the higher grades of clerks, respectively distinguished as Class A and Class B. A clerk in passing the examination of Class A, has awarded to him a sum amounting to £2 10*s.* 0*d.* To be eligible to submit to an examination in Class B the candidate is expected to be also competent to grade in the former ; and in passing his examination in Class B, the sum of £5 is awarded him. These

examinations take place half-yearly, namely, in June and December. The examination in

Class A consists in being capable of joining up and placing in circuit the telegraph instruments in use, with the exception of the Hughes, the Wheatstone, and the Translator; of comprehending the connections of, and the ability to trace the course of, the current through the instrument; of being capable to adjust the instruments aforenamed; to ascribe whether a fault is in the instrument or in the line; and to remedy all ordinary faults in the instrument; and the candidate must also demonstrate a knowledge of the construction of the batteries, and a capability of testing, charging, and refreshing them.

Class B. To obtain the gratuity in this class, the clerk must be able to "localise" a fault on the line, or to find between which of the testing points it lies; to use the "Tangent Galvanometer," the "Wheatstone Balance," and the "Differential," for ascertaining the resistance and insulation of a circuit; to pass an examination in writing on rudimentary electricity and magnetism, including the laws of the current; to pass an examination on either the "Wheatstone," the "Hughes," or the "Translator," if either of them are in use at their station.

Should any pupil in the school wish to qualify for examination in Class A, they may do so, but they are not eligible to be examined for a gratuity until they have been six months in the school.

The examiners are, for London, the chief engineer; and for the provinces, the divisional engineers. Printed questions and written answers will form part of the examination.

Postmaster, or Clerk in Charge.

Among the duties devolving upon this officer are those of enforcing discipline and a rigid adherence to regulations from his subordinates; to see that the various accounts are duly rendered; to report periodically or otherwise, as circumstances demand, on the requirements of his district, the state of signals, and the means, if any, of more widely extending the business of the district. He is responsible for his staff being in a state of efficiency, and for a due appro-

priation of their duties. Included in the books which are generally kept by him are—

The Diary, which is a record of the condition of signals, interruptions, delays from inattention at correspondent stations, and other matters of moment.

The Complaint Book, which should contain reports made by the public against members of his staff.

The General Order Book.—In this book are posted those orders which are issued from time to time from the chief office, and which have reference to his duties and the working of the line.

Scale of Charges for Inland Telegrams.

Fo. a telegram					s.	d.
Not exceeding		20 words or 4 lines			1	0
21 words		25 „ 5 „			1	3
26 „		30 „ 6 „			1	6
31 „		35 „ 7 „			1	9
36 „		40 „ 8 „			2	0
41 „		45 „ 9 „			2	3
46 „		50 „ 10 „			2	6
51 „		55 „ 11 „			2	9
56 „	and not	60 „ 12 „		the	3	0
61 „	exceeding	65 „ 13 „		charge is	3	3
66 „		70 „ 14 „			3	6
71 „		75 „ 15 „			3	9
76 „		80 „ 16 „			4	0
81 „		85 „ 17 „			4	3
86 „		90 „ 18 „			4	6
91 „		95 „ 19 „			4	9
96 „		100 „ 20 „			5	0

And for every additional line of five words, or part of a line, 3*d*.

The words in the names and addresses of senders and receivers are telegraphed free of charge, and so are those in the instructions as to the mode of delivery of the telegram, provided such instructions can be signalled by code, as for instance—

By boat	the codes for which are	B B
By cab		B C
By best means ..		B M
To wait till called for		C F

If there be no code that will represent the request, the instructions must be telegraphed literally, and the words comprising them added to those of the message and charged for accordingly.

The above rates afford a pleasing contrast to those in force in 1850, as is apparent from the undermentioned scale for twenty words, inclusive of name and address :—

London to—	Distance in miles.	Charges. s. d.
Birmingham	112	6 6
Hull	200	9 6
Newcastle	300	10 0
Glasgow	420	10 0

In times of such high charges it is doubtful whether a message was ever sent in duplicate, much less could such a circumstance as that of which we have Mr. Scudamore's assurance be expected, that a man of business recently handed in a message to be transmitted to 1,100 persons who resided in a hundred different parts of the country—the average price per thousand telegrams under the existing tariff is £57 7*s.* 9½*d.*

The American scale of charges in 1850 were considerably less than those of any other country. For instance—

Philadelphia to—	Distance in miles.	Charge. s. d.
Washington	30	0 5
Baltimore	99	1 0
Pittsburg	321	1 8
Harrisburg	107	0 10
New York	90	1 0

Repeating, or Test of Accuracy.

If it be desired to ascertain whether the telegram has been accurately transmitted, the sender or author of it may demand of the forwarding clerk that it be signalled backwards from the receiving office, but prepayment of half the amount originally paid will be required for such extra service. If an error or omission be thus discovered, the sender may claim that the amount of the latter charge be refunded to him; but if it be found that the message was correctly sent, he will not be entitled to a return of any portion of it.

Prepayment for Replies.

The sender of a telegram may, if he desires it, prepay the cost for a reply, and in such cases the same rate of charge as for the forwarded message will apply. Supposing for instance, that the original message contained 20 words, for which a shilling would be charged—and it be expected that the reply would consist of 20 or 25 words, the sum to be prepaid in the former case would be 1*s.* and in the latter 1*s.* 3*d.*

If the reply be not returned within the time (not less than two hours) which the sender of the forwarded message must state when he makes prepayment for it, he may if he wishes request the Postmaster to make inquiry by telegraph, whether delivery of the telegram has been effected, and demand that the amount paid in respect of the reply be refunded to him; but should the reply subsequently arrive, it must be delivered to (and the charges obtained from) him.

Prepaid replies may be sent from any postal telegraph office within two months from the date of the original message.

Duplicate, Triplicate, or more Copies of Telegrams.

If the sender requires copies of his telegram to be delivered to two or more firms or persons in the same free delivery, he may have this done by payment of the ordinary charge for the original message, and 3*d.* extra for each copy of it; for instance, a person wishes to telegraph the same information to three persons in Covent Garden Market—he, therefore, if the telegram consists of not more than 20 words, pays 1*s.* for one of these copies, and 3*d.* each for the two others.

Re-direction of Telegrams.

If through the removal of the addressee or any other cause, the sender should require the original receiving office to re-direct and telegraph the message to another place, he will be required to pay for such extra service half the amount of the original cost of the telegram.

Half-rates on Inland Telegrams.

In charging half-rates, a fraction of a penny is computed as a penny; thus the half of 1*s.* 3*d.* will be charged as 8*d.*, and 11*d.* must be demanded as the half of 1*s.* 9*d.*; hence in the case of the re-direction of a telegram,—

	s.	*d.*
The first charge of the message of 25 words would be.. ..	1	3
And the extra cost in respect of the re-direction would be..	0	8
Total charge	1	11

Unintelligible and Foreign Words.

Each syllable in an unintelligible or in a foreign word will be charged for as one word.

Parentheses, Inverted Commas, Underlines, and Hyphens.

In charging for those words which are included in parentheses and inverted commas, as well as for those which are underlined, two extra words must in each case be reckoned; but hyphens and combinations effected by them, such as to-day, noon-day, to-morrow, equi-distant, alms-house, country-house, well-known, half-penny, two-pence, three-pence, &c., will be charged as one word each.

Names of Persons, Places, Professions, or Trades,

Consisting of combined words, such as Mac-Laren, De-la-roche, Ashby-de-la-Zouch, Westbury-on-Severn, Saint Martin's-le-Grand, Liquorpond-street, Woollen-draper, Stock-broker, Gold-smith, are charged for as single words.

Abbreviations.

The abbreviations A.M. and P.M. for forenoon and after noon, and contractions, such as *can't, couldn't, don't,* are charged for as single words. By having recourse to abbreviations error is risked, therefore it is recommended that senders eschew them as much as possible, and the instrument and copying clerks are strictly prohibited employing them unless they occur in the telegram.

Stamps.

By the Telegraph Act of 1868, it is enacted that payments for the transmission of telegraphic messages from one place to another in the United Kingdom, shall be made in all cases by means of stamps, and the Postmaster-General shall cause a proper supply of stamps and stamped paper to be prepared for that purpose, and kept for sale to the public at such of the offices under his control as he may think fit to appoint for that purpose.

The ordinary postage stamps will be used for the prepayment of telegrams, and may be obtained at the various post offices, the respective values procurable being 5*s.*, 2*s.*, 1*s.*, 10*d.*, 9*d.*, 6*d.*, 4*d.*, 3*d.*, 2*d.*, 1*d.*

Stamps should also be affixed to the form in prepayment of extra charges in respect of special delivery.

Economising the number of Stamps.

Although it is optional with the public to use any priced stamps to constitute the aggregate charge of a telegram, they are asked to economise the number as much as possible; for instance:

To affix a shilling stamp in preference to 12 penny, 6 twopenny, or 4 threepenny stamps.

A shilling and a threepenny stamp instead of 15 penny, or 5 threepenny, stamps, and so on.

Stamped Forms.

Message forms bearing the distinctive mark A 1, impressed with a shilling embossed stamp, may be obtained in single copies at 1*s.* each, or in books containing 50 for £2 10*s.*

Unstamped Forms.

When unstamped forms are used, the requisite number of stamps must be affixed to them; a supply of these, to be used as required, may be obtained at any postal telegraph office.

Embossed Stamp Form, if defaced.

In the case of any of these forms being spoilt by the public, the value will on application be refunded to their possessor, and the Receiver and Accountant-General will return to the Postmaster fresh forms in lieu of those spoiled.

Prepayment of Telegrams

Is, as a general rule, required from the public, the following, however, are the exceptions :—

Subsequent Payment of Telegrams.

PRIVATE WIRES.

Messages received by private wires at postal telegraph offices for transmission, are subsequently paid for through the chief office. The transmitting clerk must affix to the forwarded message form a printed label of this pattern :—

Private Wire

Message.

There were, in 1872, 885 renters of private wires, the extent of such wires amounting to 4,311 miles, the receipts for which, for that year, were £31,607.

Public News.

Credit is given to Newspaper proprietors, proprietors of News-rooms, Clubs and Exchange Rooms, on making a deposit of £25, provided the message has attached to it a press pass, as per following *pro forma* :—

POST OFFICE TELEGRAPHS.

PRESS PASS BOOK.

Message sent on the business of the "Sportsman," London.

From

_____

_____

To the

"SPORTSMAN,"

LONDON.

Signature _____

Address _____

_____ 187 .

POST OFFICE TELEGRAPHS.

PRESS PASS BOOK.

The Message to which this Pass is attached is to be addressed to the "Sportsman," London, and is to contain intelligence only for publication solely in that Newspaper.

The Message is to be sent without pre-payment, in turn with ordinary Messages.

Messages containing more than 200 words must not be franked by these passes, unless notice that they will be tendered be given in writing on the day prior to that on which they are to be transmitted, or unless the Postal Telegraph Office at which they are tendered possesses the means of forwarding them without delaying the Messages of the Public.

From

_____

_____

To the

"SPORTSMAN,"

LONDON.

Signature _____

Address _____

_____ 187 .

_____ *Words.*

Unless this pass be tendered with the message, prepayment will be demanded; the transmitting clerk will attach the pass to the message to which it refers, and forward it to the chief office.

In illustration of the importance of the telegraph to the newspaper press, it is stated that, on the occasion of the discussion of the Scotch Education Bill, March 7, 1872, upwards of 1,838 press telegrams, consisting of 111,166 words, were sent from the Central Telegraph Office; and on the 19th March, when Sir Charles Dilke's motion was before the House, 2,344 telegrams, consisting of 93,033 words, were sent from the same office.

Charges for Newspaper Intelligence Messages.

The Postmaster-General, with the consent of the Commissioners of Her Majesty's Treasury, may make contracts and arrangements with the proprietors or publishers of any public registered newspaper, the proprietor or occupier of any News-room, Club or Exchange Room, for the transmission and delivery of telegraphic communications to a single address, at the undermentioned rates:—

	To Single Address or Copy.	For every additional Address or Copy.
If transmitted between the hours of 6 p.m. and 9 a.m.	per 100 words 1*s.*	An extra 2*d.*
If transmitted between the hours of 9 a.m. and 6 p.m.	„ 75 „ 1*s.*	„ 2*d.*

The Postmaster-General may also with the like consent let to any such proprietor, publisher or occupier, the special use of a wire (during such period of 12 hours per diem, as may be agreed on) for the purposes of such Newspaper, News-room, Club or Exchange Room, at a rate not exceeding £500 per annum, provided that no such proprietor, publisher, or occupier, shall have undue priority or preference in respect of such rates over any other such proprietor, publisher, or occupier.—(Extract from 31 & 32 Vic., cap. 110). Special wires are let for use during the night only to the proprietors of nine newspapers, at £500 per annum each.

Railway Companies' Messages free of charge.

Messages of railway companies, over whose line the Post master-General has acquired a way-leave, will be transmitted,

if exclusively on the business of such company, to and from any postal telegraph office in the United Kingdom free of charge, conditionally, however, that a railway post office telegraph pass be attached to such message, when it is tendered for transmission. Such pass must accompany the forwarded message form, when returned by the Postmaster to the chief office: (see page 28).

The railway companies maintain for the Postmaster-General, 48,000 miles of wire, for which they charge him at the rate of £1 per mile per annum; and the Postmaster-General, in addition to maintaining a certain mileage of wire for some of the railway companies, also maintains 45,000 miles of wire for himself.

Deposit of Telegrams in Wall or Pillar Letter Boxes.

Telegrams may be deposited in wall or pillar boxes, whence they will be conveyed to the postal telegraph office without extra charge, at the ordinary times of collection from such boxes, and the time at which they reach the office will be the recognised time of reception there. Telegrams so deposited should bear the necessary amount of stamps chargeable for transmission and (if their destination be beyond the free delivery limits) special delivery. If no stamps are affixed, the message will be dealt with as an ordinary unpaid letter.

When the value of the stamps which are affixed to the form are insufficient for the payment of the total charges, the short charge will be demanded from the addressee. Messages deposited in a pillar or wall letter box should be enclosed in an envelope, and addressed "Telegraph Office."

Telegrams deposited with the Rural Post Messengers.

Sufficiently stamped telegrams may be handed to rural post messengers when they are proceeding to postal telegraph offices, whence they will be transmitted to their destination.

Delivery of Telegrams.

Ordinary.

The ordinary delivery of a telegram is by a foot messenger, and is limited to a distance of within one mile of the terminal telegraphic office, or the town postal delivery of that office

POST QFFICE TELEGRAPHS.

RAILWAY PASS BOOK.

Message sent on the business of the _____ *Railway Company.*

From

To

Signature _____

Address _____

_____ 187 .

POST OFFICE TELEGRAPHS.

RAILWAY PASS BOOK.

The Message to which this Pass is attached is to be sent without pre-payment, in turn with ordinary Messages.

From

To

I certify that the Message to which this Pass is attached is *bond fide* on the business of the _____ Railway Company.

Signature _____

Address _____

_____ 187 .

_____ *Words.*

when it is a head post office, and the town postal delivery extends for more than a mile from it; thus if the addressee's residence is a mile and a quarter from the head post office, and yet included within the postal delivery of that office, no extra charge would be made for the service of delivery.

Postal.

When the residence of the addressee is beyond the limits of free delivery, and the sender will not incur the cost of special delivery, his message will be delivered, free of additional charge, by the ordinary postal delivery next following on the arrival of his telegram at the terminal telegraphic office.

Special Means.

When the sender undertakes to prepay the charges for special delivery, he will state the same on the space assigned to such instructions, and insert the amount prepaid by him on the back of the forwarded message form A or A 1. The charges for special delivery are per double mile—

	s.	*d.*
If by a foot messenger	0	6
If by a cab, fly, or horse, except in Ireland	1	0
If by a cab, fly, or horse, in Ireland.. ..	0	8

Fractions of a mile are computed as a mile. Foot messengers not employed if the distance exceeds three miles.

Correct Distances to be declared by Senders.

Senders of telegrams are enjoined to state as correctly as possible the distance from the terminal telegraph office, should the destination of the message exceed the limits of free delivery.

Postmaster's Horses.

Postmasters are not prohibited employing their own horses in the special delivery of telegrams, the charge, however, being restricted to the usual rate.

Double Mileage.

The journey from and to the telegraph office constitutes the double mileage; hence, if the distance from the postal telegraph office be a mile it would be computed as a double mile, and 6*d.* charged for same in the case of a foot messenger, and 1*s.* in the case of a cab being employed. If

the distance be 1¼, 1½, 1¾, or 2 miles, the charge would in respect of each distance be 1*s.* for special delivery by foot messenger and 2*s.* by cab.

Short Charges for Special Delivery.

Information as to the amount prepaid in respect of the special delivery of a telegram must be signalled to the receiving station, so that in the event of a short charge, the difference may be obtained from the addressee.

Overcharges.

If the amount prepaid is in excess of that actually chargeable for the special delivery, the receiving clerk will advise the forwarding office, and the amount of overcharge will be refunded to the sender.

Closing of Postal Telegraph Offices.

The delivery of any telegram received at the appointed time of closing the office, will be effected on the evening of the same day of its receipt.

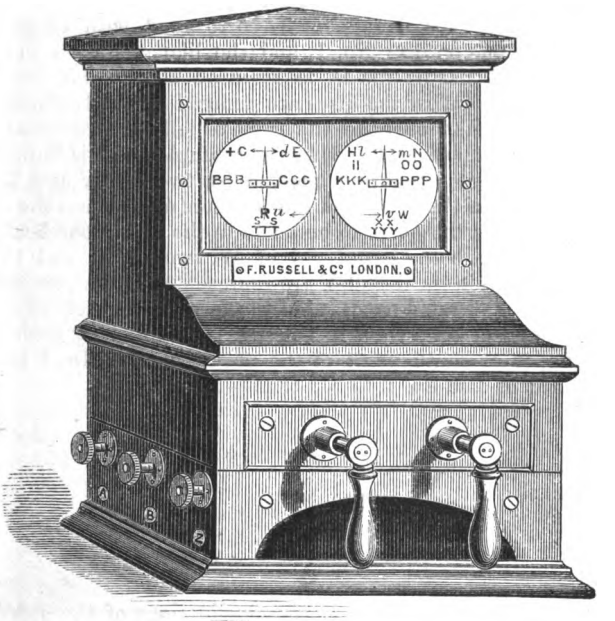
THE DOUBLE NEEDLE INSTRUMENT.*

This was originally, and until recently, the only instrument in general use, and is even now considered one of the most rapid means of non-automatic telegraphic communication; indeed, it was formerly almost invariably employed in the transmission of speeches from the Throne and important parliamentary debates. But upon the principles of economy and accuracy, the single needle bids fair to supersede it. In pernicity, however, the double needle excels in the ratio of about two to one.

It is so named from the peculiarity of its construction rendering necessary the use of two needles in the formation of the letters of the alphabet. Each of these needles has

* The double needle instrument is not employed in postal telegraph offices.

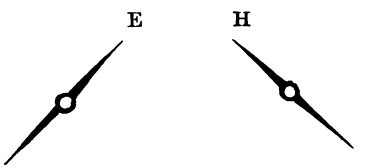
assigned to it the central position of a disc or circle, and when not in operation points to the north and south; their movements are regulated through the internal portion of the instrument, which is operated upon by two handles, each handle affecting the needle of that disc only which is immediately above it. The alphabet is distributed over the two discs precisely as shown in the diagram, and the respective



letters, with the exception of C, D, U, V, L, and M, are indicated by one or a succession of vibrations (or, in telegraph phrase, *beats*) of the needle or needles, as the case may be, in the direction of the letters to be described; hence, A appearing in duplicate on disc No. 1, must in consequence be denoted by making the needle of that disc point or beat twice in rapid succession towards it. In like manner, B is represented by a triplicate, or quick repetition of three beats in

the same direction. C is represented by a rapid transition of the point of the needle of No. 1 disc from left to right; and D, on the contrary, requires the reverse movement, viz., from right to left. In like manner, the beats of the needle of disc No. 2 are expressive of the letters in immediate proximity to it; thus, the beats to the left are, one for H, two for I or J, and three for K; and it therefore follows, that those letters on the opposite side of that disc are indicated by one beat for N, two for O, and three for P. The vibrations of this needle for L correspond with those for C of that one on disc No. 1, and the like operation to that with No. 1 needle for D, is required on this one for M. Those letters below the discs are denoted by the two needles beating simultaneously to the right or left, according to the position occupied by them, as for example:—R is indicated by both needles pointing once, S by two beats, and T by three beats to the left; and those letters underneath the disc No. 2 require the beats to be made to the right, one beat by both needles being expressive of W, two of X, and three of Y. The letters U and V are represented by the motion of the needles in rapid succession, the former from left to right and the latter from right to left. Z is denoted by directing the upper or south point of the needle of disc No. 1 to C, and that of disc No. 2 to N; thus—

and Q is represented by diverse inclinations of the needles, one of the needles pointing to E, and the other to H, thus—



The following arrangements may facilitate the progress of

the learner in acquiring the knowledge of the telegraphic alphabet :—

MOVEMENTS OF THE NEEDLE.

Disc No. 1.

Letter.	Beats to left.	Letter.	Beats to right.
A	2	E	1
B	3	F	2
		G	3
C left to right.		D right to left.	

Disc No. 2.

Letter.	Beats to left.	Letter.	Beats to right
H	1	N	1
I or J	2	O	2
K	3	P	3
L left to right.		M right to left.	

SIMULTANEOUS MOVEMENTS OF BOTH NEEDLES.

Letter.	Beats to left.	Letter.	Beats to right.
R	1	W	1
S	2	X	2
T	3	Y	3
U left to right.		V right to left.	

The pointing of the needle to +C indicates that the signal or word last completed cannot be interpreted, or was not sufficiently distinct to be read. The technical term for this signal is, "don't understand."

The pointing of the needle to E bears an opposite construction ; this latter signal is termed "understand."

One of these movements must occur after each word ; in the former case it demands that the signal or word be repeated, and in the latter case that the message be proceeded with.

The period, or full stop (.), is represented by the letters SQ, which would terminate the following sentence :—

Faraday proved that a single drop of water may afford more electricity than that causing the most powerful flash of lightning SQ

Another example—

The first Electric Telegraph Company (subsequently known as the Electric and International) was constituted in 1846, and consisted of eight persons only SQ

Inverted commas (" ") are denoted by the letter C occurring in duplicate before and after the word or sentence; hence, in the following example, it should precede the word "among," and constitute an annexe to the word "language."

CC Among recent additions or improvements in the United States relating to telegraphy is that of Bolton's Telegraph Code. To comprehend this the fact must not be overlooked that the electric current along the wire admits but of two signs, the dot and the dash, the one being but a prolongation of the other. The question Major Bolton has undertaken to solve is, how best to apply them. In the word 'best' is implied speed, as the telegraph means time; accuracy, for the message is worse than worthless if incorrect; universality, for the globe is the field and the wire is the true bond of brotherhood. Morse, out of his dot and dash, constructed the alphabet now in use. He has five dots for his first five numerals, and five dashes representing 6 to 0. Morse's alphabet is, as we have said, - — for A, which, according to Bolton's code, is 16, therefore 16 is A; — - - - means B by Morse's alphabet, by the code it is 63, therefore 63 is B; — - — - means C, and in the code 6161, hence these figures represent the letter, and so on. The code therefore takes in Morse's alphabet to be employed when required. Thus the system is made so comprehensive that it embodies everything now used, while confining itself to the numerals as symbols. In applying this code to the main consideration, time, it must be explained that spaces, of which there are three, are almost as valuable in transmitting messages as symbols. The first space separates the elements of a letter; the second, the letters of a word; the third, the words themselves. The duration of a dot is the unit of length, and the dash equals three dots. The first is the unit, the second is the dash or three dots, and the third is equal to six dots. In submarine lines the dot increases in length, indeed in equalling the dash on short open air lines. Bad spaces cause most of the operator's blunders; hence whatever reduces the number of spaces tends as well to accuracy, though more still towards economising time. The numerals cannot fail to be more simple, being confined to 10, than are the letters, consisting of 26, while stops, parentheses, accents, will also, in a measure, be done away with by the code. But Bolton's system does not only leave the alphabet as now in use for those who require it, but increases its utility, both by giving whole all the small words frequently occurring, as *and, the, but,* and by giving double letters, as 454 M, 455 M', 456 Ma, 457 Mb, 458 Mc, carrying the alphabet through the whole, each letter in capitals being printed in conjunction with every other letter of the alphabet, enabling the operator to send double letters, whereby half the time is saved. Such a code is applicable to the globe, as numerals are universal, all required being to interpret the English signification of the number into that of any other language CC

A parenthesis ( ) is indicated by the double P supplying the place of the semicircles which describe it in the ordinary way. Take as illustrations—

The transit of Venus PP by which the distance of the earth from the sun is determined PP can only occur twice in a century, because it is only twice in that time that any number of complete revolutions of Venus are just, or nearly, equal to a certain number of the earth's revolutions.

Among the telegraph apparatus in the Post Office, St. Martin's-le-Grand, is one said to be the identical instrument, the working of which led to the capture of Tawell, the murderer, and about it the following story, which may or may not be authentic, is related. It is one of Cook and Wheatstone's five needle instruments, and from the letters of the alphabet, which are displayed upon its strange looking diamond-shaped dial, the letter "Q" has been omitted. This deficiency placed a trifling orthographical difficulty in the way of the clerk who had to telegraph instructions for the arrest of Tawell "the Quaker," and occasioned great embarrassment to the person who had to receive the message. "K-w-a" was slowly spelled out by the five needles; but as he knew of no word in the English language which commenced in that fashion, he imagined that there must be some fault in the working of the telegraph, and called upon his colleague at the other end of the wire to "repeat." The same process was renewed several times, and always with the same result, always "K-w-a," until a sharp boy suggested that the sender should be allowed to complete the word. His advice was followed, and after the receipt of three more letters the word "K-w-a-k-e-r" was formed, and at once, PP read phonetically, PP recognised as the equivalent for "Quaker." The omission of the Q had compelled the transmitting clerk to use "kw" for "qu."

To signify that a sentence has been underlined, the letter L should be signalled in duplicate immediately before and after it. Examples—

A writer in the *Scientific American* suggests the Morse alphabet for the use of LL deaf mutes LL in the dark, the finger being employed as a key is for transmission. To persons who occupy apartments on different floors in the same house, connected by a common gas pipe, communication is easily maintained in this way.

Embossed Paper Automatic Process. *(From Professor Morse's Report.)*—The general advantage proposed to be obtained by automatic transmission is that a greater quantity of intelligence can be transmitted in a given time by this mechanical mode than by the ordinary or hand manipulation with the Morse key, or manipulator, and that this may be accomplished by having the dispatch, if of great length, set up or prepared by dividing it into what are called by printers "takes" or convenient portions, and employing several operators who, at the same time, prepare their several takes by setting up the type, or preparing the punched paper to be used in the transmission. The mode proposed by the writer of this report has the advantage of greater simplicity as a result of the embossing process with the *point sèche*. For this mode requires no type setting, no new instrument for preparing the paper; no new process of punching paper to be learned by the operators. The operator prepares his dispatch in the usual way, by embossing the paper, as if sending a

dispatch. It is then at once ready for transmission; needing no perforations nor other preparation. The paper strip with the embossed characters is simply passed beneath a delicate lever like that of the relay magnet. As every embossed part passes under the lever, contact is made longer or shorter according to the length of the embossed line. The result is the same as by the type process; and the punched paper process. The only variation which may possibly be required in the present Morse apparatus is a more perfect mechanical embossing point, a small wheel, for example, instead of a blunt point, by which the embossed characters shall receive a stronger and a bolder relief, and paper more capable of this strong embossing. These are within the ordinary mechanical capabilities of good workmanship. Those who are familiar with the early history of the generic telegraph will recognise the fact that the automatic mode of recording was embodied in the LL first telegraphic instrument devised by the writer in 1832, LL and it was the first mode by which the new art was demonstrated in 1835. At that early period the automatic was deemed to be the only practical, if not practicable, mode of insuring a perfect record. The details of this process are to be found in the earliest specifications and descriptions and models of the Morse invention in the Patent Office at Washington, and the instrumentalities are very fully described and illustrated by diagrams in Vail's earliest work on the telegraph, published in 1845.

No matter of how many syllables or letters a word may consist, the number of beats of each letter must be fully rendered.

As might be inferred, the elementary lesson is the alphabet, and that the learner may pursue his studies uninterruptedly, a "dummy instrument," or an instrument on short circuit (*i.e.* connected with the batteries, but not communicating with any other station), is placed at his disposal for practice. He may perfect his knowledge of it by getting one of the clerks to signal as he stands near him and reads; and when he deems himself capable of sending a message, however slowly, he may do so upon the line instruments (when not pre-occupied) by arranging with a clerk at one of the other stations to converse upon it with him. He may soon become acquainted with the manipulations necessary for the formation of the several letters, and be able to signal and receive messages by the double needle instrument; no mistake need arise, inasmuch as the instructions given on the discs are sufficient to obviate it.

The messages may be read in the course of transmission at each of the stations in the same circuit, unless the earth-wire be applied to one of the terminals (or metallic knobs, which project from the sides of the instrument).

Switches.

At stations where there are switches the electric current may, by a certain application, be intercepted, and its progress diverted to another course, at the option of the party regulating them.

Transmitting Stations.

Stations at which there are switches are called "transmitting stations," to which those communications that are destined for stations beyond them must be first telegraphed, and resignalled or transmitted by the instruments at the transmitting station to the place for which they were originally intended.

Prevention of Interruptions.

As one telegram only can be sent at a time, except by the duplex system, the stations which are engaged upon it must have the free and uninterrupted occupation of the wires along which it passes; the least interference by another instrument operates to the confusion of the clerks, and the completion of the communication is deferred until the interruption ceases. The prohibition, therefore, of irregularities of this nature, except in extreme or peculiar cases, forms the subject of one of the rules which are framed for the guidance of the clerks. By such, and other like judicious arrangements, telegrams pass and succeed each other with a swiftness that would not only have astonished our forefathers, but which seems almost incredible to the generation of our own time.

POSTAL TELEGRAPH INSTRUMENTS.

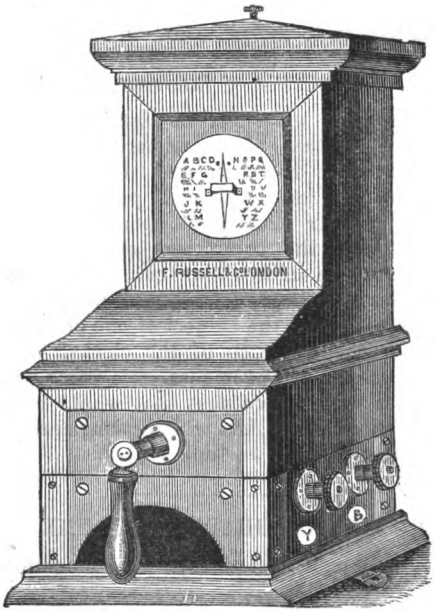
The telegraph instruments used in connection with the Post Office are—

Sounder	211
Single Needle	3,582
Bright's Bell	394
The Morse Printing	1,509
Hughes's Type-Printing	23
Wheatstone's Automatic	98
Wheatstone's A B C	2,367
Other kinds	100
Total	8,284

The former four are in general use; the type-printing and Wheatstone's automatic instruments are used in first-class offices only; whilst the A B C instrument is mostly used in connection with the wires of private firms.

The pneumatic tube is also used for the transmission of messages between some of the chief offices and certain branch offices.

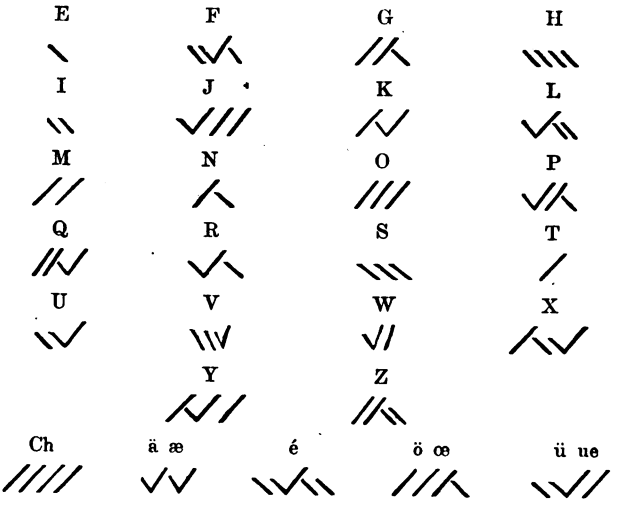
THE SINGLE NEEDLE INSTRUMENT.



The following characters show the number and inclination of the beats necessary to indicate the respective letters underneath which they are placed :—

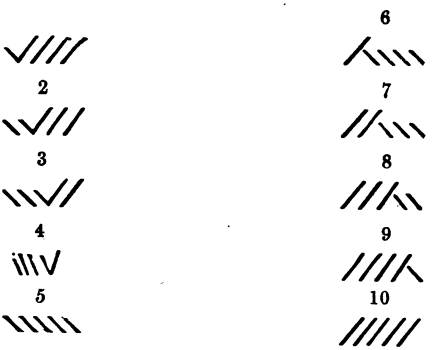
The Alphabet.

A	B	C	D
✓	/\\\	/\/\	/\\



—

FIGURES.



ANNOTATION.

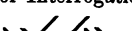
Comparative movements of Needle.
Letters Indicated.

Period, or Full Stop. (.)

Comma (,)

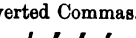
A A A

Note of Interrogation. (?)



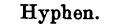
U D

Inverted Commas. (" ")



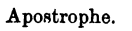
C C

Hyphen. (-)



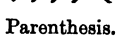
B A

Apostrophe. (')



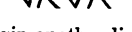
W G

Parenthesis. ( )



P P

Begin another line.



A L

Bar of Division. ($\frac{3}{17}$)

M M M

Underlined.

L L

CONTRACTIONS.

Call Signal.

C K

Understand.*

T

Not understand.†

E

Wait.

M Q

Correction, or rub out.

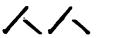
S S S

* To be given after each word that is understood.
† To be given when the word is not understood.

End of Message.

S N

Cleared out, and all right.



N N

The termination of a word is indicated by a momentary pause.

It must be understood that the beats for the respective notes, contractions, &c., must be continuous, as though they constituted one letter. The letters of which they are symbolical, are introduced solely for the purpose of impressing upon the memory the inclinations of the needle in representing them.

It will be observed that the number of movements necessary to form a letter by the single needle, exceeds in every instance those required to represent them by the double needle; hence the transmission of a message is accomplished with greater celerity by the latter.*

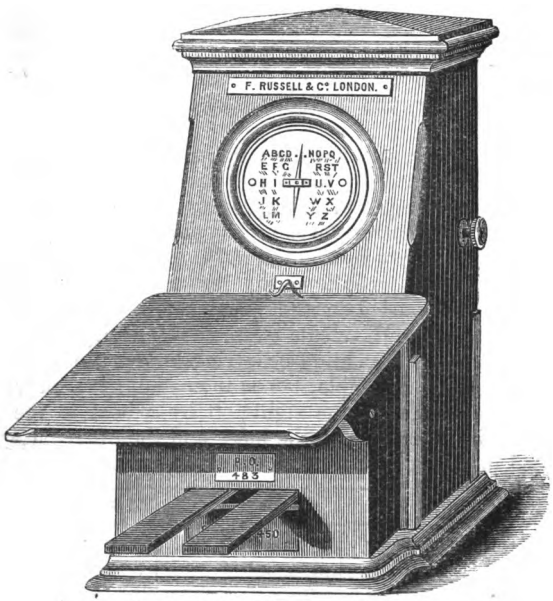
With but few exceptions the inclination of the double needle is not varied in the construction of a particular letter; but the single needle is, on the contrary, of diversified tendency, the transition occurring in some instances two or three times. Example,—A is indicated by a movement to the left and then to the right; B by a beat to the right and three in succession to the left; and the other letters are denoted in accordance with the following arrangement:—

Letter.	Beats.				Letter.	Beats.			
	1st.	2nd.	3rd.	4th		1st.	2nd.	3rd.	4th.
C	right	left	right	left	O	right	right	right	
D	right	left	left		P	left	right	right	left
E	left				Q	right	right	left	right
F	left	left	right	left	R	left	right	left	
G	right	right	left		S	left	left	left	
H	left	left	left	left	T	right			
I	left	left			U	left	left	right	
J	left	right	right	right	V	left	left	left	right
K	right	left	right		W	left	right	right	
L	left	right	left	left	X	right	left	left	right
M	right	right			Y	right	left	right	right
N	right	left			Z	right	right	left	left

* Bright's Bell Instrument is the most rapid of all non-automatic telegraphs.—Culley.

In telegraphing numbers, it is customary to enumerate the figures which represent them in successive order, commencing from the left; thus, 10 should be signalled one, nought; 20, as two, nought; 364, as three, six, four; and so on.

There is also a single needle instrument in use in the Post Office which instead of a handle, as in the engraving



THE PEDAL SINGLE NEEDLE INSTRUMENT.

on page 38, has two keys or pedals, resembling in shape the keys of a piano, and which are termed the right and the left key; the former is slightly depressed to make the upper point of the needle incline to the right, and the latter (or left key) is slightly depressed to produce a movement of the needle in the opposite direction As both hands are employed in the manipulation of the pedals, a message can be sent at much greater speed by this description of instrument than by that represented in the other engraving; hence it is intended it shall ultimately supersede it.

Of the 8,284 telegraph instruments employed in the postal telegraph service, 3,582 are single needle.

THE SOUNDER.

This instrument derives its name from the circumstance of the telegram being rendered by it at the receiving office by means of sound. A short or a prolonged sound, or a succession of either, or a combination of both varied—like the dots and dashes of the Morse alphabet—constituting the respective letters of

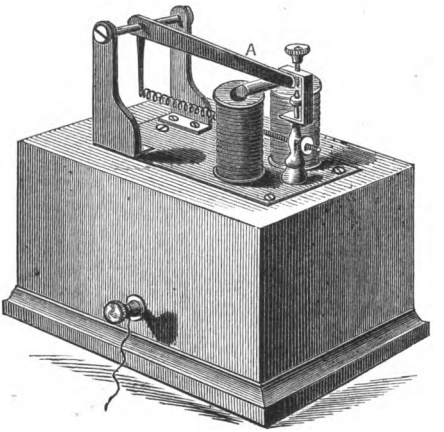
The Alphabet.

Sounds indicating the Letters.

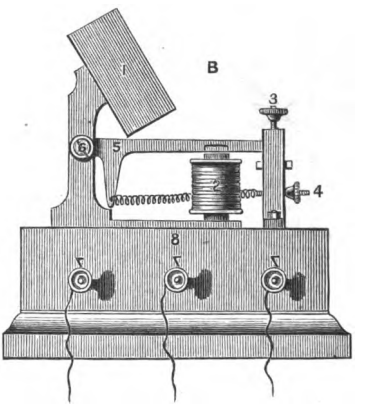
A	1 short and 1 prolonged.
B	1 prolonged and 3 short.
C	1 „ 1 short, 1 prolonged, and 1 short.
D	1 „ and 2 short.
E	1 short.
F	2 „ 1 prolonged, and 1 short.
G	2 prolonged, and 1 short.
H	4 short.
I	2 „
J	1 „ and 3 prolonged.
K	1 prolonged, 1 short, and 1 prolonged
L	1 short, 1 prolonged, and 2 short.
M	2 prolonged.
N	1 „ and 1 short.
O	3 prolonged.
P	1 short, 2 prolonged, and 1 short.
Q	2 prolonged, 1 short, and 1 prolonged.
R	1 short, 1 prolonged, and 1 short.
S	3 short.
T	1 prolonged.
U	2 short and 1 prolonged.
V	3 „ and 1 „
W	1 „ and 2 „
X	1 prolonged, 2 short, and 1 prolonged.
Y	1 „ 1 „ and 2 „
Z	2 „ and 2 short.

The Sounder is worked on the single current principle—the sounds being emitted from an armature which is in exact resemblance to the Morse armature. The Sounder consists of

two kinds, one of which (see diagram A) is used in connection with the Morse instrument on local circuits. Its mechanism,



which is fixed upon the top of a hollow case, minus one end, consists of an armature and two magnetic coils.



It differs from the Morse Recording Instrument in this particular, namely, that the latter prints the message, and

therefore the eye is employed to interpret it; but with the Sounder, the interpretation devolves upon the ear; otherwise, the two instruments are nearly identical with each other.

The current, which has two terminals, is relayed with a local battery from a Pecker, as used in the Morse instrument.

The Sounder, which is employed in connection with the Wheatstone transmitting apparatus (see diagram B), is of similar construction, with the difference that it has a galvanometer fixed immediately over the armature, the adjustment of it being like to that of the Morse instrument.

DESCRIPTION OF THE COMPONENTS OF THE APPARATUS (B):—

1. Galvanometer.
2. Pair of coils.
3. Levers for regulating the play.
4. Spring for tightening and loosening the armature.
5. Armature.
6. Pivot on which armature works.
7. Terminals—three on each side of the case.
8. Hollow case, minus the bottom.

THE MORSE PRINTING INSTRUMENT.

Telegraph printing is becoming in general use as a rapid and reliable means of communication. The process, which is simple, consists in the clerk at the sending station depressing or raising at pleasure the transmitting key, which influences the action of the style or point of the *morse*, or receiving apparatus, at the receiving station; a dot or stroke, or a succession of each (according to the will of the operator at the sending station), is impressed upon a strip or ribbon of paper as it passes underneath the style of the morse at the receiving station: these dots and strokes represent the letters of the printing alphabet.

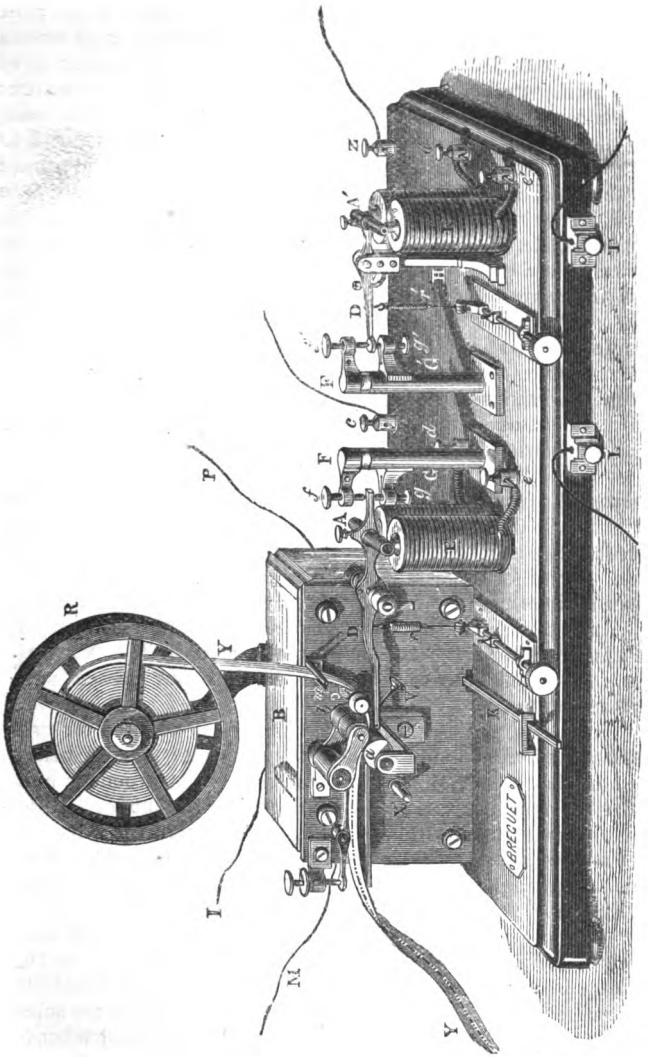
For the information of the scientific inquirer we quote the following from an article, which appeared in the *Electrician*, on the operation of the parts of which the printing instrument consists.

"The 'instrument clerks' have, in the case of lines of any considerable length, four different pieces of apparatus in their charge, viz.:—the galvanometer, the relay-magnet, the receiving instrument, the transmitting key.

"The galvanometer serves to indicate the force of the two

currents, from the near and the distant battery, which traverse the wire. It is composed of a piece of magnetised steel, poised horizontally upon a knife-edge, and surrounded by a coil of wire. The magnetised steel carries an upright pointer, which shows upon a scale the degree of deflection of the magnet occasioned by the passage of the current through the coil. The latter is compound; there being, in fact, two coils of wire of unequal length, constituting a double galvanometer, the needle of which is influenced to an equal extent by the two currents of unequal power traversing the respective coils. The 'arrival current,' weakened by loss of tension and leakage, passes through the longer coil. By simply inspecting the galvanometer, the *employée* can at any time ascertain the amount of battery power necessary for the transmission of signals, or detect the existence of a 'fault' of sufficient extent to endanger the correctness of transmission.

"The relay-magnet serves to bring into operation a 'local battery' for the purpose of working the receiving instrument the latter requiring generally a far greater power than could be communicated by the arrival current. This current is therefore made to influence an electro-magnet, the armature of which is adjusted with great delicacy, in close proximity to the poles. When the arrival current traverses the coils of the temporary magnet, the armature is attracted, and its movement causes the powerful current from the local battery to be 'turned on' to the receiving instrument. When the arrival current is cut off at the distant station, the armature is removed from the temporary magnet by the action of a spring. This, however, applies only to the ordinary system of working lines, in which relays are employed, by a succession of currents in one direction only, or from one pole of the battery. In the system of working by 'reverse currents,' introduced by Mr. C. F. Varley, and employed by the Electric Telegraph Company, the spring is advantageously dispensed with. The relay consists of an electro-magnet, the core of which is movable inside its helix, the latter being fixed. The core is delicately mounted on pivots, and its extremities play between the poles of fixed permanent magnets of horse-shoe form. When a current is passing through the helix, the iron is temporarily magnetised according to the direction of the current. The one current deflects



the iron, and closes the local circuit; the opposite current deflects the iron core in the opposite direction, and opens the local circuit, thus performing the part of the spring in the ordinary relay. The advantage of such an arrangement becomes obvious when it is considered that slight vibrations, or 'accidental currents' along the line, are often sufficient to overcome the resistance of the spring, and thus to produce at the receiving station signals which may seriously interfere with the working of the line. Again, in working by reverse currents, *i.e. in breaking the circuit of the local battery by means of a negative current, instead of by the cessation of the positive current which brings the local battery into operation*, the relay-magnet becomes self-regulating. When a spring is employed for retaining the armature of the electro-magnet, its resistance requires to be constantly re-adjusted, according to the variations in the power of the current, the increased power developed in the magnet by the repeated currents, and the various disturbing influences acting upon the line wire. In the system of reverse currents, the force which retains the armature is always proportionate to that which causes the local circuit to be completed, moreover the former instantly ceases when the latter is brought into operation. Another important advantage of this system is, that from a given number of cells of the battery twice the force is obtained to actuate the relay. Equally important advantages in the working of long lines are secured in Mr. Varley's system, which, however, do not enter into our present subject-matter.

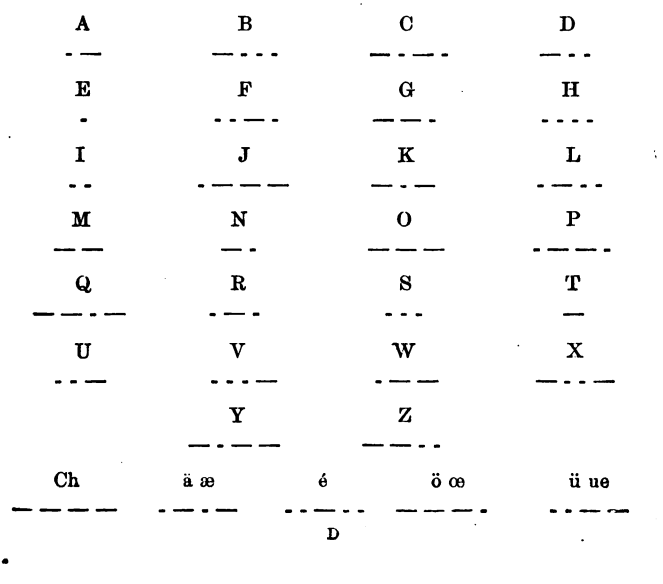
"A simple, but admirable, contrivance is adopted for preventing the vibration of the delicate relay magnets. A heavy rectangular mass of iron is enclosed in a wooden box, mounted upon supports of vulcanised caoutchouc. Upon this the instrument is placed; and by reason of the difficulty of producing vibrations in a heavy mass supported upon an elastic material, it is thus withdrawn from such disturbing influences.

"The receiving instrument used with the relay on long circuits, and occasionally worked on shorter circuits by the current from the distant station, is that which is generally known as the Morse Instrument, but has undergone some modification at the hands of the engineer and electrician to the Company. The signals are produced by the action of

an electro-magnet, the armature of which carries a lever, one end of which, when the armature is attracted by the magnet, impresses the 'dots and dashes' upon a long strip of paper moved through the instrument by the agency of clock-work. From this strip the message is transcribed in writing.

"The lever-key is a very simple piece of apparatus for transmitting a succession of currents along the line. The signals are sent by depressing one end of a brass lever, either by a momentary pressure producing a 'dot' upon the paper slip at the distant station, or for a short space of time, in which case the 'dash' is impressed. In its normal position, the lever obeys the influence of a spring, and establishes the communication between the line wire and the relay or receiving instrument. When depressed, the key brings the line wire into communication with one of the poles of the battery. In Mr. Varley's system of transmission, the lever, when released, establishes a momentary communication between the line wire and the earth, in order to facilitate the discharge of the wire, and also causes a reverse current to be transmitted."

THE ALPHABET.



NUMERALS.

1 . — — — —	6 — . . . .
2 . . — — —	7 — — . . .
3 . . . — —	8 — — — . .
4 . . . . —	9 — — — — .
5	0 — — — — —

ANNOTATION.

	Letters Indicated.
Period, or Full Stop.	I I I or S S
Comma . — . — . —	A A A or R K
Note of Interrogation. . . — — . .	U D
Inverted Commas. — . — — . — .	C C
Hyphen. — . . . . —	B A
Apostrophe. . — — — — .	W G
Parenthesis. . — — . — — .	P P
Begin another line. . . — . — . .	A L
or — — . — — . —	G Q
Horizontal Bar of Division, thus $\frac{1}{2}$ — — — — — —	M M M or O O

Perpendicular Bar of Division, thus 1 | 2

- - - S

Underlined.

- — - - - - — - - L L

CONTRACTIONS.

Call Signal.

— - - — - - - — C K

Understand.

— T

Not Understand.

- E

Wait.

— — — — - — M Q

Correction, or rub out.

- - - - - - - - - S S S

End of Message.

- - - — - S N

Cleared out, to be signalled to the last office engaged with when all communications for it are finished.

— - — - N N

EXERCISES IN PUNCTUATION, &c.

Period, Colon, and Semicolon :—

Night brings out stars, as sorrows show us truth - - - - - -

Various instances are recorded in ancient works of electricity having been given off from the hair, and other parts of the human body - - - - - -

Virgil makes mention of a harmless fire which was emitted from the hair of Ascanius - - - - - - Whether this was so or not is uncertain, as doubts even of the existence of such a person as Ascanius have been raised - - - - - -

Comma :—

Iceland spar - — - - - — - on being subjected to pressure in certain directions - — - - - - — shows evident symptoms of electric action - — - - - - — and affects the galvanoscope accordingly.

Note of Interrogation :—

The slightest flap a fly will chase,
But who can drive the numerous breed - - - - - - -
Chase one, another will succeed.

Mr. Highton remarks that however difficult it is found in practice for man to transmit, artificially, currents of electricity from any kind of electric apparatus wholly submersed in water, yet Nature, in her sublime workings, finds no difficulty whatever in so doing. The philosopher is thus invited to careful study and deep investigation. The day may come when this mode of action in the animal kingdom will be better understood than it is now; and then, probably, will be discovered a means of constructing submarine telegraphs, without any insulation of the wires; and who shall say whether such a discovery would not satisfactorily solve the problem of communicating instantaneously between great Britain and America - - - - - -

Inverted Commas :—

— - — - — - — - The world of science is not agreed as to the physical character of electricity. According to the opinion of some it is a fluid infinitely lighter and more subtle than the most attenuated and impalpable gas, capable of moving through space with a velocity commensurate with its subtleness and levity. Some regard this fluid as simple. Others contend that it is compound, consisting of two simple fluids bearing antagonistic properties, which, when in combination, neutralise each other, but which recover their activity by decomposition. Others, again, regard it not as a specific fluid which moves through space, but as a phenomenon analogous to sound, and think that it is only a series of undulations or vibrations, that are propagated through a highly elastic medium, which produce the various electrical effects, just as the pulsations of the atmosphere produce all the effects of sound. — - — - — - — -

Manufacture of the Points of Needles and Pins by Electricity.—A recent discovery has been made by M. Caudery, telegraph inspector on the Western Swiss Railroad, and is now applied with success at Aix-la-Chapelle, Belgium, whence needles and pins are shipped to all parts of the world. — - — - — - — - In establishing an electrical current by means of a small Bunsen battery, and by passing a metallic wire (brass, copper, iron, or steel), corresponding with the negative pole, through the bottom of a glass tube, closed in such a way as to contain an acidulated liquid, in leading the other wire of the positive pole through the superior opening of the glass tube, closed in such a way as to allow the positive wire to plunge into this acidulated liquid, taking care to leave a small interval between the extremities of the wires; the electric current thus established through the acidulated fluid as a conductor, produces the following phenomena :—Very soon the extremity of the positive wire takes a conical point of more or less sharpness, depending on the free distance existing between the two wires plunging into the acidulated liquid. During this phenomenon, which takes from 5 to 15 minutes, according to the acid used, its

strength, the composition of the wire, its degree of thickness, and also the intensity of the electric current, very fine sections of the wire are seen to separate from the wire. Water, acidulated with sulphuric acid, appears to be more efficacious, especially for iron and steel wires. Nitric acid is used in preference for brass and copper wire. The same effect will take place if to the positive pole (superior) an indefinite number of wires are tied together and dipped in the acidulated water, instead of the single wire, care being always taken to keep this positive wire at a little distance from the negative wire. We have seen a hundred brass wires, after having been submitted to this operation, present points as sharp as the best English pins, although the electric current was produced by a very small Bunsen battery. It appears to us very desirable that this new method should receive proper encouragement, and everything should be tried to bring it into general use. The operation of making the points of needles and pins in their manufacture is a dangerous and costly one. Medical men in large manufacturing cities have long recognised the dangerous effects produced by the fine metallic dust resulting from it on the health of the workmen. The remedies for this evil are very imperfect, little used, and very impracticable; inhaling apparatus communicating with the outside air has been tried, but every danger would be suppressed by the method above described. —·—·—·—·

Hyphen :—

The war in America furnishes examples, not only of the rapid establishment of lines of telegraph, but of the constant use of field telegraphs, both in cantonments and during active operations in the field. General Sherman, before commencing his march through Carolina and Georgia, made all the necessary preparations for establishing telegraphic communication in his rear, and was often enabled, within two hours after a halt, to report his movements thereby. McClellan combined the use of the telegraph with the employment of observatory balloons. The telegraphic operations thus carried out were on a truly gigantic scale. They embraced about 5,000 leagues of wires and forty leagues of submarine cable. The cost of *personnel* and *matériel* amounted to about two and a-half million dollars. The quarter master —·—·—·— general, who had charge of the correspondence o the army, had two superior officers and a large number of subalterns constantly engaged in these operations. Several thousand soldiers were also employed, including a complete corps of signallers.

The electric fluid is evolved by the combination of three bodies, the zinc, the copper, and the acidulated solution in which they are immersed. The production of the current depends on the chemical action of the solution of the zinc: that metal, being very susceptible of oxidation, decomposes the water which is in contact with it. One constituent of the water combining with the zinc produces a compound called the oxide of zinc; and this oxide entering again into combination with the acid which the water holds in solution, forms a soluble salt. If the acid, for example, be sulphuric —·—·—·— acid, this salt will be the sulphate of the oxide of zinc; and as fast as it is produced it will be dissolved in the water in which the slips of metal are immersed. Meanwhile, the copper not being as susceptible of chemical

action as the zinc, remains comparatively unaffected by the solution, but the hydrogen evolved in the decomposition of the water collects upon its surface, after which it rises and escapes in bubbles at the surface of the solution. It is to this chemical action upon the zinc that the production of the electric current is due.

Apostrophe :—

Look around,
And tell me, shall we to blind chance ascribe
The scene so wonderful, so fair, so good?
Shall we no farther search than sense will lead,
To find the glorious Cause which so delights
The eye and ear, and scatters ev - - - - - - - rywhere
Ambrosial perfumes?

In some states of the weather, and in certain fogs, an insulated rod extending high into the atmosphere, with a range of exploring wire attach - - - - - - - d to it, will bring down torrents of the electric fluid. It is a remarkable fact, too, that the power within a few minutes changes from positive to negative, and *vice versa* from negative to positive.

Parenthesis :—

Setting aside those magnificent natural displays of the electric action - - - - - - - - - the thunder-storm and aurora borealis - - - - - - - - - not a cloud passes over our heads but the electric equilibrium of the earth below is affected thereby.

Begin another line :—

To produce the effects, whatever these may be, by which the telegraphic messages are expressed, it is necessary that the electric current shall have a certain intensity. Now the intensity of the current transmitted by a given voltaic battery, along a given line of wire, will decrease, other things being the same, in the same proportion as the length of the wire increases. Thus, if the wire be continued for ten miles, the current will have twice the intensity which it would have if the wire had been extended to a distance of twenty miles. - - - - - - -

It is evident, therefore, that the wire may be continued to such a length that the current will no longer have sufficient intensity to produce at the station to which the dispatch is transmitted those effects by which the language of the dispatch is signified. - - - - - -

The intensity of the current transmitted by a given voltaic battery upon a wire of a given length, will be increased in the same proportion as the area of the section of the wire is augmented. Thus, if the diameter of the wire be doubled, the area of its section being increased in a fourfold proportion, the intensity of the current transmitted along the wire will be increased in the same ratio.—*Lardner.*

Some in their age - - - - - -
Ripe for the sickle; others young like him,
And falling green beneath th' untimely stroke.

The student should note that the formation of a letter does not depend exclusively upon the number of dots and strokes —their position has also to be considered; as, in some cases, the characters are, by variation of place, made to express a plurality of letters. Examples,—a dot and stroke (the former preceding the latter) constitute the letter A; but reverse their position, and the combination will represent N. In like manner D and U are indicated by two dots and a stroke, but not concurrently disposed; G and W have also a kindred number of marks, but differently arranged; and similar remarks will apply to B and V, and to Q and Y. The dots and strokes are indented by the same style or printing instrument, the difference in the length being influenced by the continuance or otherwise of the pressure of the finger upon the transmitting key.

The learner may easily, indeed almost imperceptibly, attain to a proficiency in reading the printing alphabet, by committing to writing as he reduces from one character of letter to another, as illustrated below :—

From

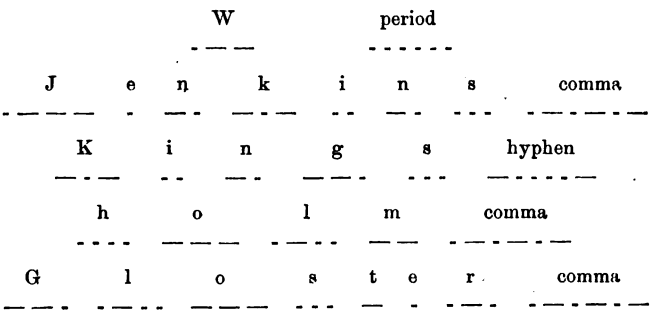
W. JENKINS, Kings-holm, Gloster.

To

PARFITT, 420, Strand, London.

Council Chamber open'd punctually; all the members (except one present. Excuse assigned—"engaged." Is this admissible?

EXERCISE.



P a r f i t t comma

4 2 0 comma

S t r a n d comma

L o n d o n period

D Q

C o u n c i l

Ch a m b e r o

p e n apostrophe d p

u n c t u a l

l y semicolon a l l

t h e m e m b e r s

parenthesis e x c e p t

o n e parenthesis p r e

s e n t period E x c u

s e a s s i g n e d

inverted commas	e	n	g	a	g	e
— - — . — - — .	-	— -	— — .	- —	— — .	
d	inverted commas	I	s	t	h	i	s
— - -	— - — - — - — .	- -	- - -	— -	- - - -	- -	- - -
a	d	m	i	s	s	i	b
- —	— - -	— —	- -	- - -	- - -	- -	— - - -
l	e	note of interrogation.			End of Message.		
- — - -	-	- - — — - -			- — — - — — - —		

It should be observed, that messages issuing from the Morse, or telegraph printing press, appear on the movable strip, or paper ribbon, in one line in continuous order. Mr. Scudamore, in his Report to the Postmaster-General, observes—"The offices at which a Morse printing is used, are, and always will be, in class A or B.

Grouping of Letters of different Alphabets.

The Postal authorities have, with the view to more readily and forcibly impress upon the mind of the learner the telegraphic alphabet, arranged the letters signalled by the three principally used instruments into groups. Each of these groups consists of letters, the telegraphic formation of which bears the nearest resemblance to each other.

Letter.	Inclinations of the upper point of the needle.	Strokes on the Bells.	Impressions made by the Printing Instrument.
E	1 to left	1 on left	1 dot
I	2 to left	2 on left	2 dots
S	3 to left	3 on left	3 dots
H	4 to left	4 on left	4 dots

Letter.	Inclinations of the upper point of the needle.	Strokes on the Bells.	Impressions made by the Printing Instrument.
T	1 to right	1 on right	1 dash
M	2 to right	2 on right	2 dashes
O	3 to right	3 on right	3 dashes
Ch	4 to right	4 on right	4 dashes

Letter.	Inclinations of the upper point of the needle.	Strokes on the Bells.	Impressions made by the Printing Instrument.
A	1 to left 1 to right	1 on left 1 on right	1 dot 1 dash
W	1 „ 2 „	1 „ 2 „	1 dot 2 dashes
J	1 „ 3 „	1 „ 3 „	1 dot 3 dashes
U	2 „ 1 „	2 „ 1 „	2 dots 1 dash
V	3 „ 1 „	3 „ 1 „	3 dots 1 dash

Letter	Inclinations of the upper point of the needle.	Strokes on the Bells.	Impressions made by the Printing Instrument.
N	1 to right 1 to left	1 on right 1 on left	1 dash 1 dot
D	1 „ 2 „	1 „ 2 „	1 dash 2 dots
B	1 „ 3 „	1 „ 3 „	1 dash 3 dots
G	2 „ 1 „	2 „ 1 „	2 dashes 1 dot
Z	2 „ 2 „	2 „ 2 „	2 dashes 2 dots

Letter.	Inclinations of the upper point of the needle.	Strokes on the Bells.	Impressions made by the Printing Instrument.
R	1 to left 1 to right 1 to left	1 on left 1 on right 1 on left	1 dot 1 dash 1 dot
L	1 to left 1 to right 2 to left	1 on left 1 on right 2 on left	1 dot 1 dash 2 dots
P	1 to left 2 to right 1 to left	1 on left 2 on right 1 on left	1 dot 2 dashes 1 dot
F	2 to left 1 to right 1 to left	2 on left 1 on right 1 on left	2 dots 1 dash 1 dot

Letter.	Inclinations of the upper point of the needle.	Strokes on the Bells.	Impressions made by the Printing Instrument.
K	1 to right 1 to left 1 to right	1 on right 1 on left 1 on right	1 dash 1 dot 1 dash
C	1 to right 1 to left 1 to right 1 to left	1 on right 1 on left 1 on right 1 on left	1 dash 1 dot 1 dash 1 dot
Y	1 to right 1 to left 2 to right	1 on right 1 on left 2 on right	1 dash 1 dot 2 dashes
X	1 to right 2 to left 1 to right	1 on right 2 on left 1 on right	1 dash 2 dots 1 dash
Q	2 to right 1 to left 1 to right	2 on right 1 on left 1 on right	2 dashes 1 dot 1 dash

HUGHES' PRINTING INSTRUMENT.

The Hughes' printing telegraph instrument is based upon entirely different principles to all other telegraph instruments now in use.

The main object of this invention has been to reduce the work to be performed by electricity to the least possible amount, both as regards the number and duration of the electrical waves, and the sensitiveness and rapidity of the recording apparatus.

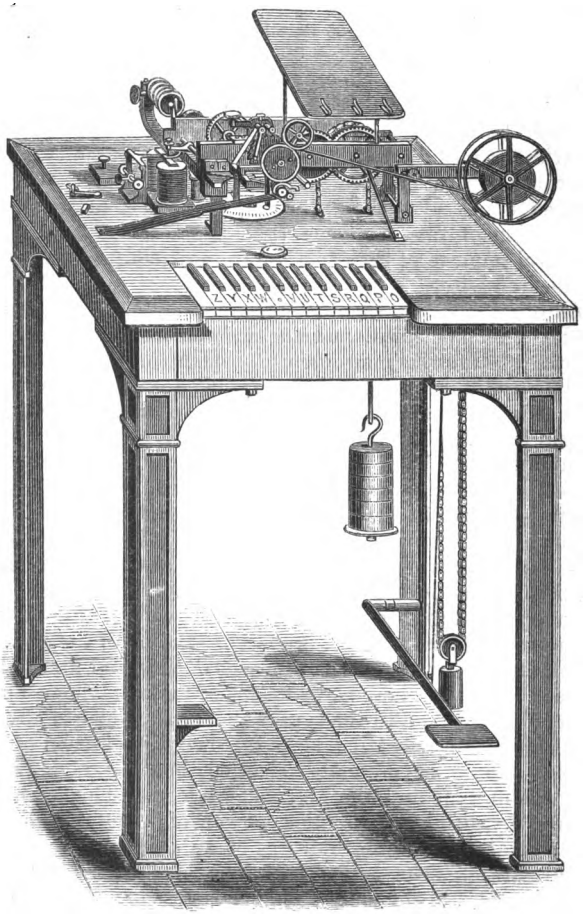
The Hughes' system depends for its correct action on the subdivision of time between each signal or letter. Each electrical impulse of the same duration of contact producing the desired letter.

All other systems, such as Morse's recorder, Wheatstone's needle, Bain's chemical and the dial, or step by step letter-pointing telegraph instruments, depend either upon the number and duration of different signals to produce the letter intended, or upon a certain number of signals indicating a certain letter.

In order to obtain these results, we must secure—1st. Perfect synchronism or time keeping of two or more instruments. In the Hughes' instrument the speed is regulated by means of the vibrating spring; and the differences of speed of each, or of two or more instruments, are, in addition to the regulation by the vibrating spring, corrected at each letter by means of a correcting cam, which adjusts any difference that might exist. 2nd. The sending of the currents should be perfect as regards intervals of time and duration of contact. This is obtained by means of the revolving contact-maker being geared to the type-wheel shaft, which is already regulated by the vibrating spring. 3rd. The arrival of the current should be perfectly recorded, both as regards the intervals of time and the signals obtained. This result is secured by using the holding power of a natural magnet acting strongly through the cores of an electro-magnet upon the armature. The current merely detaches the armature from the poles of the electro-magnet, consequently the armature can move with any rapidity wished for. The right letter is recorded by means of the machine pressing the paper against the type-wheel the instant the armature rises.

Before, however, describing the instrument in detail, we will in a few words give a general idea of its action:—

The instrument is driven by a weight, acting upon a train



of wheels, and its speed is governed by a vibrating rod. The type-wheel revolves continuously, and carries by means

of bevel wheels a contact-making arm, which travels around a disc of pins acted upon by the finger-keys; whenever any one of these keys is pressed down, the corresponding pin comes into contact with the revolving arm at the time wished for. The current is thus sent on the line, passing through the electro-magnet, detaching the armature, which in its rapid upward motion comes in contact with a detent, which locks at will a small shaft to the train in motion. A cam on the shaft raises the paper against the type-wheel, causing the impression of the letter intended on the paper. At the receiving station, the current acts in the same way as in transmission, detaching the armature, thus permitting the printing shaft to make one revolution and to take the impression of the intended letter—once for each current received.

The type-wheel of the receiving station is brought in unison with the transmitting one by a simple detent, which by pressing does not allow them to start but from a given point, thus starting them in unison.

Having thus briefly given an idea of its operation, we will now examine the most striking features of this instrument; and first amongst these, from its importance and supposed difficulty, must stand the means by which perfect synchronism is maintained in instruments many hundreds of miles apart.

Many attempts have been made to obtain synchronism at high speeds. Combinations of pendulums, centrifugal balls, fans, &c., have been tried without success, and Professor Hughes was the first to arrive at this point, by the employment of the rapid vibrations of a steel rod or spring. In Hughes' instrument the free end of a round vibrating rod is attached to a crank upon the fly-wheel, its other end being held fast in its support. The free end has perfect freedom to increase or diminish its arc of vibration according to the force employed upon it. The greater the motive power the greater the arc of vibration; but no amount of motive power can alter the speed or number of the vibrations. The force is merely transformed into greater or less arcs of vibration. Thus the instrument is obliged to run only at the speed allowed by the vibrations of the rod; and in order to bring two or more instruments to the same perfect rate of speed, it is only necessary to move a sliding weight upon the rod, which can be done during motion.

The number of vibrations per minute are 840; the type-

wheel making 120 revolutions in the same time; and at this high rate of speed the instruments can easily be adjusted to such perfection, that the error per minute does not exceed one thirty-thousandth part of a second.

There is, however, no necessity for this extreme accuracy, as at each letter printed—which upon the average is at the rate of 200 per minute—a correction takes place by means of a wedge-shaped corrector or cam acting upon the interstices of a wheel in connection with the type-wheel; these being held to the type-wheel shaft by friction, allows the type-wheel to be advanced or retarded as required.

The next feature of importance is the arrangement of the electro-magnet by means of which the maximum effect is obtained instead of the minimum, as in all other telegraphic arrangements. In this invention the armature rests constantly against the cores of the electro-magnet, being held strongly by induced magnetism produced from a strong permanent magnet polarising the cores of the electro-magnet. An adjustable spring on the armature tends constantly to draw it from the poles; but the holding of the induced magnetism being the stronger retains the armature in its position until a current is sent through the electro-magnet neutralising the induced magnetism. The spring then becomes the stronger; draws the armature rapidly away with the full force of the spring; the armature comes in contact with a detent which unlocks the printing shaft, and this shaft whilst taking the impression replaces gently by means of a cam the armature in its normal position against the poles of the electro-magnet. Suppose the induced magnetism in the cores of the electro-magnet held the armature with a force of 100. and the spring opposes a force of 91, it is evident that a simple depolarising of but 10 would allow the armature to rise with all the rapidity and force of 21. Suppose, again, the spring more nicely adjusted, say to 99·9, then ·2 would be amply sufficient to make it work with the same force as before. In fact, the only limit to the sensibility of this arrangement is the close approximation to which we can balance these forces. Thus it may be seen that the armature is placed in the best condition to feel the maximum of electro-magnetic disturbance in the cores—near the poles; and after leaving and performing its work, it is replaced by the machine. Therefore there is really no action whatever for electricity to perform; it has really only to produce a slight

magnetic change in the cores, and this but once for each letter.

The arrangements of the electrical circuits in this invention are also important, allowing only the required quantity of current to pass through the instrument. The instant the armature rises, the current, instead of passing through the electro-magnet, passes by a short wire direct either to line or earth. Supposing that 100 of currents arrived, and 5 sufficed to detach the armature, the surplus 95 would pass without resistance direct to earth. This arrangement is not only important as regards allowing only the required quantity to pass through the electro-magnet, but more important in the case of submarine lines, as the return current is discharged to each direct, without passing through the electro-magnet, and it is thus discharged during the whole revolution of the printing shaft.

The mechanical portions of the instrument which perform important functions will now be described briefly:—

The type-wheel contains a simple arrangement, by means of which the letters of the alphabet or figures are printed; with 28 keys it prints 54 different characters. This result is gained by obtaining the letters and figures alternately on the type-wheel, and, by a lever, forcing the type-wheel to present one or the other series at will. In order to do this, the correction-wheel is fixed upon an independent axle from that of the type-wheel, and the two are locked together by a lever with two projections, which are acted upon by the corrector, thus turning the type-wheel for either series of characters as desired.

Upon the printing shaft is a catch which locks the fly-wheel shaft and printing shaft together. This catch acts by a strong spring when the detent releases it; it instantaneously locks by the catch falling down an incline on to a tooth-wheel on the fly-wheel shaft; but as the shaft revolves, the catch comes up the inclined plane, which raises the catch free of the tooth-wheel. After it has just passed the centre of the inclined plane, it cannot again descend until released by the action of the detent, as it blocks against the detent.

The contact-maker consists of a vertical shaft—divided into two insulated portions at its lower extremity, and bearing a projecting arm. The upper part of the shaft is in communication with the wheels and frame-work of the instrument.

The lower of the two projecting arms is in communication with the tube upon which it turns, and which passes through the centre of the brass disc of keys; but is insulated from this disc by means of a large piece of ivory in the centre of the disc. The connection between the two arms is made by means of a contact screw upon the lever moving on the upper arm. The point of the screw when resting upon the lower arm forms a metallic connection between these two arms, a spring upon the lever keeping it firmly pressed against the lever arm. There is also an insulated steel plate under the lower arm with two angles, for the purpose of preventing false or short contacts, and throwing the key pins out of range when the keys are held longer than necessary.

In practical use, at the commencement of each morning's service, it is usual to make a few "blanks," or in other words, touch the same key consecutively in order that the synchronism of the instruments may be perfectly adjusted; for instance, Liverpool sends blanks by touching his key corresponding to the blank on the type-wheel; and if London prints A, then B, and so on, the apparatus at London is running too fast, and the operator retards the regulator; if he receives Z, then Y, and so on, his apparatus is running too slow, and he advances the regulator until his apparatus also makes nothing but blanks, when both are ready to communicate. Blanks may be struck at every revolution or at every five or ten or more, thus testing the synchronism to any desired extent.

The preliminary verification each morning requires but a few seconds, and the instruments are then ready to transmit the actual messages.

It will be seen from a careful study of this instrument that it possesses special merits, not only for land lines, but for long submarine lines, from the fact of its requiring but one wave to each letter, and from the sensitiveness and simplicity of the electrical arrangements.

Theoretically its speed is three times greater than the Morse, and this has been fully borne out in the many numerous practical trials the instrument has had. The patents for this instrument have been purchased by the Governments of France and Italy, after a series of practical trials of one year's duration. It is now in daily use on their most important lines. In the United States it has been purchased by the American Telegraph Company, and has been in opera-

tion there since 1855, although since that time many important improvements have been effected. The United Kingdom Telegraph Company formerly possessed the sole right* for Great Britain, and this instrument is in daily operation upon their lines between Liverpool, Manchester, and London. The severe practical tests that this invention has been successfully subjected to in several countries, and in the course of several years, sufficiently demonstrate that the various advantages it professes to possess are not merely the logical results of theoretical principles, but are substantial facts, which have effectually aided in removing the grave difficulties that have so long retarded the progress of telegraphy.

THE BELL INSTRUMENT

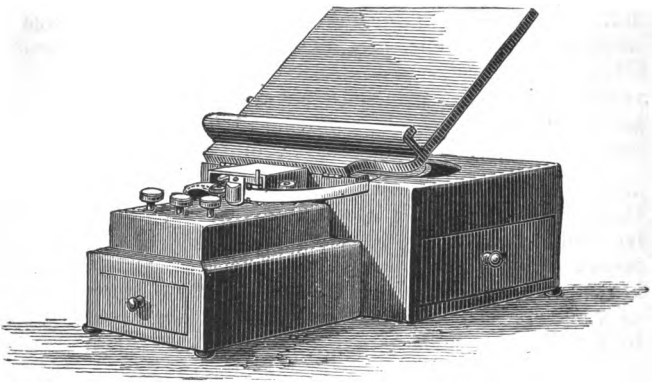
Consists of two bells, designated the right bell and the left bell. By striking these bells with finger-keys or hammers they emit distinctive sounds. In some cases one, and in other cases both, of the bells are employed in the signalling of a letter. For example—the letter A would be indicated by first striking the left bell and then the right bell; whilst one stroke on the right and three on the left bell constitutes the letter B. The manipulator will do well to bear in remembrance that the order in which the bells are intoned is identical with the inclination of the upper points of the single needle. The following alphabetical arrangement will explain the disposition of the strokes to form the respective letters :—

To Signal.	Strike the Bells in the following order.				To Signal.	Strike the Bells in the following order.			
	1st stroke.	2nd stroke.	3rd stroke.	4th stroke.		1st stroke.	2nd stroke.	3rd stroke.	4th stroke.
	Bell.	Bell.	Bell.	Bell.		Bell.	Bell.	Bell.	Bell.
A	left	right			N	right	left		
B	right	left	left	left	O	right	right	right	
C	right	left	right	left	P	left	right	right	left
D	right	left	left		Q	right	right	left	right
E	left				R	left	right	left	
F	left	left	right	left	S	left	left	left	
G	right	right	left		T	right			
H	left	left	left	left	U	left	left	right	
I	left	left			V	left	left	left	right
J	left	right	right	right	W	left	right	right	
K	right	left	right		X	right	left	left	right
L	left	right	left	left	Y	right	left	right	right
M	right	right			Z	right	right	left	left

* This right is now vested in the Postmaster-General.

WHEATSTONE'S AUTOMATIC TELEGRAPH SYSTEM

Consists of a Perforating, Transmitting, Receiving or Printing, and Translating Apparatus.



The Perforator.

The name of this instrument explains its purpose—to perforate—and the first stage of the automatic process is identified with it. Of its operations, it may be remarked—a strip of paper (scarcely half-an-inch wide), termed a paper ribbon, similar to the paper ribbon used in connection with the "Morse" printing instrument, is, by a mechanical contrivance, conducted through a guiding groove, at the bottom of which is an opening sufficiently large to admit of a backward and forward motion of the upper end of a frame containing three punches. The external punches effect the perforations, which represent the letters of the alphabet, and they also make the small holes which occur between the upper and lower of such orifices, whilst the intermediate punch perforates the small hole which intervenes as a mark of division between the automatic alphabetical signs. These marks of division occur in continuous line with the small perforations made by the external punches.

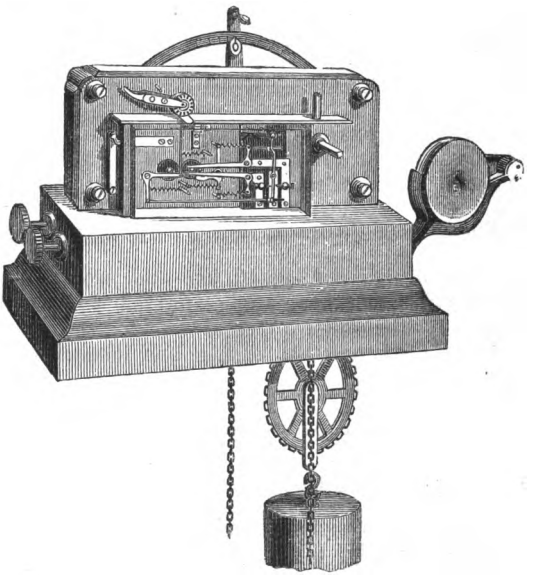
The function assigned to one of the external punches is

the perforation of those holes which are in perpendicular line, thus $\begin{smallmatrix} & o & \\ & o & \\ & o & \end{smallmatrix}$; this sign is the representation of the letter E. The object of the other punch is the making those perforations which are transversely disposed, inclining from left to right, besides which it makes the two small intermediate perforations, thus $\begin{smallmatrix} & o & \\ o & & o \\ & o & \end{smallmatrix}$; this sign represents the letter T.

The middle punch makes a small orifice of the same proportion as, and intervening between, the small perforations produced by the outside punches, thus $\begin{smallmatrix} E & & T \\ o & & o \\ & o & \\ o & & o \end{smallmatrix}$; E and T are thus represented. But supposing the perforated mark of division was omitted, the signs for E and T would merge into each other, and such combination would constitute the sign for the letter A, thus $\begin{smallmatrix} o & o \\ o & o \\ o & o \end{smallmatrix}$.

The perforator has a "step-by-step" motion; the two large holes, and the intermediate small hole, forming the perpendicular line, are perforated by a single movement of one of the external punches, thus $\begin{smallmatrix} & o & \\ & o & \\ & o & \end{smallmatrix}$. The two large holes which are transversely disposed, and the two smaller holes in connection with them, are perforated by two distinct movements of the other external punch; first the large orifice to the right, and the smaller one immediately below it, is perforated thus $\begin{smallmatrix} o & \\ o & \end{smallmatrix}$; the punch now advances a step and makes the other perforations, $\begin{smallmatrix} o & \\ o & \end{smallmatrix}$, and the sign being completed, appears thus $\begin{smallmatrix} & o & \\ o & & o \\ & o & \end{smallmatrix}$. This law is recognised as often as the above signs are repeated, either when used singly or collectively, to constitute a letter. Each of the punches, the middle one of which is smaller than the two external ones, may be separately elevated by the pressure of a key. By the pressure of either finger-key simultaneously with the elevation of the punch with which it is connected, for the purpose of perforating the paper ribbon,

two different movements are successively produced—first, the raising of a slip which holds the paper firmly in its position, and secondly, the advancing motion of the frame containing the punches, by which the elevated punch carries the paper ribbon to its proper distance. During the reaction of the finger-key consequent on the removal of the pressure, the slip first fastens the paper ribbon, and then the frame is adjusted to its normal position. As the perforations progress, the paper ribbon, which is of indefinite length, issues gradually from the apparatus, until the whole of the message is thus prepared, and made to partake of the appearance of what is well known to the ladies as "Insertion." The slip thus perforated, and which describes in that peculiar manner the whole of the letters of which the telegram consists, is now in proper order for

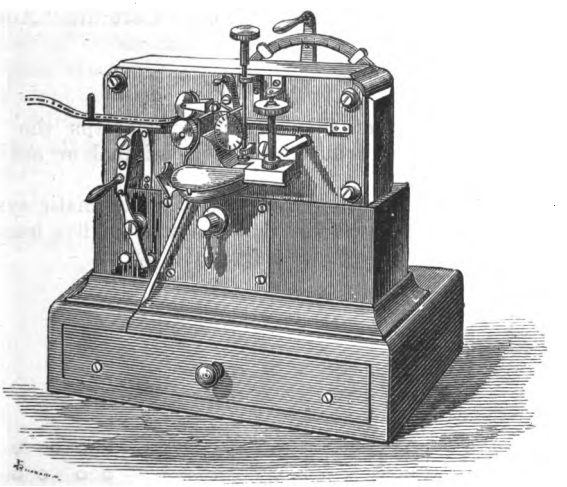


The Transmitting Apparatus.

A double-action groove is made to receive the perforated message ribbon, prepared as before described, and to convey

it forward by its advancing motion, and by mechanism similar to that operating upon the perforator, the currents produced by a rheomotor (a source of electricity), such as a voltaic battery, an electro-magnetic or magneto-electric machine, are transmitted. The order observed in the perforation of the letters in the strip is recognisable in their transmission by this instrument. Instead of punches, as in the perforator, three wires, arranged so as to be parallel with each other, are employed, the intermediate wire serving as a guide during the operation of the current; the elevation and depression of the external wires are influenced by the irregularities in the surface of the perforated strip. When the free end of one of those wires penetrates a large orifice, the current passes in a particular direction, and when the free end of the other penetrates a large orifice the current passes in the opposite direction; by this means the currents are made to succeed each other automatically, and the message is thereby signalled and recorded in the dot and dash Morse alphabetic character, by the printing instrument at the office of destination.

The Recording or Printing Apparatus.



The pens are entirely independent of each other in their action, which are so arranged that when the current passes through the coils of the electro-magnet in one direction one of the pens is depressed, and when it passes in the contrary direction the other is depressed; when the currents cease, light springs restore the pens to their elevated point. The mode of supplying the pens with ink is as follows:—A reservoir about an eighth of an inch deep, and of any convenient length and breadth, is made in a piece of metal, the interior of which may be gilt, in order to avoid the corrosive action of the ink placed in it; at the bottom of this reservoir are two holes, sufficiently small to prevent by capillary attraction the ink from flowing through them: the ends of the pens are placed immediately above these small apertures, which they enter, when the electro-magnets act upon them, carrying with them a sufficient charge of ink to make a legible mark on a ribbon of paper passing beneath them. The motion of the paper ribbon is produced and regulated by apparatus similar to those employed in other register or printing telegraphs.

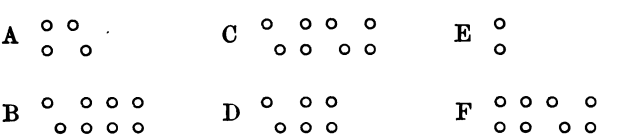
Each part of the automatic system has its independent originality, and may be associated with other instruments. The printing instruments, in connection with this system, in general use at the postal telegraph offices are the "Morse."

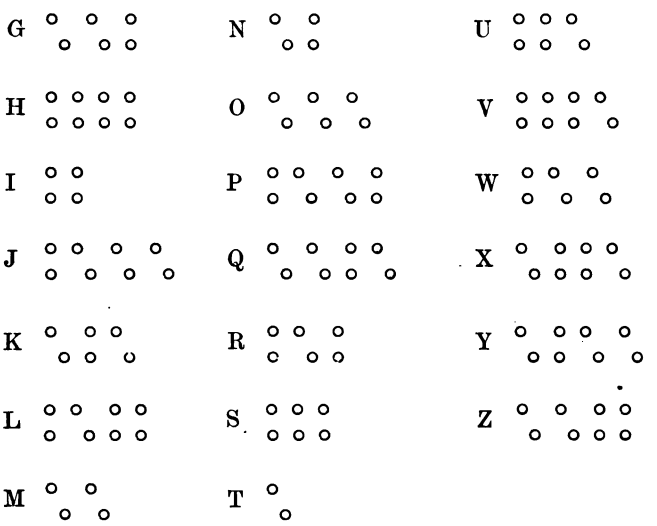
The Translator.

By the operation of this ingenious apparatus the telegraphic symbols are reduced to their original or ordinary alphabetic characters.

Some idea of the speed attainable by the automatic system may be deduced from the fact that upwards of five hundred letters per minute have been telegraphed by it.

The Automatic Perforated Alphabet.





It will be observed that the letter E consists of two perforations, one of which occurs immediately above the other; and T also consists of two perforations, but differently arranged. A series of either of those signs, or a combination of the two signs, are employed in the formation of the other letters of the alphabet.

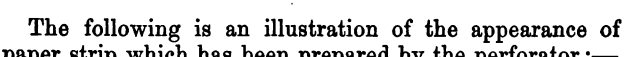
The following is the order in which the components of the remaining twenty-four letters of the alphabet are represented:—

		Order in which the signs for E and T occur.			
		1st.	2ndly.	3rdly.	4thly.
In representing	A	E	T		
„ „	B	T	E	E	E
„ „	C	T	E	T	E
„ „	D	T	E	E	
„ „	F	E	E	T	E
„ „	G	T	T	E	
„ „	H	E	E	E	E
„ „	I	E	E		
„ „	J	E	T	T	T
„ „	K	T	E	T	

			Order in which the signs for E and T occur. 1st.	2ndly.	3rdly.	4thly.
In representing	L	E	T	E	E
,,	,,	M	T	T		
,,	,,	N	T	E		
,,	,,	O	T	T	T	
,,	,,	P	E	T	T	E
,,	,,	Q	T	T	E	T
,,	,,	R	E	T	E	
,,	,,	S	E	E	E	
,,	,,	U	E	E	T	
,,	,,	V	E	E	E	T
,,	,,	W	E	T	T	
,,	,,	X	T	E	E	T
,,	,,	Y	T	E	T	T
,,	,,	Z	T	T	E	E

The following is an illustration of the appearance of a paper strip which has been prepared by the perforator:—

A U T O M A T I C



The learning of the automatic perforated alphabet may be facilitated by a knowledge of the circumstance, that the holes in perpendicular line represent the dots, and those transversely disposed the dashes, of the Morse printing alphabet. Examples:—

Alphabetic Signs.

	The Automatic.	The Morse.
A	o o o o	- —
B	o o o o o o o o	— - - -
C	o o o o o o o o	— - — -
D	o o o o o o	— - -

WHEATSTONE'S A B C INSTRUMENT.

Wheatstone's automatic instrument is in operation in thirty-nine postal telegraph circuits, of which thirty-one circuits are in communication with the Central Telegraph Office. The thirty-nine circuits referred to comprise 10,633 miles. This instrument possesses the power of doubling, trebling, and even quadrupling the transmitting capacity of the wire. Mr. Scudamore remarks on its advantages thus:—"Eight circuits between England and Ireland are worked automatically, the use of the automatic instruments doubles the transmitting power of those circuits, so that we are relieved of the necessity of erecting eight land wires of great length, and of laying down a costly submarine cable. In the case of shorter circuits—such, for instance, as the London and Manchester—the transmitting power of the instrument is quadrupled by its use, *i.e.*, the instrument makes one wire do the work of four. On one occasion, when four out of five London and Birmingham circuits were broken down by a storm, the remaining circuit, worked automatically, did the work of all. To get the full value of the instrument, it is necessary to employ a large force. It can send messages at the rate of 200 words per minute, but no single penman can write them out at a rate of more than 40 words per minute, and therefore several writers must be and are employed on each circuit, the same remark applies to those who punch the messages for transmission—no one can punch as fast as the instrument can transmit. We have, in the automatic instrument, the means of dealing with a large increase of traffic over great distances, without the erection of additional wires. It requires, for the effective display of its powers, a staff from three to four times as large as that required for the ordinary 'Morse' instrument. During a racing season, 200 messages per hour were sent by its agency on a single wire."

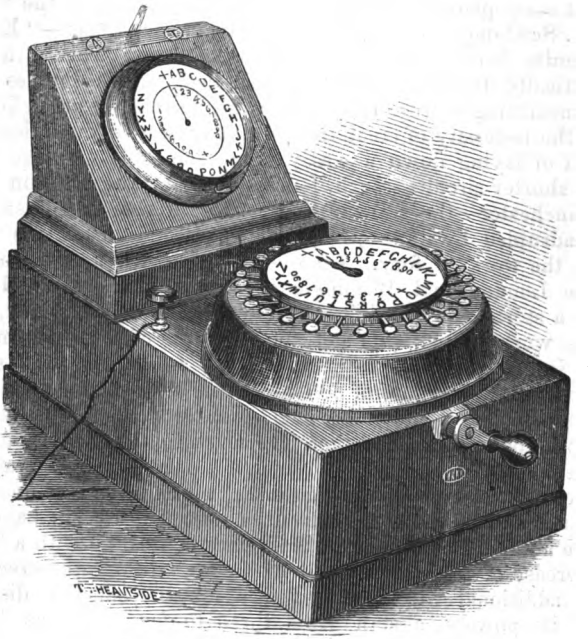
Sir Charles Wheatstone derives a royalty of £1,600 per annum for its use by the postal telegraph establishment.

The A B C instruments are the most readily understood of any of the telegraphic instruments; indeed, it may be truthfully said—

"He who runs may read it."

This is one of the inventions patented by Professor (Sir Charles

Wheatstone, and is extensively used by private firms in the metropolis and other large towns, as an expeditious means of transmitting information, instructions, orders, &c., between main and branch establishments in the same town or district. A complete set of the apparatus consists of a Communicator, or sending instrument, an Indicator or receiving instrument,



and an alarum for each of the two places of business or stations which are connected by the telegraph wire. The face of the Communicator and Indicator is of circular shape, and has imprinted on it the whole of the letters of the alphabet, a cross, and a period, comma, colon, or a semi-colon; and, forming a ring, immediately underneath are duplicated a cross, the digits, and a cypher. The position of the dial or face of the Communicator is flat, so that the manipulator has to look down upon it, whilst that of the Indicator is perpendicular, and in that position, when viewed from a distance,

bears a resemblance somewhat to that of a timepiece. In the centre of each instrument is a hand or pointer, which has a rotary motion. Surrounding the dial of the Communicator are 30 studs or keys, which should be respectively depressed by the finger as occasion requires to produce an instantaneous and simultaneous movement of the hand of each instrument to the letter, character, or figure which it represents. As an illustration, to telegraph the word "Bond"—

First, depress the stud	in	immediate	contiguity to	B
Secondly	„	„	„	O
Thirdly	„	„	„	N
Fourthly	„	„	„	D

and the hand of the Communicator and Indicator will instantly rotate in the same order to those letters.

By this process practice will enable the manipulator to signal—

By the high-speed apparatus, 100 letters per minute.
„ medium-speed „ 50 „ „

The attention of the Receiving Clerk is obtained by means of the alarum, which is operated upon by turning the handle of the Communicator, and then depressing one of the studs, usually that opposite the sign +.

The letter A, which appears on the pedestal of the Indicator, signifies "Attention," and the letter T denotes "Telegraph."

The frame of the Communicator contains a permanent horse-shoe magnet with coils for producing the necessary magnetic currents. An exterior handle, on revolution by the hand, or other means, causes an axis carrying a soft iron armature in the instrument to revolve. This armature is so arranged upon the axis as to be in close proximity with the soft iron cores of the coils on the poles of the horse-shoe magnet, so that at every revolution of the axis with which the handle is connected, the soft iron armature passes over the poles of the magnet; and at the moment of making and breaking contact, induces currents of electricity, moving in opposite directions through the wire of the coils, if the circuit be complete. These induced currents through the coils taking place each time contact is made and broken, during the revolution of the soft-iron armature with the poles of the magnet; a succession of currents or waves of electricity is

obtained by the continuous revolution of the handle attached to the axis carrying the armature.

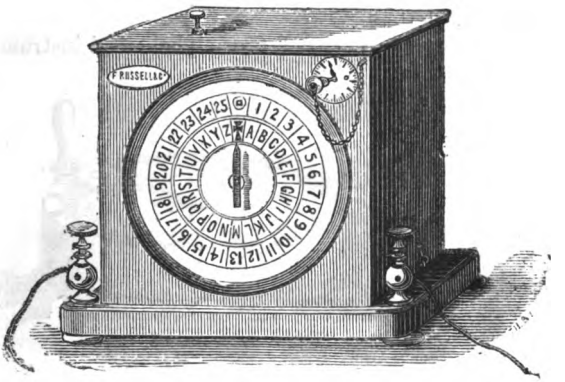
The mechanism of the Communicator is so arranged that when any one of the thirty keys round the dial is pressed down by the finger, that key has the effect of cutting off the passage of the current along the line and through the instrument, and of making a short circuit with the earth so long as it remains depressed. When any other key is similarly depressed, a simple piece of mechanism causes the depression of this key to elevate the former key, open the electrical circuit, and allow the induced currents derived from the magnet to flow in succession through the instrument and along the wire to the distant station, until they are again interrupted and passed into the earth by the depressed key. This short circuit contact is made by means of a loose carrier arm attached to the axis which carries the pointer on the dial, and thrown in or out of gear by the depression or elevation of a key. Motion is communicated to this axis by a bevelled wheel working into a pinion fixed to the axis carrying the armatures, the motion being so adjusted that for every separate current induced in the coils, the hand shall move one space or letter on the dial. The keys, therefore, being depressed in succession will each liberate one current, or thirty distinct currents during an entire revolution of the hand round the dial, fifteen in one direction and fifteen in the opposite direction.

The face of the Indicator is spaced into thirty divisions like the Communicator, with its double circle of letters and figures, and its movable hand or index. A step by step motion is imparted to this hand by means of an electro-magnetic apparatus, which consists of two permanent magnetic bars or needles fixed to an axis, and lying parallel between two small electro-magnetic coils with soft iron cores. These electro-magnets are so arranged that when a current of electricity from the Communicator passes through the coils, their armatures exercise a mutual attraction and repulsion on the poles or extremities of the magnetic needles, the effect of which is to impart a backward and forward motion to the axis carrying the magnetic bars. Fixed to the end of this axis is a short vertical arm, carrying a small escapement wheel of fifteen teeth, the axis of which carries the pointer on the dial, and to which a step by step motion

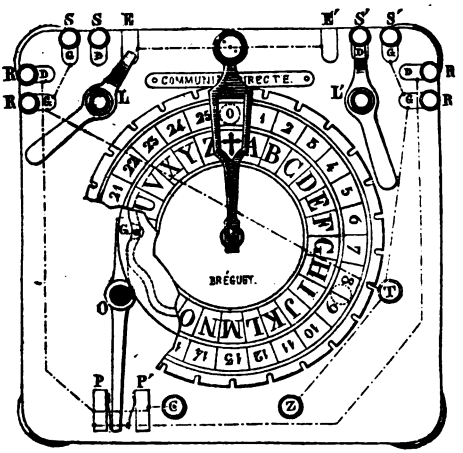
is imparted by the rotation of the escapement wheel working to and fro against fixed stops or pins.

BREGUET'S ALPHABETICAL TELEGRAPH.

This, which is a French invention, is in extensive opera-



BREGUET'S A B C INDICATOR.

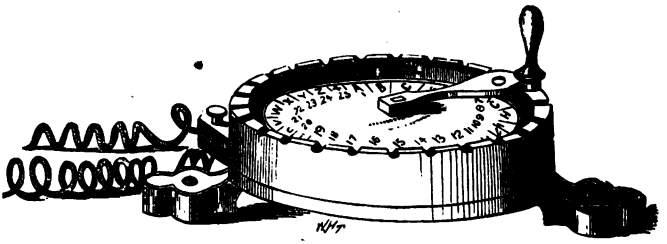


BREGUET'S A B C MANIPULATOR.

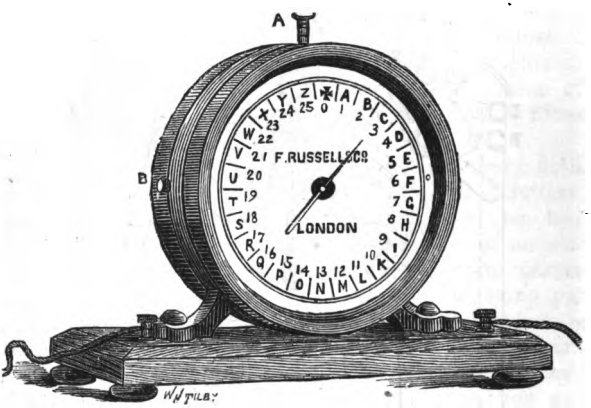
tion on the Continent, and is also largely used in connection

with private places of business in England. Like the former, it may be easily worked, even by those who are unacquainted with the principles of telegraphy—the pointer of the manipulator has merely to be directed to the letters required to constitute the telegram, and the pointer of the indicator is thereby simultaneously made to incline to corresponding letters.

There are several other A B C or alphabetical instruments; as for instance, Bailey's A B C.



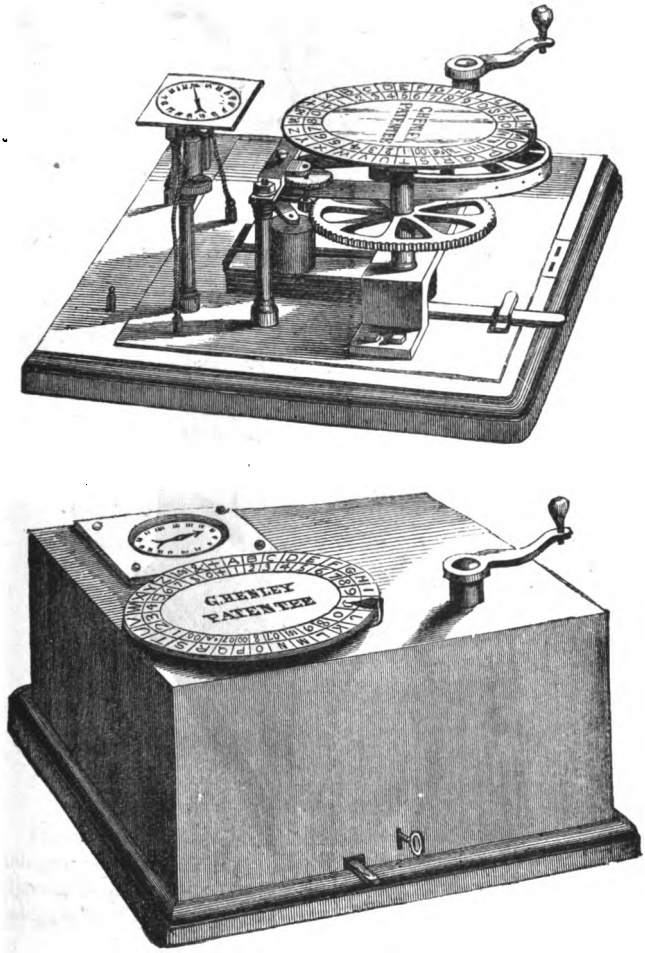
BAILEY'S A B C TRANSMITTER.



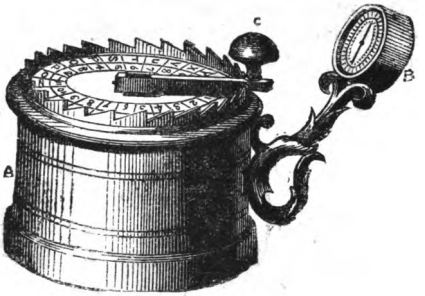
BAILEY'S A B C RECEIVER.

The French, German, and Greek, as well as our own alphabet, are, in accordance to requirement, inscribed on the dials of this instrument, and can, in either language, be readily operated upon.

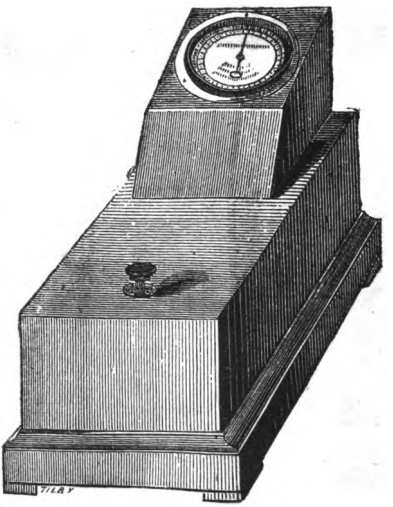
Amongst the other inventions of this class of A B C instruments, are Henley's Magnetic, Siemen's Magnetic, Improved Magnetic, Wilder's Patent, &c., &c.



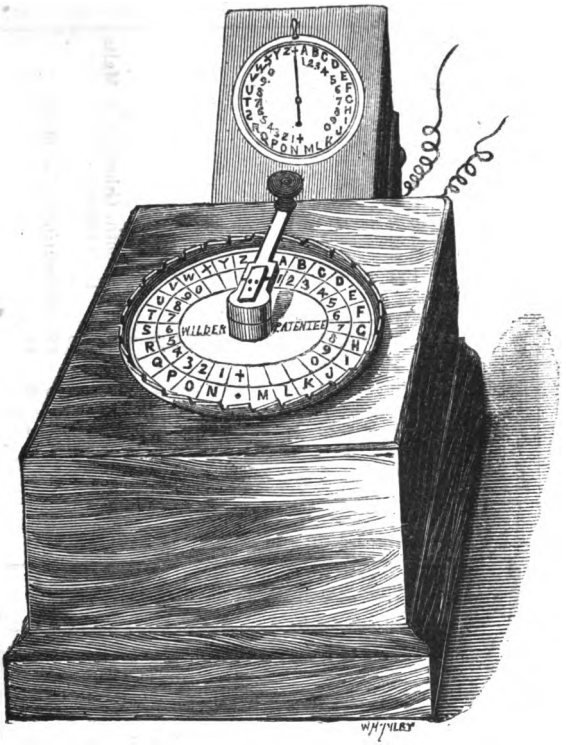
HENLEY'S MAGNETIC A B C INSTRUMENT.



SIEMEN'S MAGNETIC A B C INSTRUMENT.



IMPROVED MAGNETIC A B C INSTRUMENT.



WILDER'S PATENT A B C MAGNETIC INSTRUMENT.

None of these instruments require a battery.

The Pneumatic Tube.

Pneumatic tubes are employed for the transmission of telegrams between the Central Telegraph Station, Telegraph Street, London, the code of which is T S, and the postal telegraph offices tabulated below:—

To	Engine H.P.	Pneumatic Tubes.			Time occupied in transmission.				Remarks.
		Material of Tubes	Length Yards.	Diameter. inches.	Pressure.		Vacuum		
					Min.	Sec.	Min.	Sec.	
West Strand	1 of 20 H.P.	Iron	3413	3	9	0	—	—	Tubes looped at West Strand —St. Martin's-le-Grand and Temple Bar intermediate.
,, ...	1 of 15 H.P.	,,	3413	3	—	—	9	0	
Anglo-American Office .	,,	Lead	62	2¼	0	5	0	6	
Baltic Coffee House	,,	,,	590	2¼	0	35	0	38	
Cornhill	,,	,,	490	1½	0	37	0	40	
Fenchurch Street	,,	,,	980	2¼	1	5	1	20	
Founders Court.....	,,	,,	223	1½	0	13	0	14	
F Division	,,	,,	50	2¼	0	4	0	5	
Gresham House.....	,,	,,	588	1½	0	40	0	51	
Indo-European Office ..	,,	,,	57	2¼	0	5	0	5	
Intelligence Department	,,	,,	44	1½	0	5	0	6	
Leadenhall Street	,,	,,	659	2¼	0	35	0	38	
Lloyd's	,,	,,	343	1½	0	17	0	25	
Metropolitan Gallery ...	,,	,,	29	2¼	0	5	0	4	
Old Bond Street	,,	,,	370	1½	0	25	0	29	Falmouth, Gibraltar, & Malta Co.'s Office.
South Gallery	,,	,,	50	2¼	—	—	—	—	
Stock Exchange	,,	,,	314	1½	0	15	0	15	
Threadneedle Street....	,,	,,	566	2¼	0	34	0	48	Submarine Co.'s Office.
,, ,,	,,	,,	559	2¼	0	32	0	45	

Total length of Tubes referred to, above 12,800 yards, or 6 miles 1,240 yards.

There are also pneumatic (lead) tubes in connection with the postal telegraph establishment in

		Yards.
Birmingham, length of Tubes	.. ..	698
Dublin	,, ,, ...	2,700
Glasgow	,, ,, ...	242
Liverpool	,, ,, ...	2,403
Manchester	,, ,, ...	2,026
	Total	8,069

4 miles 1,029 yards.

Postal Telegraph Codes, etc.

In telegraphing there are various abbreviations, denominated *codes*, which are significant of instructions, time, names of stations, &c. These codes have their peculiar position, some occupying the precedence in the telegram, whilst others of them are intermedials, and some again form the termination. The codes included in the category of the former are called *prefixes*, and those in that of the two latter come under the term *affixes* and abbreviations. These codes may be severally defined as the signification of few or many words by one or two letters, and when constituted as signals are momentarily recognised, as but a few beats, or even a single beat, are indicative of a meaning, the full rendering of which would occupy more time, and not be so readily understood. Codes which are adopted by the Post Office authorities:—

MESSAGE PREFIXES.

Prefixes.	Their Signification.
B	.. Government message with priority.
C	.. For a message to or from the Submarine Telegraph Company.
D	.. For a message to or from the Danish-Norwegian Telegraph Company.
F	.. For a message to or from the French Atlantic Telegraph Company.
G	.. For a special service message service on business of the Post Office, sent by or to the Postmaster-General, Secretary, or Engineer:
I	.. For a message to or from the Indo-European Telegraph Company.
M	.. Remittance message.
P	.. Press or news message.
R	.. Repeated. This prefix indicates that the message is to be signalled back to the sending station.

S .. Ordinary Private Message. When there are no telegrams bearing the extraordinary prefixes, the transmission of telegrams of this code must be regulated by the time delivered to the company, the earliest having the precedence.

U .. Ordinary Service Message. To be forwarded when the wires are not engaged with other communications.

V .. For a message to or from the Anglo-American and Atlantic Telegraph Companies.

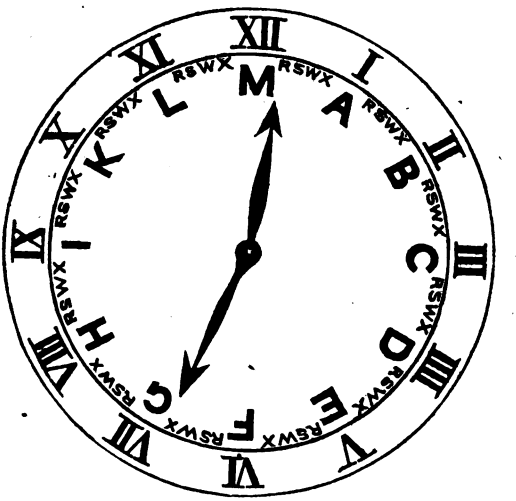
X .. Private Message to be retransmitted.

S or X .. One of these must form the first part of each of the prefixes; the former—S—implying that the message is signalled direct to the office of its destination, and the latter—X—that it requires to be retransmitted. Hence, if the Government message (prefix B) is signalled direct to the postal office of its destination the compound prefix would be SB; but if requiring to be first signalled to a "transmitting" station and thence re-telegraphed to the office of its destination the compound prefix would be XB.

S and X are the only prefixes that are employed separately.

TIME CODES.

These are shown on the diagram below. The large letters



represent the hours and the twelve divisions of the hour,

and the four smaller letters are expressive of from one to four minutes.

A	denotes	the 1st	hour, or	5	minutes.
B	,,	2nd	,,	10	,,
C	,,	3rd	,,	15	,,
D	,,	4th	,,	20	,,
E	,,	5th	,,	25	,,
F	,,	6th	,,	30	,,
G	,,	7th	,,	35	,,
H	,,	8th	,,	40	,,
I	,,	9th	,,	45	,,
K	,,	10th	,,	50	,,
L	,,	11th	,,	55	,,
M	,,	12th	,,	60	,

R	is significant of	1	minute.
S	,,	2	,,
W	,,	3	,,
X	,,	4	,,

It is sometimes necessary to employ a combination of these letters in a code, for example :—

		H.	M.
A B	would signify	1	10
B A	,, ,,	2	5
B A S	,, ,,	2	7
B A W	,, ,,	2	8
B A X	,, ,,	2	9
D F	,, ,,	4	30
G R	,, ,,	7	1
G G	,, ,,	7	35
K L	,, ,,	10	55
M R	,, ,,	12	1

Postal Telegraph Office Codes.

These, like other codes, consist of one letter or a number of letters which, when telegraphed, convey the same information as if the whole of the letters in the name of the postal telegraph office were signalled letter by letter. Take for example the following cases :—

Banbury is represented by the letters			B B
Bristol	,,	,,	B S
Cardiff	,,	,,	C F
Chepstow	,,	,,	C J
Chippenham	,,	,,	C P
Coal Exchange, London		,,	C X
Covent Garden Market Piazza		,,	C N F
Gloucester Head Post-office		,,	G B E
Gloucester Docks	,,	,,	G R
House of Commons		,,	H M K
Stroud	,,	,,	S D
Tredegar	,,	,,	T R

Grouping of Offices' Codes.

Certain sub-offices are generally grouped with a head office, and in addition to the general code each of them has a local code, the employment of which is recognisable only amongst themselves; but in communicating to places without the circuit, the general code is adopted by them; but the head office is distinguished both in the circuit and elsewhere by one code only. The local code consists of the following letters:—D, G, K, O, R, S, U, W, F, L, P, Q, X, Y, Z; but as there are but seldom instances of a group consisting of more than eight sub-offices, the letters preceding F are all that are as a rule required. The station next in proximity to the head office is expressed by D; the next in distance to the head office is expressed by G; the next in distance to the head office is expressed by K, and so on in successive order. On the sub-office circuit cards, which are exhibited at each of the sub-offices, the names of the places in the particular group to which it belongs and the two codes are enumerated.

In this example Birmingham is the chief office, and if that station should call Sparkbrook, the code used would be D; but if Sparkbrook should call Birmingham, the code would be B M; whilst the code by which Sparkbrook would call Moseley would be G. If Liverpool, which is without the circuit, should call Sparkbrook or Moseley, the code used in the former case would be S O L, and in the latter M M D.

POST OFFICE TELEGRAPHS.

HEAD-OFFICE CIRCUIT.

HEAD OFFICES.	CODE.
Birmingham	B M
Liverpool	L V
Switches at	

POST OFFICE TELEGRAPHS.

SUB-OFFICE CIRCUIT.

HEAD OFFICE.	CODE.	
Birmingham	B M	
SUB-OFFICES.	**CODE.**	**CALL LETTER.**
Sparkbrook	S O L	D
Moseley	M M D	G
King's Norton	K C C	K
		O
		R
		S
		U
		W

Affixes, Abbreviations, and Prefixes to Service Communications.

Codes.	Their Signification.
A L	Instructions to receiving clerk to commence a fresh heading in news messages, Colonial wool sales, prices firm; A L London Coal Market—house coal advanced 3*d*.
A U	Answer, which has not been paid for, to be waited for by messenger.
B B	Telegram to be forwarded by boat from the station at which received.
B C	By cab, coach, gig, or other such vehicle.
B M	By best ordinary means, due regard being observed as to the expense.
B P	By first postal despatch or delivery.
C C	Inverted commas, to be signalled at the commencement and completion of a quotation. Thus—CC Man wants but little here below CC
C F	Message to be called for.
C Q	All Stations. A notification to all postal telegraph offices to receive the message.
D F	Yes; or, in other words, Direct line free. In reply to T Q.
D Q	Completion of Addresses. This code is signalled in order immediately after the address of the intended receiver.
F I	To indicate that a figure or a group of figures will be signalled next in order. Thus—F I. 60.
F Q	This code indicates to the sending clerk that the marks are to be made more distinct to enable them to be read by the receiving clerk.
G Q	Commence a fresh line.
H Q	Inquiry made by the sending clerk as to the appearance of his signals or marks to the receiving clerk.
I F	To indicate that the figure or group of figures is completed. Thus—60 I F.
I P	Deficiency. This code precedes the amount short paid by sender.
I Q	No; or, in other words, in short circuit. In reply to T Q.
K Q	Inform me when you can attend to my signals. This code is in reference to the request M Q.
L L	Underlined. This code is signalled immediately before and after words which are underlined.
L Q	Keep line clear for testing.
M E	Greenwich or Dublin mean time.
M H	Message to be conveyed by man on horseback.

M M .. Instructions, and is represented by a stroke thus — This code is to precede all others, having reference to the disposal or delivery of a message, and must occur immediately after the completion of the text of the message.

M Q .. Wait. A request to the office calling you to wait, you being otherwise engaged.

N N .. Cleared Out. Indicating that the signalling clerk has completed all the communications he had to make to his correspondent.

N Q .. Broken down to ——; or, no communication to ——.

O Q .. Signal more slowly.

P D .. Amount Paid for delivery. To precede the amount prepaid by sender in respect of postage, cab hire, or other mode of special delivery. If these particulars are not signalled, the receiving clerk will act on the supposition that the sender has paid for the message only.

P P .. Parenthesis. Words in parenthesis must be preceded and succeeded by this code. Thus—PP with the exception of PP

P Q .. Completion of telegram, and of special instructions, when there are any. This code is represented thus =.

R Q .. Discrepancy in the number of words. This code is signalled by the receiving clerk if the number of words contained in the message received does not agree with that in the statement of the sending clerk.

R T .. Number of words correct. If the total number of words, of which the telegram as received consists, corresponds with the statement of the signalling clerk, the receiving clerk signals back this code.

S L .. State of lines.

S X .. Telegram to be delivered by special express, expense being no consideration.

T I .. Daily time signal.

T Q .. Am I through to ——? An inquiry as to whether the line is clear through the switch.

W P .. Reply paid for by sender. Messenger to wait for it.

X Q .. Attend to relay.

Y Q .. Request to two or more stations to receive the message simultaneously.

Z M .. Weather intelligence.

Z Q .. Attend to switch.

Definition of the word "Inland."

The term Inland comprehends the whole of the postal telegraph offices in the United Kingdom.

Order to be observed in writing Telegrams.

Senders are requested to commence their message in the first division of the message form by writing one word in it, and to write the next word in the second, the next to that in the third, and so on until the whole is written; and it is to be hoped that as the object of such an arrangement is to save time, no person will refuse to fall in with it; but the disregard of it is not to be construed as prohibitory of its acceptance by the telegraph clerk for transmission.

Erroneous Spelling.

If the consent of the Postmaster or clerk in charge be obtained, errors in spelling which occur in the message may be rectified before transmission by the telegraph clerk.

Indistinct Writing.

If a word is indistinctly written, it will be the duty of the clerk to whom it is handed for transmission to write it distinctly, after obtaining an explanation from the sender of what was intended to be expressed by him.

Incapability of the Sender to write.

In a case of this nature, the telegraph clerk is authorised to write the message at the dictation of the sender.

Telegrams of an Obscene, Abusive or Libellous Character

Ought not to be accepted for transmission; but the clerk must not refuse to receive them before taking the instructions of his superior officer, to whom he must submit them.

Figures and Ciphers.

An exception to the general rule, prohibiting the signalling of figures, is made in the case of certain messages telegraphed on the Morse printing instrument, such, for instance, as news or stock messages, and then only when they are so written in the message. When figures are to be

A.

	A.M.	P.M.	Words to
Prefix			In Addresses (
Received at ..			In Telegram (
Code Time			In Instruction
Sent at	.....	.....	Tot
To the Office at			Counter C
By me			.....

The Blank spaces above are for use by the Officers

FOR I

It is particularly requested that the Name and address of the Sender of the Telegram. Addr

From *J. Jones,*

Gloucester Docks.

In each of the spaces below, one word only should be wr line is divided, and so on. When the Message is i Message or Form by pin, or wafer, or gum.

telegraphed as such, the figure code FI must precede and the code IF must succeed them; this is the course to be pursued in respect of any figure or group of figures which occur in a message. It may be observed that those codes should not be introduced on the form, but only used by the instrument clerk when signalling. Example: if 100 has to be telegraphed, first signal FI, then 100, then IF, but if the number is to be spelt, the words "one hundred" will suffice.

Similarity of Signals.

WORDS, THE SIGNALS FOR WHICH BEAR A RESEMBLANCE.

If great care is not observed in telegraphing by the Morse printing instrument, the following words may be read for each other:—

Boys	for	Boxes	Into	for	Inch.
Calls	,,	Calais.	Seen	,,	Scene.
Cash	,,	Cases.	Save	,,	Have.
Found	,,	Pound.	Wheat	,,	What.
Give	,,	Gave.	Will	,,	Well.
Hall	,,	Half.	Your	,,	Four.

WORDS LIABLE TO BE MISTAKEN FOR OTHERS IF NOT DISTINCTLY WRITTEN.

Ale	for	All.	Piece	for	Price.
Close	,,	Clear.	Seventy	,,	Twenty.
Light	,,	Eight.	Send	,,	Lend.
Our	,,	One.			

Inland Telegrams.—The Forwarded Form.

The forwarded form is that on which the sender writes the telegram for transmission. (See opposite.) It may be obtained at postal telegraph offices, either unstamped or with an embossed shilling stamp on it, the unstamped form is marked A, and the stamped form bears the mark A1.

This telegram is precisely as tendered by the sender, and the charge for it would be 1*s.* 6*d.*: the ten words in address, and the five words (viz. "best means, five shillings paid"), in the instructions for delivery of the message, are telegraphed free of charge.

The only portion of the preceding form which the sender supplies is the "message," commencing after the word

"from." The codes, time, and number of words are inserted by the clerk, and, with the exception of the time when the forwarding of the message was completed, must be supplemented before the signalling is commenced.

Preparation of "Forwarded Form" for the Instrument.

The order to be observed by the counter clerk in connection with this form is indicated by the figures which appear in parentheses against the various spaces in the heading. He will—

1st. Count the words in the addresses, the message, and the instructions, and, having written down those of which each consists, add them together.

2nd. Enter the charges.

3rd. How paid.

4th. Progressive number of telegraphic form: thus, the first message sent would be numbered 1, the next 2, the next 3, and so on; those numbers are the progressive or consecutive numbers.

5th. Previous to making any additional remarks on this form, the clerk must enter in the Forwarded Message Abstract Book, against a number corresponding with the progressive number on the message form, the surname of the sender, the destination of the message, and charges.

6th. The message prefix, which explains the class of telegram; for instance, if an ordinary message can be sent to the office of its destination direct the prefix would be S, but if required to be transmitted the letter X would explain as much.

7th. Time Code, or time received from sender.

8th. Signature of counter clerk.

9th. Time received at instrument. If the instrument room is distinct from the counter the instrument clerk will write this when handed to him by the counter clerk, but if the counter and instrument are attended to by the same clerk he will supplement such particulars, and complete, in the order which will be hereafter explained, the remarks against other portions in the heading of the form.

10th.* The time of completion of the signalling of the message.

11th.* The name of the place to which the message was signalled.

12th.* The signature of the sending clerk.

The necessary preparations for the commencement of operations being now matured (see opposite), the message must be hung in front of the instrument, in order that it may be read by the clerk as he signals it, word by word, and letter by letter.

* The particulars against these Nos. are to be inserted after the message has been telegraphed.

ber	*ton*
ne	*with*
best	*house*
t	*Gloucester*
hire	*in*

[*To face p.* 92.

Unskilful Clerks.

It is enjoined that sending clerks will not manipulate with greater speed than will adapt itself to the capabilities of receiving clerks who have not attained to a proficiency in reading off the signals.

The "Call" Signal.

Formerly, it was the practice to attract the attention of a station by an alarum, when a message was to be forwarded; but, whether from the fact of its being too clamorous, or from another cause, that mode of call has grown into desuetude, and the less noisy one of working the needles a few times backwards and forwards, is sometimes substituted for it. By the postal telegraph arrangement, the system of calling the attention of an office for which a message is destined, or to be sent for transmission, is by signalling the code of such office continuously until an intimation of your correspondent there being prepared to receive your message is given by him repeating the code. To illustrate this, we will assume that the instrument clerk at Gloucester Docks (the office code for which is GR) could telegraph direct to Tredegar (the office code for which is TR), he would signal the Tredegar code, TR, and the Tredegar clerk would reply by repeating TR, after which the clerk at Gloucester Docks would telegraph the code of his own office, GR, and then other particulars in the order observed below:—

1. The message prefix (which in that case would be S').
2. Time code.
3. Total number of words.
4. Name and address of sender.
5. Name and address of the intended receiver.
6. The code D Q.
7. Message.
8. The code M M if there are any instructions.*
9. Instructions as to disposal of the message.
10. The code P Q.

As it happens that Cardiff—code CF—is the transmitting office through which telegrams from Gloucester Docks to

* If there are no instructions as to the disposal of the telegram signal P Q (which indicates the end of the message) instead of M M.

Particulars must now be inserted against Nos. 10, 11, and 12, at the commencement of the printed heading of the message form.

Tredegar should first pass, the telegram in question would be a transmitted one, and should consequently bear the prefix X; with that difference, the preparation of the forwarded form would be precisely as if the message could be signalled direct.

Transmitted Form B (see opposite).

When a message cannot be telegraphed direct from the sending office to that of its destination, but has first to be signalled to an intermediate office; and thence re-transmitted to the latter, the intermediate office is called the transmitting office, and the form on which the telegram is written by the clerk, as received at such station, is called the transmitted form. The prefix to transmitted messages is the code X.

This form, which is of a buff colour, differs from form C in one respect, viz., in that the heading does not contain the space for charges. After the message is received, the clerk at the transmitting office, which is in this example Cardiff, signals to the office for which the message is intended (in this instance Tredegar) in the same order as the original sending station, the information contained in the heading and the various sections of the telegram, and enters on the first vacant line in the abstract of Transmitted Message Book, the particulars expressed at the top of the respective columns comprised in it. He then transcribes the consecutive No. to the transmitted form, and enters the time of completion of the transmission of the telegram against the words "sent at;" after that the name or code of station to which he signalled it opposite the word "To," and finishes by affixing his signature to the words "By me."

Received Message Form C (pink paper).

Each postal telegraph office is supplied with what are denominated "pads" of received message forms gummed together by the upper edges. Underneath each of the forms C is a form imprinted, on which are lines for the two names and addresses, and a space below for the message. Before commencing to write the telegram, the receiving clerk has to insert between the two forms a piece of carbonic paper, whereby two impressions of the message are obtained simul-

.....P.M.	No. of Message	3
R.	OFFICE with	*Cardiff.* STAMP date
all.		

To *Bevan and Pryce,*

Argoed,

near Tredegar,

In each of the spaces below, one word only should b

Words.	Charge		
		(6) *At*	
		can	
20	1/-	*fifty*	
		Coal,	
25	1/3	*Station ?*	
30	1/6	*price.*	
35	1/9		
40	2/0		
45	2/3		
50	2/6		

ieously. The carbonic paper has to be so placed as not to reach above the sender's name; this is to prevent the remarks in the heading being duplicated; the upper form is to be retained by the postal authorities as an office copy, and the lower one is the one to be delivered to the addressee.

As the respective portions of the heading, addresses, message, &c., are received, the receiving clerk must write them with a black-lead pencil on the form C. After each word is signalled, he must intimate to the sending clerk by the letter T, if the signal is understood by him, and by the letter E if it is not understood. When the letter T is employed the sending clerk will proceed to signal the next word, but if the "not understand" signal E is given by the receiving clerk, the sending clerk must repeat the word until the letter T is signalled back to him.

The practice of giving the not understand code is not to be dispensed with by inexperienced clerks, nor by clerks at second-rate or sub-offices, but a discretionary power in reference thereto may be exercised by the experienced instrument clerks of important offices or circuits.

When an instrument clerk has not the assistance of a copying clerk, he must write down each word before signalling back the understand signal T.

The period or full stop should be read by the instrument clerk as period, as the word stop is likely to be mistaken by the writing clerk as "stock," and to be thus introduced on the message form.

The affix D Q is not to be written on the form C. A stroke thus —, instead of the code M M, must be written at the end of the message if there are instructions as to the disposal of it, and two strokes parallel with each other thus = must represent the code P Q to denote the completion of the telegram.

Order of Filling up of Form C (see opposite).

The numbers which occur in the circle or ring against each portion are explanatory of this; for example:—

(1). Message prefix.
(2). Time code.
(3). Total number of words.

(4). Name and address of sender.

(5). Name and address of receiver.

(6). Message.

(7). — this stroke represents the code M M. There will be no necessity for introducing it if there are no instructions given for the disposal of the telegraphic dispatch.

(8). Instructions.

(9). = these strokes represent the code P Q, or completion of the telegram, and must be written immediately after (6) if there are no instructions.

After proceeding thus far, the receiving clerk must count the whole of the words in the telegram, and if the total agrees with the statement of the sending clerk, he will signal back the code R T and the name of the addressee, but if it does not correspond, he will telegraph back the code R Q and name of addressee, and then proceed according to instructions contained in the paragraph "Collating, or Repeating back," page 88.

When the receiving clerk has satisfied himself of the accuracy of the message he will enter—

(10). Time of completion of receipt of message.

(11). Code of the office from which the message is received.

Entries have now to be made on the first vacant line of the Abstract of Received Message Book, the headings of which are explanatory—

(12). Number on Form C to correspond with that prefixed to the entry in Abstract Book.

The message may now be enclosed in an addressed envelope and sent out for delivery.

(13). Time handed to messenger for delivery.

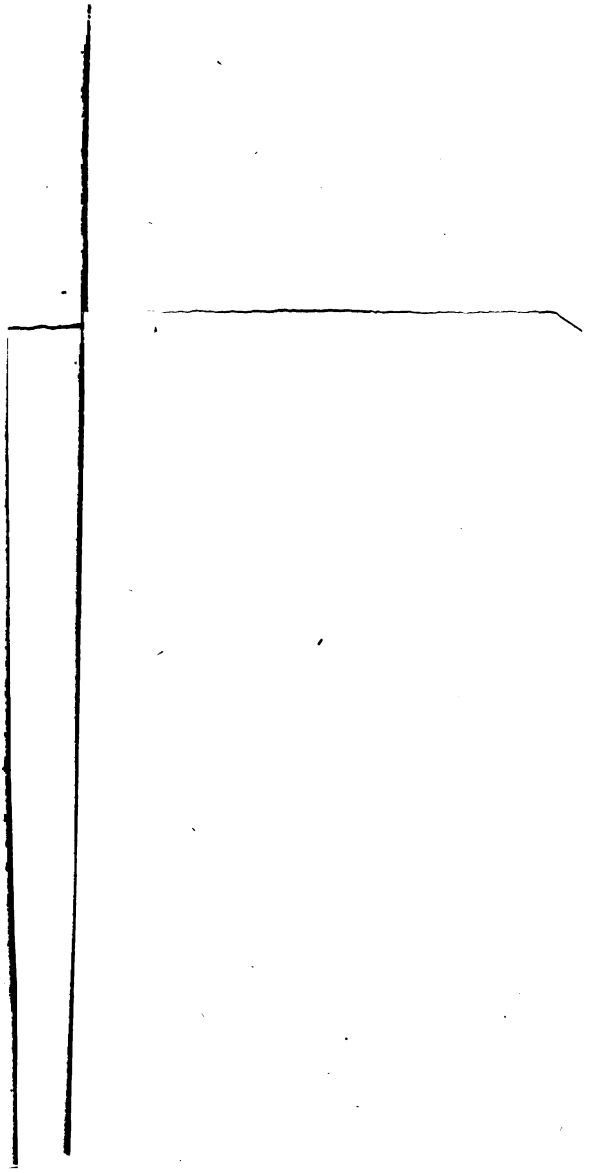
(14). The word delivery.

(15). Signature of clerk by whom sent out for delivery.

Interruptions.

It is only in the case of precedence of a message prefix that interruptions to the transmission of messages are sanctioned, as, for example, S B or X B.

Should two or more messages be handed in at two or more sub-telegraph offices that are associated in the same



circuit, the office which is in nearest proximity to the head office has accorded to it the precedence; but no office is allowed to interrupt another in the transmission of a message, even though the time code of that one which is in the course of being signalled be later than that of the office which requires possession of the line. In such cases the office with the earlier time code must keep a vigilant look out for the code P Q, and avail himself of the earliest opportunity to claim his turn.

Quarrelling for the possession of the line is strictly forbidden, as more time may be thus lost than would be required for the transmission of the message.

Undue Preference.

Undue preference is not under any circumstances allowed. All telegrams must be transmitted and delivered in the order in which they are received. When two or more copies of the same message are for different persons they must be delivered as nearly simultaneously as possible.

Priority.

The only telegrams to which priority in sending or delivery is accorded, are those on which the word "priority" is specially marked or stamped by the Secretary of State, the Board of Trade, or other departments of Her Majesty's Government sending the same, and every message so stamped or marked is retained by the Postmaster-General for a period of not less than twelve calendar months from the date thereof.

Messages emanating from the above sources which are not stamped or marked "Priority" are transmitted in consecutive order, and treated in every respect as ordinary messages.

The Instrument Room.

The authority to allow a stranger to enter the above is vested in the secretaries to the General Post Office only. Nor must any one, even though possessing that authority, be permitted to loiter near the instruments when they are at work, nor to read the messages at hand; nor must even a

post office clerk enter the room if business does not require his presence there.

The instruments are to be kept clean, the dials of the needle instruments must not be defaced nor the needles bent or broken.

Interruption of Communication.

In the event of any sub-postal telegraph office being cut off from communication by wire with its head office, the sub-postmaster must explain the circumstance to the senders of any messages which he may have on hand, and inform them that on application to the secretary the money paid by them will be refunded. He must also report the circumstance to his head postmaster by the first post, and suspend the further receipt of messages from the public until the communication by wire is restored.

In the event of any head postal telegraph office being cut off from communication by wire with all other head telegraph offices, but not cut off from communication with its sub-offices, the postmaster must inform his sub-postmasters of the circumstances, and warn them that they can send no messages beyond his office until the communication is restored. He must act in the manner above described with regard to the messages in his hands, and must suspend the further receipt of messages until the means of sending them are restored to him. If the communication between his office and other head offices is only partially interrupted, so that he can send messages forward, though not by the route which they would usually take, he must make the best arrangements in his power for sending them forward. He will in any case take the earliest possible means of informing the central telegraph office that an interruption has taken place.

State of Wind and Weather.

The state of the wind and weather is reported by certain offices to the central telegraph office at 8 A.M. daily.

Greenwich and Dublin Mean Time.

At 10 A.M. daily, Sundays excepted, Greenwich mean time will be sent to every postal telegraph office in Great Britain, and Dublin mean time will be sent to every postal telegraph

station in Ireland. At two minutes to 10 o'clock all offices must give special attention to their circuits. At that time the signals representing T I will be sent from London or Dublin, as the case may be, and the stations receiving these signals must at once repeat them to all the other circuits. All work on the wires along which these signals pass must be suspended from 9.58 A.M. until 10 A.M., at which time precisely the signals representing M E will be sent from London or Dublin, as the case may be, to be in like manner repeated over all circuits. The sending of the signals for M will represent the true time, and on the arrival of those signals every clock is to be adjusted to 10 A.M.

Diary.

At 8 A.M. daily, an entry is to be made of the state of the weather and the condition of the wires, as indicated by the weakness or otherwise of the signals.

Irregularities in the working of the lines or failure of apparatus.—Inattention, slow writing, or blundering on the part of corresponding offices are recorded in the Diary as they happen.

The postmaster reports to the central telegraph office daily the cases of irregularity or interruption of communication and defects of apparatus, and to the surveyor of his district inattention, slowness, and blundering.

Anticipated Influx of Business.

In order that the postal telegraph department may take proper steps to provide for any sudden increase of telegraphic business on occasions of public interest, postmasters are, if possible, to report to their surveyors, a fortnight in advance, the date fixed for any important public proceeding.

Races.

In reporting the dates fixed for races care should be taken to state the distance of the racecourse from the nearest telegraphic office. A special staff, consisting of one controller, two superintendents, five assistants, five first class and five second class clerks, is attached to the postal telegraph establishment, to provide for and act on extraordinary occasions, such as races, agricultural shows, elections, and

other cases of emergency that are likely to conduce to an influx of business. In the year 1871 there were 140 race meetings in various parts of the kingdom, and the business occasioned thereat included 125,284 forwarded, and 86,845 received messages. The receipts therefrom amounted to £7,649 2*s.* 7*d.*

Out of Door Officials.

Mail guards, mail-cart drivers, letter carriers, and messengers observing any damage to posts, wires, or insulators, are expected to report the same.

Collating, or Repeating Back.

To insure accuracy in the transmission and receipt of messages, it is customary for the receiving station to signal back, or, in telegraph phrase, *collate* all words and figures of doubtful import, and for the sending clerk to insert the mark O, and the receiving clerk the mark + underneath the collated or repeated words.

The mode of drawing the attention of the sending clerk to a supposed error, is for the receiving clerk to work the needle, backwards and forwards two or three times, and signal the code P E (which is synonymous to the words "repeat from"), followed by the word preceding the doubtful one. Suppose, for example, the message to run thus: "Can you come here this evening?" and the receiving clerk is uncertain as to, or cannot understand, the third word, his duty is to give the code "P E you," and the sending station will supply the word "come," and then proceed with the other portion.

In the event of a doubt arising as to the correctness of a word, after the completion of a telegram, the receiving clerk must signal the code W A (which signifies "word after") or W B (which means "word before"); hence, in the same example, the question would be asked thus—"W A you," or it might be "W B here;" but where a plurality of words require to be repeated, the receiving clerk would preface the preceding and succeeding words by P F (which implies "repeat from——to——"); consequently, if the portion of the example "here this" has to be repeated, he would telegraph "P F come, evening."

If, after the receipt of a telegram, the receiving clerk should upon computing find that there is a discrepancy in the number of words, he must give the code R Q, followed by the name of the addressee, to which he will add the total number of words as counted by him, which, for example, we will assume to be 39, and that the statement of the sending clerk shows 41. We will also assume the latter number to consist of 10 words in the addresses, 26 in the message, and 5 in the instructions; the sending clerk should therefore telegraph "10-26-5"—it will thus be momentarily discovered whether the error is in the addresses, in the body of the message, or in the instructions, and that section in which it may occur must be signalled afresh.

If the total number of words received correspond with the statement of the sending clerk, the receiving clerk will signal back the letters R T, followed by the name of addressee By a recent order, all figures in the address or body of a telegram, except news messages, must be invariably repeated back to the sending office.

The Funds and Share List.

This requires no explanation.

Date, 18

Consols for Money .....
" Account .....
3 per Cents. .....
Bank Stock .....
Exchequer Bills, large .....
" " small .....

Buckinghamshire .....
Caledonian .....
" Preference .....
Eastern Counties .....
Great Northern .....
" " A .....
" " B .....
Great Western .....
Midland .....
North Western .....
South Wales .....
West Midland .....

Turkish Sixes .....
" Fours .....

Regulations affecting those Messages which cannot be Delivered.

The addressee may decline to receive a telegram, the address may be imperfect, or some other cause may operate to prevent the delivery of a telegram. In such a case particulars of the cause of non-delivery must constitute a service telegram, code S U, to the sending office, and the postmaster in charge thereof will, by post, or earlier means as circumstances may seem to require, inform the sender of the circumstance; the expense, if any, will have to be paid by the sender, and a copy of the communication made to the sender must be attached to the forwarded message form. The S U telegram in a case of this nature should be in this style, P R (*i.e.*, Postmaster) T R to P R, G R Jones G R to Bevan and Pryce, T R cannot be delivered because * * * *

Abstracts.

These are transcripts of the Abstract Books, and are rendered to the chief office daily.

Abstract Books.

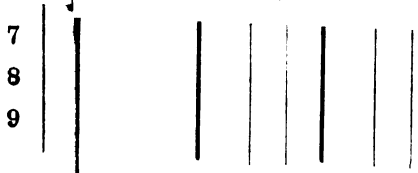
Messages should, at the period of sending or receiving, be registered in the *Forwarded* or *Received Message Abstract Book*, as the case may be. The accompanying examples are intended to exhibit the daily account. It is customary to "rule off" daily, to cast up the amounts which appear in the respective columns as components of the day's receipts, &c., and to insert the totals immediately below the line which occurs after the closing entries.

Counter Message Abstract Books.

These are the only Abstract Books in use at those offices in which the counter and instruments are in the same room, and are self-explanatory. (See Forms 1 and 2, opposite.)

Instrument Room Message Abstract Books.

When the counter and instrument are in distinct rooms, the above form will be used by the counter clerk, and the following will be used by the instrument clerk. The consecutive No., and the entries in the two succeeding columns in the counter and instrument clerk's books must correspond.



[*To face p.* 102.

(No. 3.)

POST OFFICE TELEGRAPHS.

INSTRUMENT ROOM. — ABSTRACT OF FORWARDED MESSAGES.

Date 1873.	Consecutive Number of Message.	Office to which message was sent.	Remarks.	Date 187 .	Consecutive Number of Message.	Office to which Message was sent.	Remarks.
April 10	1	Tredegar			51		
	2				52		
	3				53		
	4				54		
	5				55		
	6				56		
	7				57		
	8				58		
		*	*	*		*	*
	48				98		
	49				99		
	50				100		

At transmitting offices the subjoined form of book is issued in which to register messages that have been re-transmitted:

(No. 4.) POST OFFICE TELEGRAPHS.

INSTRUMENT ROOM.

Date 1873.	Consecutive Number of Transmitted Message.	Surname of Sender.	Name of Office. From which the Message was Received.	Name of Office. To which the Message was Re-transmitted.
	1			
	2			
April 10	3	Jones	Gloucester Docks	Tredegar
	4			
	5			
	*	*	*	*
	48			
	49			
	50			

ABSTRACT OF TRANSMITTED MESSAGES.

Date 187 .	No.	Surname of Sender.	Name of Office. From which the Message was Received.	Name of Office. To which the Message was Re-transmitted:
	51			
	52			
	53			
	54			
	55			
*	*	*	*	*
	98			
	99			
	100			

(No. 5.) POST OFFICE TELEGRAPHS.

INSTRUMENT ROOM. ABSTRACT OF RECEIVED MESSAGES.

Consecutive Number of Received Message.	Surname of Sender.	Office of Origin.	Remarks.	Consecutive Number of Received Message.	Surname of Sender.	Office of Origin.	Remarks.
1				51			
2				52			
3				53			
4				54			
5	Jones	Gloucester Docks		55			
6				56			
7				57			
8				58			
9				59			
10				60			
	*	*	*	*	*	*	
49				99			
50				100			

Messages passing through Shoots or the Pneumatic Tube.

Special abstract books are used for telegrams passing from the counter to the instrument room, or *vice versâ*, by means of a lift or shoot, and for those passing to or from branch offices through the tube.

Railway Accounts.

At railway stations where postal telegraphic business is authorised, a return (form 6) is made daily, either by post or train, as arranged, to such head post office as the Postmaster-General may order. The cash balance, and the forwarded and received telegrams, have to accompany such return.

Accounts.

Returns (compiled from the "Counter Abstract of Messages Forwarded," and "Abstract of Messages Received and amount paid out," Books Nos. 1 and 2), and designated respectively "Account of Messages Forwarded" and "Account of Charges collected on Received Messages," are rendered to the Central Postal Telegraph Office daily.

The hours of closing the telegraph account must be at the same period daily, and the returns rendered once in every twenty-four hours.

In the return No. 8, must be inserted the consecutive number of each forwarded telegram, and the cash or stamps received in respect of it, the total number of messages forwarded during the day, the total amount remitted on account of receipts at railway offices at which telegraphic business is authorised to be transacted on account of the Postmaster-General, and the total charges collected on account of received messages as returned on form No. 7.

The whole of the messages received are not enumerated in detail in this return, but merely those in respect of which amounts are collected on delivery, but the total number of messages entered in the margin must include every direct and transmitted message.

Messages on Forms A, A 1, B, and C.

These are arranged in numerical order, and made up into three separate packets, and the daily returns folded round them, and the whole enclosed with the postmaster's other returns.

Replies for which pre-payment was made by sender are pinned to the received message to which they refer.

(No. 6). POST OFFICE TELEGRAPHS.

Account of Receipts and Payments by the Railway Telegraph Clerk at _____ *on account of Messages Forwarded and Received on the* _____ *day of* _____ 187 .

	Cash.	Stamps.
Total Charges received on Forwarded Messages ..		
Ditto collected on Received ditto		
Gross Totals		
Deduct Cash paid out		
Cash Balance sent to the Postmaster of _____ with the Account £		

(Signature)

_____

Station Clerk.

_____ *the* _____ *day of* _____ 187 .

(No. 7.)

Account of Charges Collected on RECEIVED Messages, and of Money Paid Out by the Postmaster of

Stamp of Offices.

Consecutive Number of Message.	Charges Collected on Delivery.		Money Paid Out.		
	In Cash.	In Stamps.	Particulars.	Amount.	
					Total Number of Messages Received this day and enclosed in this Account.
TOTALS			TOTALS		.....
,, Railway.....			Railway Account.....		.....
Totals Carried to FORWARDED Message Account			Total carried to *Credit* of Daily Cash Account...£		

Messages bearing Charges are alone to be entered in this part of the Account.

Money Paid Out for Porterage or for Special Conveyance, or Money ordered to be refunded, must be entered in this part of the Account.

(No. 8.) POST OFFICE TELEGRAPHS.

Stamp of Office.

Account of Messages FORWARDED by the Postmaster of

Consecutive Number of Forwarded Message.	Charges Received. In Cash.	Charges Received. In Stamps.	Remarks.	Consecutive Number of Forwarded Message.	Charges Received. In Cash.	Charges Received. In Stamps.	Remarks.
1	5	1 6	Brought forward...				
Carried forward							
				Total Number of Forwarded Messages enclosed in this Account.			(Signature)
Totals.....							
Totals of Railway Account							
Total Charges Collected on Received Messages.....							Postmaster.
Totals Carried to Daily Cash Account .....£							

Messenger's Weekly Return.

This return, showing the consecutive No. of telegram, and numbers of messenger's tickets to which they respectively refer, are rendered weekly to the postmaster, who has to attach a voucher for payment to the account, in which he takes credit for the sum he pays in respect of such porterage.

POST OFFICE TELEGRAPHS.

Account of Message Fees due to _____

Messenger No. _____, for the week ended

Saturday, the_____day of_____ 187 .

No. of Message.	No. of Ticket.	No. of Message.	No. of Ticket.	No. of Message.	No. of Ticket.	No. of Message.	No. of Ticket.

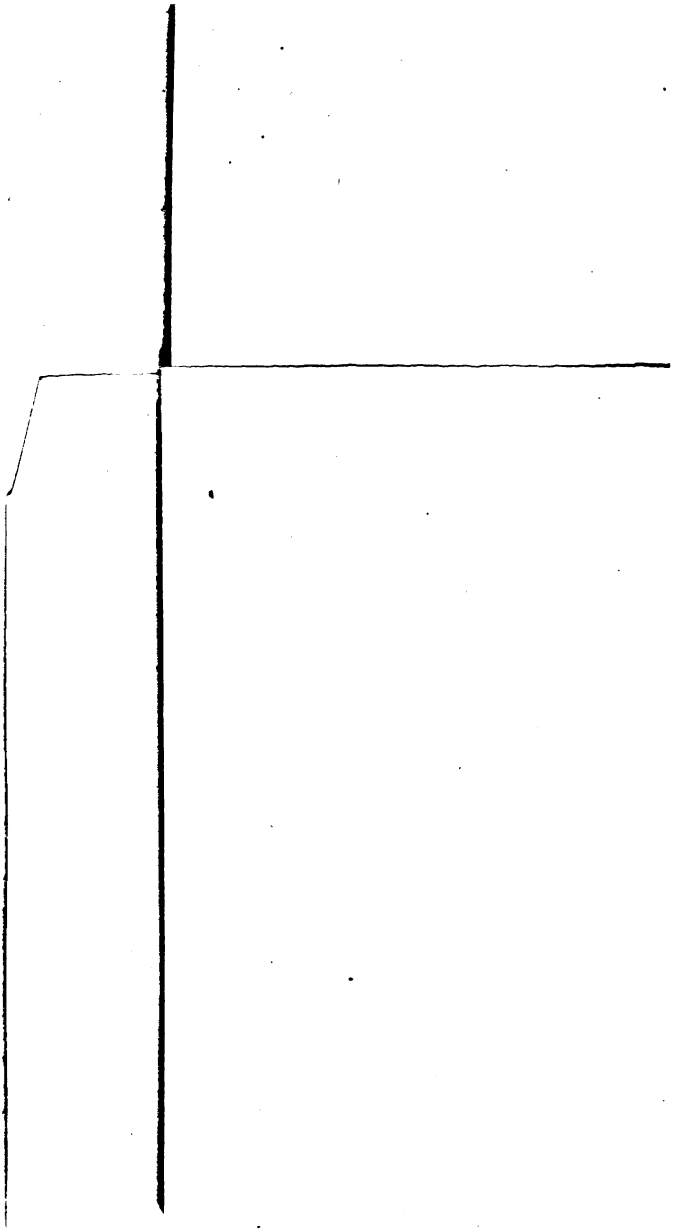
Total No. of Tickets for the Week, all being tied to this Account .... } .....

	£	s.	d.
.....at one halfpenny each.			
.....at three farthings ,,			
.....at one penny ,,			
£			

Examined, _____ Postmaster.

Received Payment_____,

Signature of Messenger.



RAILWAY PRIVATE MESSAGE PREFIXES.

Codes.	Their Signification.
C S	Director's or Secretary's message telegram.
D B	Ordinary railway telegram.
D G	Danger Telegram. Messages with this prefix have reference to accidents, or contain instructions for their prevention. The D G Code has the precedence of all others assigned to it. When it is signalled, the transmission of other messages is suspended. This is the only code which authorises an interruption to the signalling of a message. To insure accuracy it is repeated back by the receiving to the sending station.
D L	Ordinary transmitted message, and is used for those telegrams which are signalled to an intermediate station for transmission to the station for which they are destined.
D S	Engineer's or Telegraph Superintendent's Dispatch. Telegrams with this prefix have the precedence next in order to the Chairman's. Such communications relate to the occupancy of the wires, &c., for repairs or other purposes by the staff of the Engineer's or Telegraph Superintendent's Department, members of which only are empowered to use it, except when clerks in charge have special communications to make to the Engineer, Telegraph Superintendent, or Secretary.
G S	General Manager's message.
S P	Special railway message.
S R	Message to be repeated. This prefix has the precedence of all others except the C S, D G, and D S Codes.
T A	Train reports used in signalling the arrival and departure of trains.

Railway Affixes and Abbreviations.

The affixes and abbreviations, such as A L, C Q, D Q, M M, M Q, O Q, P Q, R Q, R T, and others, which do not refer to money, are used as required in connection with the signalling of railway telegrams.

Authorised Free Messages by Railway Companies' Private Wire Telegraph.

Railway companies are authorised by the Acts 31 & 32 Vic., to make arrangements from time to time with Coal and Iron Masters and Traders generally, upon such companies' system, for the erection and working of private telegraphs, between coal pits, iron works, factories, warehouses, and offices, in

connexion with the stations of the companies respectively, or over their line; but such telegraphs shall be used for the transaction of private business only, and no payment shall be made or received in respect thereof, except by way of annual rent or payment for way-leave and other accommodation.

RAILWAY COMPANIES' FORMS, ETC.

The forms on which the telegrams are written which have reference to railway matters, and are addressed from one railway official to another, differ from those in general use; it may therefore be necessary to submit, for the information of the reader, the *pro formæ* which are peculiar to that service.

Forwarded Message.

[All messages must be distinctly written, and no abbreviations used by the sender, who must enter the time at which he delivers them to the clerk.]

Newport Station.

Prefix, D B.* Code Time, K F.† Number of words, 16.

April 10, 1873.

Received, 10·30 a.m.
Finished, 10·33 ,,

Sent to Gloucester Station,
By me, J. Wilkes, Clerk.

From { R. Jones, Newport Station,

To { C. Thomas, Gloucester Station.

Truck two six four arrived here unentered. Please furnish particulars.

Signature of sender, R. Jones.

Received Message.

Prefix, D B. Code time, K F. Number of words, 16.

Code of Station from which the Message is received.	Receipt finished.	Signature of Receiving Clerk.	Code of Station to which the Message is transmitted.	Transmission, or time sent out for delivery.	Signature of Transmitting Clerk or Messenger.
N P	10·33 a.m.	T. Brown		10·34 a.m.	J. Williams

* D B signifies Railway Message.
† K F, 10·30, the time received from sender.

respective place, and if the fa

The following message forwarded from Newport Station received at Gloucester Station April 10, 1873 :—

From { R. Jones, Newport Station. *To* { C. Thomas, Gloucester Station.

Truck two six four arrived here unentered. Please furnish particulars.

Receiver's initials, C. T. Time received, 10·35 a.m.

Lydney Station.

Train Signal Book,

For registering the time of departure, &c., of Trains.
April 10, 1873.

Train.		Time of Departure.	Time reported to office.	Signalled, *i.e.*, Telegraphed.		Remarks.
Date of.	Description.			Time.	To what Station.	
4·0	Goods	5·4	5·5	5·10	Chepstow	
6·10	Passenger	8·5	8·10	8·12	Gloucester	
7·0	„	9·0	9·1	9·3	Newnham	
8·30	„	9·30	9·32	9·34	Neath	
11.0	Goods	11·0	11·1	11.3	Llandore	
12.0	„	1·0	1·5	1·6	Magor	

The date of train means the time at which the train is appointed to commence its journey.

The code T A is the prefix for train reports.

It is the practice for the clerk in charge of the instruments at a station, to render to his superintendent a periodical report of the state of the instruments and batteries, and another of the signals, and to point out the nature of the defects, if any. (See opposite.)

RAILWAY TRAIN TELEGRAPH.

Block or Signal Telegraphs.

Between certain stations there are telegraphs which are exclusively devoted to the guidance of the officials in the despatch of trains. These denote if the line is clear or otherwise, and are termed

Block Instruments.

Railways on which the Block Instrument is in operation are divided into sections or crossing stations, and the transit or otherwise of the trains is regulated by the instrument; hence, at terminal stations one only, and at intermediate crossing stations two are in use, one of which is connected with the next up crossing station, and the other with the next down crossing station. In illustration of these remarks, we will assume the Sirhowy Railway crossing stations to consist of Tredegar, Blackwood, and Tredegar Junction, and the terminal stations to be Nantybwch and Quarry Mawr: the number of instruments and their connection would be in accordance with the following table:—

Stations.	Number of Instruments in operation.	One Instrument being in connection with that at	Another Instrument being in connection with that at
Nantybwch	1	Tredegar	
Tredegar	2	Nantybwch	Blackwood
Blackwood	2	Tredegar Junction	Tredegar
Tredegar Junction	2	Blackwood	Quarry Mawr
Quarry Mawr	1	Tredegar Junction	

Block or Train Signalling Telegraph.

This, as do most of the block instruments, resembles in shape the single needle alphabet instrument. One half of the disc, that on the left, is of a white colour; and the other half, that on the right side, is painted red.

These colours are appropriate, as on railways white is used to denote "all right," and red is significant of danger.

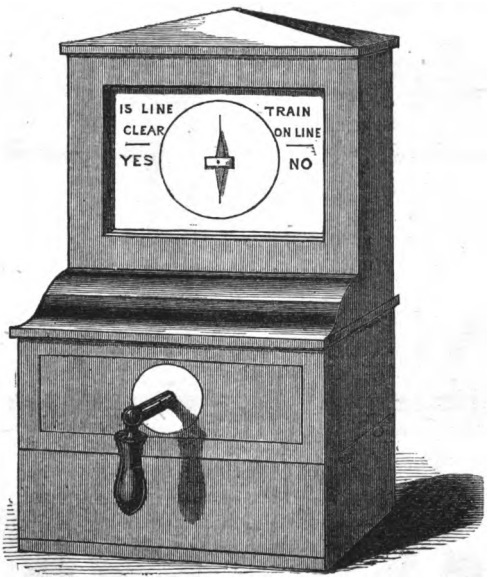
On the white half of the disc of the instrument occur the words, "Is line clear?" Then a line ———— Then the monosyllable "Yes."

The red half bears the words, "Train on line?" Then a line of division ———— Then the monosyllable "No."

The needle is fixed between the two halves of the disc, and is moved steadily to and fro to attract the attention of the

station in the direction of which the train is required to be started; and that station will repeat the movements to indicate that the signal is observed there. The first station will then give three beats of the needle to the left; these beats are understood precisely as the inquiry, "Is line clear?" If it is clear, the contemporary station will signal back three beats in the same direction, which mean "Yes."

If it is a goods train the first station will give five beats of



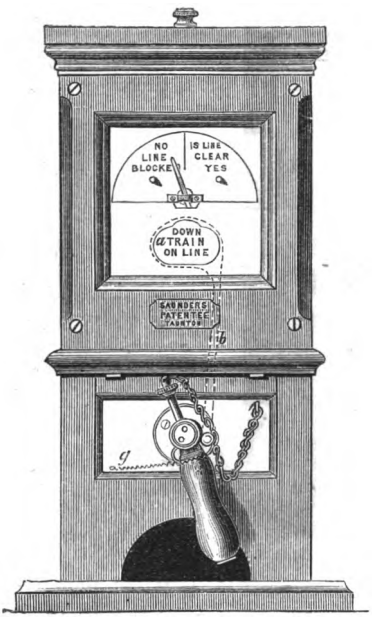
the needle; and, if a passenger train, three beats to the right. These beats are of synonymous import to the words, "Train will start;" and the second station will then prevent further communication from the former by directing the upper point of the needle to the red side of the disc, on which are the words "Train on line," and placing a peg in the handle. This is called blocking the needle.

The train is then started, and on its arrival the peg is removed from the handle of the instrument; the second station

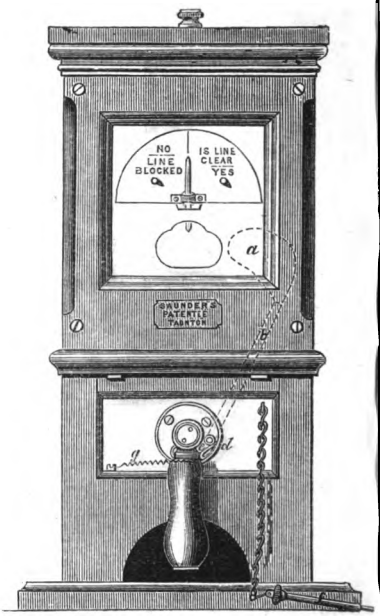
gives one beat of the needle to the left, and the first station repeats the signal.

If the line should be obstructed, or not clear when the inquiry "Is line clear?" is made, the second station, or station of which the inquiry is made, will give eight beats to the right, which means "No; a train on line."

There are in use on different railways other descriptions of block telegraph instruments, for the prevention of collisions, and amongst them those referred to below:—



No. 1.



No. 2.

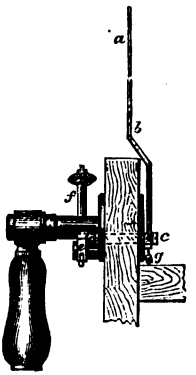
SAUNDERS' PATENT BLOCK INSTRUMENT.

This important improvement in the block system of telegraphing, is the invention of Mr. J. B. Saunders, telegraph contractor, of Taunton.

The frequent reference made to the "block system" has

familiarised the public with the term, and the advocacy of it by Government inspectors of railways. Railway managers and others, who are supposed to be best acquainted with its advantages, seem to have so closely and inseparably identified its adoption with safety in railway travelling, that any invention conducing to render it more perfect must be hailed with general satisfaction. The apparatus now under consideration is one of such improvements, and therefore appears to claim for itself a full description in these pages; the leading feature of it is an arrangement whereby a movable disc is made to indicate the direction whence a train is approaching, hence the contingency of the tele-

No. 3.



No. 4.

graphist erroneously signalling an up for a down train, or *vice versa*, is obviated by its use.

The engraving, numbered 1, represents the instrument as blocked for a down train; the second engraving represents the instrument in its normal state; the third engraving is a side elevation of the disc and apparatus connected therewith, whilst the front elevation of the disc, lever, &c., is represented in the fourth engraving.

The modus operandi observed in blocking the line by this invention consists in inserting the pin (*f*) in the axle so far as to make the end of the pin to press against the end of the lever (*e*), which is thereby depressed, whilst it at the same time throws up the lever (*b*) and disc (*a*) to the positions

shown in the first engraving, and from which it is impossible to remove it until the pin (*f*) is withdrawn, when the spring (*g*) draws the lever (*b*), and with it the disc (*a*), behind the screen, or in other words, from the position represented in the first to that in the second engraving.

Tyer's Train Signalling Telegraphs.

The pointers or needles in each section of the dial are of distinct colours, viz., black and red; the positions of the black are influenced by the operator at the station only which is in communication with yours; whilst the movements of the red are regulated by you, and indicate the signal transmitted from your station. The indicators are influenced by an Electro-Magnetic Apparatus. Inscribed on the dial are the words "train on line" and "line clear." Underneath the dial are two plungers on which the same words occur. By pressing in the plunger marked "train on line," the red indicator is made to point to the corresponding words on the dial as represented in the diagram, and the dial of your correspondent's station is simultaneously made to exhibit a like signal. When it is required to change the signal to "line clear" the plunger bearing that inscription is pressed in, and the indicator on the dials at both stations is made to point to "line clear." To this description of instrument belong a bell and gong, the application of both of which is explained in the following codes:—

Code for Bell.

1 Beat—To call attention for an up train.

1 Beat—Acknowledgment of signal of down train.

2 Beats—Indicate the despatch of an up passenger train.

3 Beats—Indicate the despatch of an up goods or mineral train.

Code for Gong.

Beat—To call attention for a down train.

1 Beat—Acknowledgment of signal of up train.

2 Beats—Indicate the despatch of a down passenger train.

3 Beats—Indicate the despatch of a down goods or mineral train.

CODE FOR GONG OR BELL.

5 Beats—Denote an obstruction on the line, and should be given after the signal "up or down train on line."

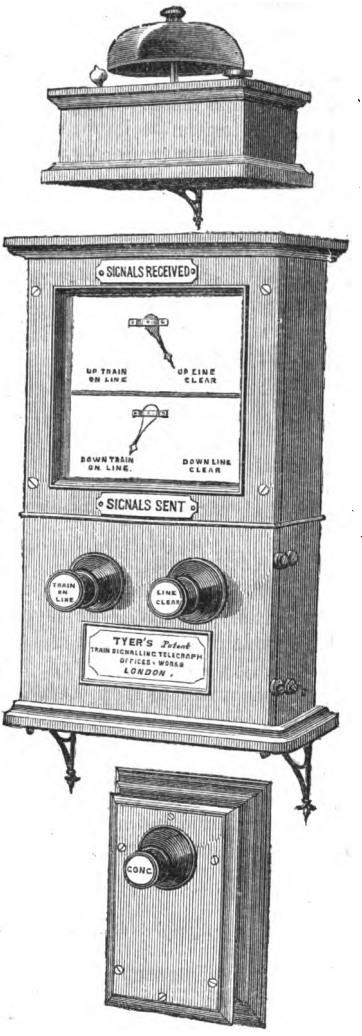
5 Beats—Acknowledgment of above signal.

6 Beats—Signify that the instruments are being tested.

6 Beats—Acknowledgment of above signal.

7 Beats—Special code, or acknowledgment of special code.

8 Beats—Cancelling signal, or acknowledgment of cancelling signal.



The latter code is employed in cases in which a signal has been erroneously given—and therefore requires to be cancelled—a corresponding number of beats is required for this signal and the acknowledgment of its receipt.

The signals, "train on line," or "line clear," have reference to that portion of the line only between the two stations sending or receiving them. The regulations to be observed are—

1. Supposing that an up passenger train is due to start from station A to station B, and the latter has telegraphed "line clear" (but not otherwise), the train may be despatched. A has now, without a moment's delay, to communicate with B by two strokes on

the bell at the latter station; and the duty of B will then be to acknowledge, by sounding the gong at A once, and instantly telegraphing back, "up train on line." When the train has passed the station B, B must reverse the signal to "up line clear." If it be an up goods or mineral train, three notes must be intoned on the bell at station B, and the subsequent course of procedure will be as for an up passenger train.

2. In telegraphing down trains, the gong instead of the bell must be sounded at station B; and B must acknowledge receipt of such signal by striking the bell once at station A, and then telegraphing "down train on line." When the train has passed, he must reverse the signal to "down line clear." No signal is considered to have been received until its receipt has been acknowledged.

3. The receiver of a signal cannot alter it; the sender alone is enabled to reverse it.

4. The signal once given remains fixed until the next signal be sent, and can therefore be referred to at any moment.

Special Code.

In the event of a signal-man observing anything unusual to a train, during its passage in front of his signal hut, such as goods falling off, a truck on fire, a broken axle, the coupling of chains parted, &c. (and it being very desirable and important to stop such train at the next station), he is to call the attention of the signal-man in advance, and notify to him that something is wrong with the approaching train, by sounding his bell or gong seven times. The signal-man receiving this special signal will reply by giving seven beats in return, and immediately hoist his distant signal and stop the approaching train.

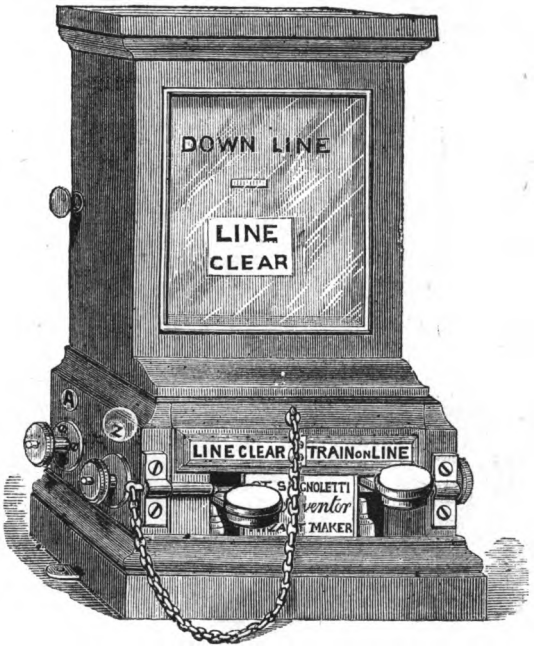
Spagnoletti's Disc Telegraph Instrument.

This instrument consists of a plain green dial, with black in it; behind this dial are two discs, one white with a hole, letters upon it, in large type, "line clear," and the other is red, with the words "train on line" in white letters on it.

These discs are so arranged that when the instrument is not in use, only half of each is seen through the hole in the green dial.

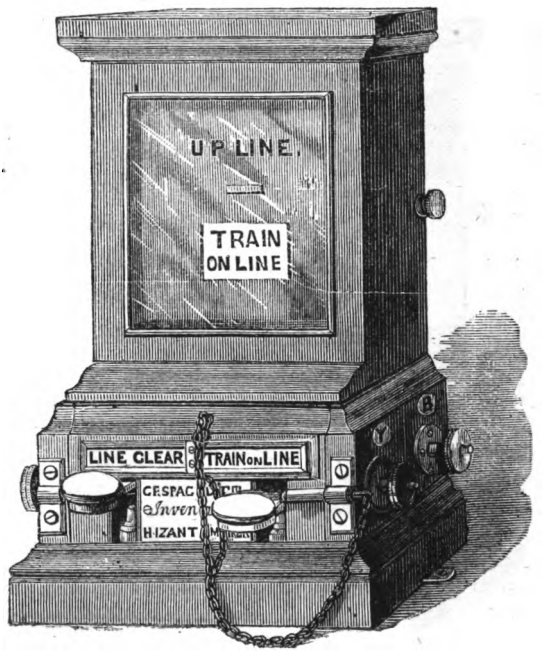
The colours white and red correspond with the signals and lights, representing All Right, and Danger.

The instrument is worked by two keys, one for each disc, and labelled the same as the discs, so that by pressing down



the white key, labelled "line clear," the white disc, "line clear," appears in the hole of the green dial, and on pressing down the red key, labelled "train on line," the red disc, with "train on line," appears in the hole of the green dial; thus, one signal only, and the one intended to be shown, can be seen; hence no confusion or doubts can arise, the dial being green, and the discs red and white, by the contrast of colour, a clear and unmistakable signal is obtained.

Either of the keys can be pegged down by a pin, which passes through an eye, by the side of each key, so that either signal can be kept on as long as necessary. These instruments are so constructed, that whichever signal is given at the station, the same must show at the one to which it is sent; and when a signal is given, and the key



pegged down, it cannot be reversed from the end to which it is sent.

This instrument also registers the gradual exhaustion of the battery, so that the battery can be attended to before it becomes too weak to perform its work.

A single striking bell is worked in connection with this instrument, separately, or attached to the instrument; if the former, it has a key of its own; if the latter, on either of

the keys of the instrument being pressed down, the signal is shown, with a simultaneous stroke of the bell, so that by having a code of the number of the beats on the bell, a corroboration is given to the signals shown by the discs.

1st. This instrument can be worked on two systems, on that which is called the Permanent Block, so as to show the constant condition of the line, whether clear or blocked.

2nd. On that which is called the Block System, by asking if the line is clear, and blocking only during the time a train is on the section so worked.

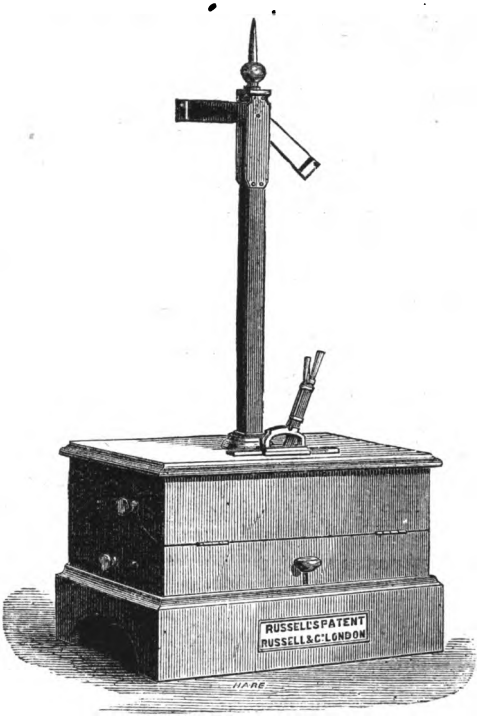
The first system is better suited for overcrowded double lines, and when the instrument is thus worked, any defect in it or in the line wire, is immediately registered by the discs, and showing half red half white in the hole in the green dial, so that directly the defect occurs, it is immediately shown at both ends.

Russell's Patent Electric Semaphore.

A very ingenious block telegraph, termed Russell's Patent Electric Semaphore Block Signalling Instrument, is the invention of Mr. F. Russell of Gracechurch Street. The reader who has seen the semaphore signals in use on railways will not fail to perceive how exactly the idea is identified with the elevated parts of this invention, and the same characteristic must conduce to familiarise the railway official with its operations. There are, in fact, the post, the arms, and the sheath, and the position of the arms is regulated and the colours (white and red) selected to assimilate them with the railway semaphore signals. When the arm is made to project from the post in horizontal position, it indicates that the line is obstructed or blocked; whereas, on the contrary, to represent "all right," or that the line is "clear," the arm is lowered so as to be concealed within the sheath. If necessary, discs and cross bars may be substituted for the semaphore arms.

The case on which the post is fixed, encloses the electric apparatus, the battery current in connection with the line wire is thrown by a spring lever which works in a quadrant that is situated on the case. The alarum, or bell, has its locale in the under part of the case; the arms remain at "clear" during the flow of the current from the battery;

but simultaneously with the flow of the current, they assume their normal or horizontal position. The whole of the apparatus being in equilibrium, the arms fly to danger immediately the line wire sustains rupture. When neces-

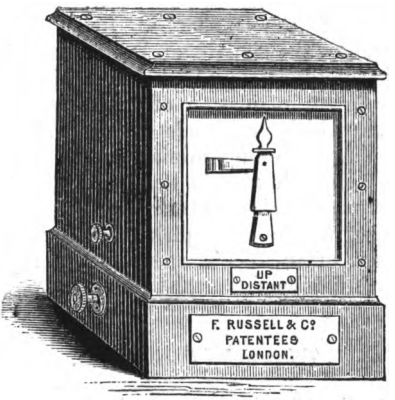


sary, as at railway junctions, additional arms or posts may be employed, and a locking arrangement used in connection with the lever. The signals and bells for both up and down lines require but one battery.

Russell's Electric Repeating Signal.

The importance of this invention cannot fail to be appreciated by the railway official, for whose use it is especially

designed. For the information of those of our readers who have not been initiated into railway operations, it may be observed, that in addition to what is termed the "home" or station signals, railway stations are respectively protected in each direction, *i.e.*, up and down the line, by a "distant signal," which is, according to circumstances, situated at distances varying from 200 to 1,000 yards and upwards from the station in which it works in connection, due regard being had in the selection of the site to the nature of the gradients, perspective, and other ruling causes.



It is to be understood that distant signals are intended to be fixed in such sites as to be seen at a sufficient distance by the driver of an approaching train, to enable him, when the arm is extended, to gradually reduce the speed of his engine, to bring it to a stand at such site. Now it not unfrequently happens that the radii of curves or other causes interfere to prevent the man in charge of a distant signal having a view of it. In such cases, railway regulations provide that an intermediate signal be erected within sight of the signalman, which is an exact counterpart of the former, and is termed an auxiliary or repeater, the latter appellation being derived from its object, which is to represent exactly the motions indicated by the distant signal—the uniformity of the movements of the two signals being

produced by the wire working on a wheel (affixed to the distant signal) and extending backwards to the repeater, to which it is connected. By this contrivance the repeater is intended to make manifest to the signalman the position of the distant signal.

The "Electric Repeater," which is the invention of Mr. Russell, of Talbot Court, Gracechurch S treet, is less costly in material and labour of fixing, &c., than the repeater just described, and as it is reliable inasmuch as the construction of the apparatus prevents liability to derangement from lightning, a knowledge of its advantages will doubtless insure for it a very widespread adoption.

The locale of the "Electric Repeater" being the signalman's cabin, the signalman has indicated to him by the repeater, simultaneously with his raising or depressing the lever, the exact inclination of the distant arm, disc, or cross bar, as whichever mode of line signalling is in operation, a corresponding miniature is employed as the repeater. A telegraph wire is used to connect the repeater with the distant signal. If an accident happens to the distant signal or to the telegraph wire, the man in charge is made cognisant of the occurrence by the repeater immediately indicating danger.

Telegraph (Train) Pass.

Previous to the starting of a train, in respect of which the "Line Clear" signal has been received, a pass must be handed to the engine driver as his authority for proceeding with the train, this pass he will deliver up to the person in charge of the destined station on his reaching it.

SIRHOWY RAILWAY.

No.

Date_____18

From_____

To_____

Train_____

Time of Departure h. m.

Guard_____

SIRHOWY RAILWAY.

No.

TELEGRAPH PASS.

Issued to_____Driver

_____Train.

Date_____18. Time of Departure h. m.

Single Clea Line from_____Station to

_____Station.

_____

Signature of Station Master.

☞ To be given by the Station Master to the Driver, who will return it to the officer in charge at the end of the Single Line.

A record of the respective trains which have been started in accordance with the Block Instrument principle is kept in

THE LINE CLEAR BOOK.

*_____ TRAINS.

_____ *day* _____ *day of* _____ 187

Station.

1 Description of Train.	2 Time. Gave Line Clear. H. M.	3 Time of Departure of Train from H. M.	4 Time. Signalled arrival of Train. H. M.	5 Signalman's Initials.	6 REMARKS.
	,,	,,	,,		
	,,	,,	,,		
	,,	,,	,,		
	,,	,,	,,		
	,,	,,	,,		
	,,	,,	,,		
	,,	,,	,,		
	,,	,,	,,		
	,,	,,	,,		
	,,	,,	,,		
	,,	,,	,,		

In No. 1 column, say whether Mineral, Goods, or Passenger Train, Columns Nos. 2 and 3; the heading of these is self-explanatory.

Column 4; insert the time that Station B reverses the signal to "line clear."

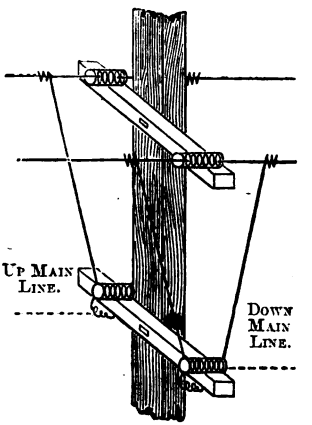
Column 5; the Clerk at Station A has to insert his initials in this column.

* State here whether Up or Down Trains.

Train Telegraph Wire.

Between certain points on some railways two wires are affixed below the ordinary telegraph wires to the poles, the one being on the right, and the other on the left side of them; one of these wires being identified with the up and the other with the down line. When a train is disabled between stations, and the up line is obstructed in consequence, the guard or engineman has to walk to the nearest telegraph post, where he breaks the loop of the up wire. Instantly the next up station is thereby informed of the up line being obstructed; but if, on the contrary, the mishap should occur on the down line, the loop of the down wire must be broken, and an intimation of the obstruction is thereby conveyed to the next down station.

When the train is able to proceed on its journey, the guard or engineman, as it may be, has to repair the loop by twisting the pieces of broken wire.



Post as fixed on Up Side of Line.

Railway Signals.

On the Midland Railway is a signal which consists of a clock with a face four feet in diameter. It is fixed on the top of a column fifteen feet high. Only a quarter of the

clock is shown. It is of ground glass, the figures on it—viz., 0, 5, 10, 15, are red. Attached to the clock is a long rod, connected with a traddle sixteen feet long, which lies along the inside of one of the rails. On the train passing over the traddle, it is depressed slightly by the wheel flange, and the clock hand is set at liberty, and is so adjusted by a counterpoise that it turns to the figure 0. Immediately the train has passed over, the hand begins again to mark the time up to 15 minutes, when it is stopped, thus indicating to the next train exactly how long up to *fifteen minutes* the preceding train has passed the signal. The same clock works two faces—one for the up and one for the down line. The signal is illuminated at night.

OFFENCES—THEIR PUNISHMENT.

Improperly Disclosing or Intercepting Telegrams.

Any person having official duties connected with the Post Office, or acting on behalf of the Postmaster-General, who shall, contrary to his duty, disclose or in any way make known or intercept the contents or any part of the contents of any telegraphic message, or any message entrusted to the Postmaster-General for the purpose of transmission, shall, in England and Ireland, be guilty of a misdemeanour, and in Scotland of a crime and offence, and shall upon conviction be subject to imprisonment for a term not exceeding twelve calendar months; and the Postmaster-General shall make regulations to carry out the intentions of this section, and to prevent the improper use by any person in his employment, or acting on his behalf, of any knowledge he may acquire of the contents of any telegraphic message. 31 & 32 Vic., cap. 110.

Illegal Transmission or Delivery of Telegrams.

Any company, corporation, or person who transmits, or aids or is concerned in transmitting, any telegram in contravention of the exclusive privilege conferred on the Postmaster-General by this Act, or who receives, collects, or delivers any telegram in contravention of such privilege, or aids or is concerned in the receipt, collection, or delivery of such telegram in contravention of such privilege, shall, on summary conviction, be liable for every such offence to a penalty not exceeding £5, or where any person offending against this Act is a servant, or hired to do the act complained of, the master or other person employing such servant shall be subject to a like penalty. 32 & 33 Vic., cap. 73.

If any person in the service of the Postmaster-General shall wilfully or negligently omit or delay to transmit or deliver any message or signal; or shall wilfully or negligently do anything whereby the

transmission or delivery of any message or signal shall not take place, or shall be delayed or prevented; or shall wilfully or negligently omit to do or perform any act or thing, by reason whereof any message or signal shall not be transmitted or delivered, or shall be delayed in its transmission or delivery; or shall improperly divulge the purport of any such message or signal to any person, shall, for every such offence, forfeit a sum of money not exceeding £20.

If any person shall wilfully remove, destroy, damage, or obstruct the working of any electric telegraph which shall or may have been lawfully erected, or any wire, standard, apparatus, or other part of any such telegraph, or any works connected therewith, he shall be guilty of a misdemeanour.

If any person shall wilfully or negligently break, throw down, damage, destroy, or injure any such telegraph, or any wire, standard apparatus, or other part of any such telegraph, or any of the works connected therewith, and shall not make sufficient satisfaction for the damage thereby done them, it shall be lawful for the Postmaster-General to recover such damages from the person so offending as any two justices shall think reasonable.

With respect to offenders whose names or residences are not known, be it enacted that any officer or servant of the Postmaster-General, or any constable or servant of any railway company along or near to whose railway the telegraph, or any of the apparatus thereof, shall or may be erected or placed, or any other constable, and all persons called by any such officer, servant, or constable as aforesaid, to his assistance, shall or may seize and detain any person who shall or may, in the presence of such officer, have wilfully broken, injured, or obstructed the working of the telegraph of or belonging to the Postmaster-General, or any of the wires, standards, instruments, apparatus, or other parts of any such telegraph, and whose name or residence shall be unknown to such officer, servant, or constable, and shall or may carry such offender, with all convenient speed, before some Justice, without any warrant or other authority than this Act; and such Justice shall proceed, with all convenient speed, to the hearing and disposing of the complaint which may be preferred against such offender. 16 & 17 Vic., cap. 203.

USEFUL HINTS.

These hints, which constituted a portion of the regulations issued by the Electric Telegraph Company to telegraphists, may be advantageously quoted here.

Daily Inspection of Instruments and Batteries.

The Telegraph Agents must each morning examine their instruments and batteries, and call the proper officer's immediate attention to any defect.

The Magnet

Will lose its power if not with its own keeper, therefore do not keep them separate.

Magnetising.

To magnetise a needle, lay the marked end of the needle on the unmarked end of the magnet, and the unmarked end of the needle on the marked end of the magnet, and rub them together.

When the dials or coils are taken out for magnetising, care must be taken to connect across the two terminals of the coil removed by the brass bar provided for that purpose, or by a piece of clean copper wire, so that the other stations may not be interrupted by the circuit being broken.

Care must be taken to avoid bending the needle axles, or breaking the pivots, and when the coil is replaced the bare part of the wire must be screwed under the terminals.

Opposite Movement of Needles and Handles.

When the instrument is worked after a storm, if the needles move in a direction opposite to that of the handles, their reversal is attributable to lightning, and remagnetising is requisite.

Handles not to be touched unnecessarily.

The handles of the instrument must not be touched, unless for the purpose of communicating with a station. Great care must be taken to leave the handles upright, and not to touch them when signals are passing between other offices.

Defects in Wires or Batteries.

When the communication is interrupted, the apparatus should be carefully examined. If you cannot move your needles when the instrument is put on short circuit by connecting the line terminals by a key or wire, it is probable the battery wires are broken or that a plate is faulty. In the latter case connect the defective battery across by a wire from terminal to terminal without disturbing the other connections. If a wire be loose or broken, replace it.

Wires Damaged, or requiring temporary support.

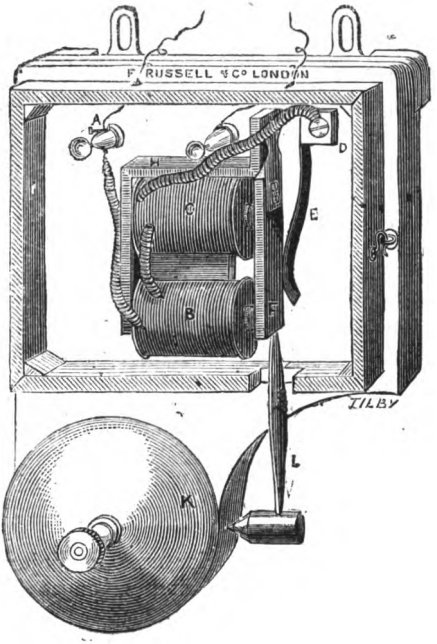
Each agent should do his best to repair temporarily any damage that may arise to the wires, at or near his station. Wires must be kept from touching each other and from resting on metal, wet stone, or wet wood. Should the wires require support, dry wood will answer the purpose.

Wires to be kept Clean.

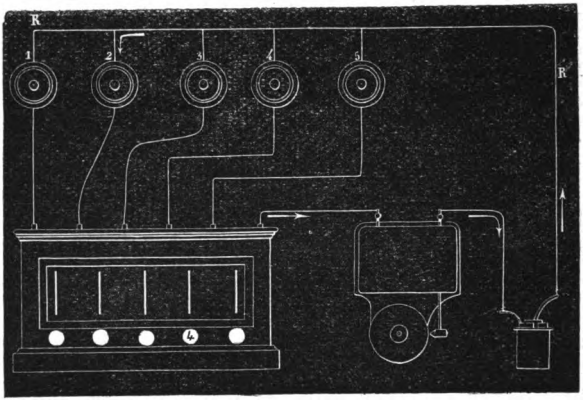
Boughs of trees, or waste, or rubbish that may be hanging on the wires, should be removed, and if the wires are twisted they should be separated.

Telegraph Domestic Bells.

Where these are employed, a stud or button made of porcelain, ivory, or any other suitable material is fixed in,



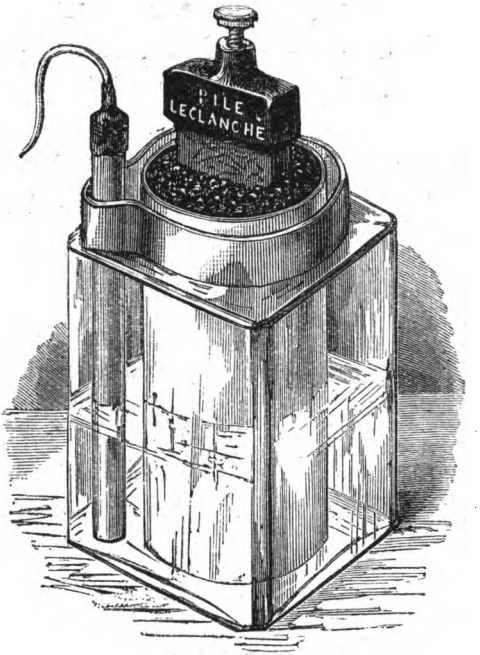
or projects from, the wall of the bed-room, drawing-room, or other apartment, and by a slight pressure of it a bell is rang, and the indicator, which stands in the hall or some other place accessible to those whose attention is required, is simultaneously made to show the number of the apart-



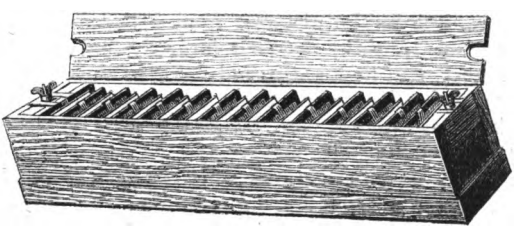
ment whence the summons emanates. The bell is suspended over the indicator.

It will be observed that No. 4 is represented on one of the tablets of the indicator, thereby showing that the presence of the attendant is required in the apartment also bearing that number. When necessary, a name may be employed instead of a number: for instance, if the indicator be in an office, and the bell be rang by the principal, who requires the attendance in his sanctum of a particular clerk, he would manipulate with the stud which would act upon the tablet bearing the official's name, the bell is sounded, and, presto, the name is immediately in view. A small wire is used as a conductor, and this, with the addition of a battery, which rarely (in some instances say about annually) requires attention.

There are a variety of batteries used in conjunction with the telegraph domestic bells, and amongst them those represented in the following plates.



THE LECLANCHE BATTERY.



SULPHATE BATTERY.

TELEGRAPHIC STATISTICS.

In 1872, the United States were connected with the majority of the West Indian Islands, and thence with South America, to effect which, the length of cable used was 3,600 miles,

In the year 1871, upwards of 39,000,000 of telegrams were examined in the telegraph message branch.

The total extent of telegraph line in the four colonies of South Australia, Victoria, New South Wales, and Queensland (in the year 1863), was 6,607 miles; the number of messages transmitted annually upwards of 401,685, and the annual receipts amounted to £78,261.

In Europe it is calculated that there are now about 100,000 miles of line in use, and about 50,000 miles in the North American States. India, in 1860, possessed 11,000 miles of wire, with 136 offices. In Australia, there are between 4,000 and 5,000 miles in use.

In Great Britain, the Electric and International, and Irish Magnetic Companies alone owned nearly 11,000 miles of line and 50,000 miles of wire, and employed 3,000 skilled clerks. In 1850 but little more than 7,000 miles of wire had been erected.

Messages were transmitted, per Bonelli's telegraphic apparatus, between Liverpool and Manchester, with remarkable accuracy, at the rate of over 400 words per minute.

It is estimated that 28,000 persons are engaged in Peru in obtaining india-rubber to supply the foreign demand.

The telegraphic station at Iakoutsk, on the route to China, has been opened, the distance from St. Petersburg being 5,700 versts. Messages, which formerly took twenty-three days by post, will now reach that point in eight hours.

The Peruvian Government has determined to construct a network of telegraphy over the whole of its territory, consisting of 430,000 square miles.

The proportion of telegrams to letters in the United Kingdom has varied in the following ratio :—

1860	1	telegram to	296	letters
1863	1	„	197	„
1866	1	„	121	„

The number of telegrams transmitted by the Electric and International Telegraph Company in one year was between three and four millions.

The Electric (the first) Telegraph Company commenced operations with the following tariff of charges for telegrams of 20, or less, words, addresses included:—

			d.
For distances not exceeding	50 miles	per mile	1
ditto ditto	100 „	„	½
ditto exceeding	100 „	„	¼

ESTIMATED ANNUAL REVENUE DERIVED TO THE POST OFFICE FROM TELEGRAPH BUSINESS:—

	£	
In respect of private telegrams	925,000	
„ press	47,420	
„ rents and private and special wires	48,790	
Total		1,021,210
Expenses		669,990
Net Revenue		£351,220

	miles.	
The length of wire in operation between the postal telegraph stations is equal to	83,408	
Private wires rented by the Post Office to press and private individuals for use between the establishments of the renters	4,311	
Length of wires maintained by railway companies for the Postmaster-General at the rate of £1 per mile per annum	43,000	
Length of wires on railways maintained by the Postmaster-General	45,000	
		175,719
The postal telegraph offices number	3,291	
The railway companies' offices at which messages are transmitted on behalf of the Post Office are	1,807	
		5,098

It has been found, by careful examination, that telegrams sent in the year 1872, would, under the old tariff have been subjected to an additional charge to the senders of upwards of £400,000.

Submarine cables exceeding 350 miles in extent are in operation in connection with different branches of the postal establishment.

During the year ending March 31, 1872, upwards of

12,473,796 telegrams were transmitted through the postal telegraph system, and it is estimated that the number in the current year will be 16,120,000.

The number of officials connected with the Central Telegraph Office, London, is 1358.

The telegrams originating at the following places, viz.,—Belfast, Birmingham, Bristol, Dublin, Edinburgh, Glasgow, Hull, Leeds, Liverpool, London, Manchester, and Newcastle, are equivalent to 48 per cent. of the entire number of telegrams transmitted from the whole of the United Kingdom.

	£
Estimated receipts of telegrams sent by railway wire ..	64,000
Cost to Government, about 4¼*d.* per telegram, or	20,000

Telegrams forwarded by the postal and railway wires on behalf of the Postmaster General, are in the proportion of 93 per cent. by the former, and 7 per cent. by the latter.

It is estimated that the telegrams sent by the postal telegraph wires cost 1⅛*d.* each transmission.

Comparative Statements.

	Population.	Superficial Contents. Square miles.	Telegrams Annually.	Average number of Telegrams per square mile.
The United Kingdom	29,500,000	122,000	6,127,000	51
Belgium	5,000,000	11,313	692,536	61
Switzerland	2,534,000	15,233	668,916	44

In Great Britain the greatest distance over which a telegram can be signalled is	900 miles.
In Belgium	160 ,,
In Switzerland	200 ,,
In France	600 ,,
In Prussia	500 ,,

AMOUNT OF PURCHASE BY THE GOVERNMENT OF TELEGRAPH COMPANIES INTERESTS IN THEIR RESPECTIVE UNDERTAKINGS.

	£	*s.*	*d.*
The Electric and International Telegraph Company	2,938,826	9	0
The British and Irish Magnetic Telegraph Company	1,243,536	0	0
Reuter's Telegram Company	726,000	0	0
The United Kingdom Electric Telegraph Company ..	562,264	9	11
The Universal Private Telegraph Company	184,421	10	0
The London and Provincial Telegraph Company ..	60,000	0	0
	£5,715,948	8	11

DUPLEX WORKING.

Considerable improvements have recently been effected in what is termed "Duplex" telegraphy, by means of which system two telegrams can be simultaneously transmitted by a single wire from opposite directions, as for example from Cardiff to Bristol, and *vice versa*. The idea originated with Dr. Gink, of Vienna, in 1854, but many improvements were made upon his plan to render it practicable. In those days (1854—6) the wires were too imperfectly insulated and the lines too indifferently constructed to guarantee perfection in the working of the system; however, those difficulties have yielded to talent and energy, so that at the present time the extraordinary principle we have alluded to, and which was at one time deemed impracticable, is in successful operation between many of the busy centres of the Postal Telegraph Department. Three plans of Duplex telegraphy are recognised, namely that of Siemen's and Frischen (1855), that of Preece (1855), and that of Stearns (1872). The peculiarity of the first is that the relay is wound with two wires, which are so arranged that the current going through one wire neutralizes the effect of that going through another wire; the line current divides, half going through one wire and half through the other. In the second plan (Preece's) two relays are used, which by acting on one tongue in opposite directions, neutralizes each other's effects, whilst in Stearns's plan a Wheatstone bridge is employed, the instruments not being specially prepared; but Stearns has made a very material improvement by adding a condenser, so as to compensate for the electrostatic capacity of the line. In the whole of these plans the outgoing currents do not affect the instruments, but rather leave them open to be operated upon by the in-coming currents, no matter whether such instruments are in use or otherwise. To amply elucidate the Duplex system elaborate diagrams and enlarged description is necessary. Many difficulties have to be encountered in the actual working of the system. The speed of working either way is reduced; but the ultimate effect is to considerably enlarge the capacity of the wires. To convey messages hence by a well-worked wire from 40 to 50 messages per hour, may, in ordinary cases, be transmitted, but by the adoption of the Duplex principle the capabilities

of the wire are so increased as to enable it to convey from 70 to 80 messages within the same time, and, doubtless, as experience remedies defects, the advantages in that aspect will be augmented. The plan which promises to give the best effects is a combination of Preece's and Stearns's, whereby Stearns's condensers are applied to Preece's system.

APPENDIX.

QUESTIONS ON MAGNETISM, ELECTRICITY, AND PRACTICAL TELEGRAPHY FOR THE USE OF STUDENTS.

By W. McGREGOR,

FIRST ASSISTANT SUPERINTENDENT, INDIAN GOVERNMENT TELEGRAPHS.

INTRODUCTORY REMARKS.

THE following *Questions on Magnetism, Electricity, and Practical Telegraphy* have been compiled after a careful perusal of, and are principally based on, the eighth, ninth, and tenth books of Ganot's "Physics," Noad's "Manual of Electricity," and the same author's admirable "Text Book," Bakewell and Fergusson's "Electricity," Cully's "Practical Telegraphy," &c.; and are intended to aid the student in general, and those connected with Telegraphy in particular. I cannot too strongly recommend the system of writing and working out the answers as a means of fixing on the mind what otherwise might be read and forgotten.

Having felt the want of some such questions or exercises for self-examination, I have determined on publishing those framed during my attendance on a course of lectures by Professor Tyndall at the Royal School of Mines, and the leisure afforded whilst in England on sick furlough, for the benefit of others who may, like myself, be desirous of gaining at least an elementary knowledge of the science of Electricity, and some slight knowledge of Practical Telegraphy.

The necessity for publishing a Key to the Questions does not exist, so long as students and others can procure works on the subject by such authors as mentioned; but to those who may not be in a position to purchase expensive, or care to study large works, "Weale's Series" offers the best and cheapest Keys.

The Questions might with advantage be used by officers on circuit, to examine those under them.

Since the above was written, I have obtained the necessary permission to include some of the Examination Questions prepared by Sir W. Thomson and others for candidates for the Indian Telegraph Service; also those by Professor Tyndall and others used at the Royal School of Mines. I have further added several Examination Questions used at the Schools of Science, South Kensington Museum.

MAGNETISM.

1. State the difference between a natural and artificial magnet, and mention where the load-stone was first discovered.

2. Give an example to prove that a magnet possesses a north and south polarity, and state why the centre of a magnet is called the neutral line.

3. Under what circumstances have artificial magnets more than two poles?

4. Mention the law regarding mutual action of the two poles, and describe an experiment by which this law may be verified.

5. By the aid of the hypothesis of two magnetic fluids, give a clear idea of the distribution of magnetism in a magnetised bar, and account for the circumstance that there is no free magnetism in the middle of the bar.

6. Describe an experiment to prove that every particle or molecule of a magnet possesses a north and south pole.

7. What is meant by magnetic induction or influence? and can it take place without actual contact?

8. What are we to understand by the coercive force as applied to magnetic substances? Is this coercive force greater in steel or iron? State the difference between magnets and magnetic substances.

9. Describe what is known as the directive action of the earth on magnets, and to what this action may be compared.

10. State in a general way what you know regarding the magnetic meridian, the declination and annual variations of the magnetic needle.

11. How is the declination accidentally disturbed in its daily variations?

12. Describe the declination compass and the method of reversion.

13. Describe the mariner's compass, and, if possible, give the name of the inventor, and when or where first used.

14. What is meant by the magnetic equator, and the inclination or dip of the magnetic needle? What are the magnetic poles? and if near them, what would be the position of the inclination needle?

15. What is an inclination compass, and for what is it used?

16. Give one or two examples by which we can do away with the earth's influence as a magnet upon a magnetic needle; in other words render the needle astatic.

17. What is understood by the intensity of the earth's magnetism? At what time of the day does the intensity vary? When does it attain its maximum, and when is it at its minimum?

18. By whom were the laws of magnetic attractions and repulsions discovered, and by what method did he prove them?

19. State what you know about magnetism, and illustrate the method by single, double, and separate touch, and mention the method which produces the most regular magnets.

20. What effect has the earth on a bar of soft iron held in the magnetic meridian, and one of steel held in the same position?

21. Can you explain the reason why tools in a smith's shop generally sess a feeble magnetic polarity?

2. When is a bar or needle said to be magnetised to saturation. Can

a bar be magnetised beyond this point? If so, is any benefit derived from it?

23. How is a magnetic battery or magazine constructed?

24. What is meant by the portative force of a magnet, and how can this force be increased?

25. Mention some of the circumstances which influence the power of magnets. What happens if a magnet is heated to redness?

26. By what method did Coulomb investigate the magnetic force in different parts of the magnet?

27. Name the different forms of magnets, and state why the horse-shoe form can support a greater weight than any other.

28. What are magnetic armatures or keepers?

29. When a steel rod is held in a position parallel to the dipping-needle, what change takes place in the course of time? Would the same effect be observed in a rod of soft iron held in the same direction?

30. What effect has temperature on magnetism?

31. What method did Gauss adopt for ascertaining the intensity of the earth's magnetism? Describe by diagram his bifilar magnetometer.

32. What do you understand by magnetic charts? Describe in a general way, and also mention what is understood by isogonic and isoclinic lines.

33. Explain what is meant by variation of the needle—secular, annular, and diurnal.

34. Mention some of the theories of terrestrial magnetism by Gilbert, Halley, Hausteen, Barlow, or Gauss.

35. What is diamagnetism, and how does a diamagnetic substance suspended between the poles of a magnet set itself when at rest?

36. What is the difference between *paramagnetic* and *diamagnetic* substances? Mention some of each—solids, liquids, and gases.

37. Does magnetism in any way act on light? What is noticed if a ray of light is passed between the poles of an electro-magnet?

38. How can you tell whether a flame or liquid is paramagnetic or diamagnetic?

39. What are magnetic storms?

40. Describe the method for converting a bar of steel or iron into a magnet by the galvanic current.

41. Are electro-magnets in any way better or stronger than natural magnets?

42. Of bismuth, zinc, nickel, tin, lead, and cobalt, which are paramagnetic, and which diamagnetic?

43. What is known of diamagnetic polarity?

44. Mention some of the results of Professor Tyndall's investigations into the laws of magnetic force.

ATMOSPHERIC ELECTRICITY.

45. The condition and intensity of atmospheric electrity depend on certain changes. Name some.

46. What is the principle of Thomson's divided ring electrometer?

47. Of his common house electrometer, and his simple apparatus for observing atmospheric electricity?

48. For what purpose did the late Mr. Crosse make use of his exploring wires, and with what result?

49. What have been the means employed for examining the electrical condition of the higher regions of the atmosphere?

50. Is there any analogy between the electric spark and lightning?

51. What was Franklin's original experiment by which he established the identity between electricity and lightning?

52. What are thunder and lightning?

53. Into what three classes does Arago divide lightning?

54. What are supposed to be the safest positions during a thunder-storm?

55. Why should we avoid being near water during a thunder-storm?

56. What is meant by a person being killed by the back stroke of lightning? Explain the back stroke by diagram.

57. For what purpose, and on what principle, are lightning-conductors made?

58. Are volcanic eruptions in the sea, and tornadoes, in any way connected with electricity?

59. From what are the phenomena of water-spouts considered to arise?

60. How can the appearance of the Aurora be closely imitated by electricity?

61. To what agency and influence is the devolopment of the Aurora ascribed?

62. Mention what you know about De la Rive's theory of the Aurora.

63. By what experiment did De la Rive illustrate why the phenomena of the Aurora appear at the magnetic and not at the terrestrial pole?

64. State Humboldt's grounds for assuming the Aurora to be a magnetic phenomenon.

65. What do you know of the action of atmospheric electricity on the wires of the electric telegraph?

66. Can the natural state of the telegraph wires be disturbed in the absence of a thunder-cloud, and how?

67. What is observed in the telegraph wire when there is vapour, fog, snow or rain at one end of the wire, and not at the other?

68. What effect does a distant cloud, moving first towards, and then from, the wire, exercise on the natural electricity of the telegraph wire?

69. During a thunder-storm many miles off the telegraph needle is considerably disturbed; give the cause of this.

70. Describe the experiment by Professor Henry to illustrate that discharges from electricity accumulated in the Leyden jar are competent to induce secondary, and even tertiary and quaternary, currents in vicinal conductors.

71. Describe Matteucci's method of demonstrating the development of secondary or induction currents by the discharge of a Leyden jar or battery.

72. Enumerate some of the damages which occur to the telegraph lines and instruments from lightning, and mention any particular cases known to yourself.

73. Is there any identity between the sparks produced by an electric machine and atmospheric electricity?

74. In what direction have atmospheric electric currents along tele-

graph wires been known to proceed, and does the direction vary at any time of the day or night?

75. What influence has the *Aurora Borealis* on the electric telegraph?

76. Name and describe some of the *paratonnerres*, or lightning conductors, for the protection of telegraph lines and instruments.

77. How is the best lightning conductor for protecting buildings, &c., constructed?

78. What is atmospheric electricity?

DYNAMICAL ELECTRICITY.

79. What was the fundamental experiment which led to the discovery of dynamical electricity, and to whom due?

80. What led to the invention of the well-known voltaic pile, and how was the pile constructed? Is there any recent invention you can name constructed on a similar principle?

81. How can you demonstrate the development of electricity in chemical action?

82. Does any disturbance of the electric equilibrium accompany chemical action in substances in the liquid or gaseous state? and of all chemical actions, which are the most productive of electricity?

83. Illustrate in the most simple manner how current electricity can be generated, and the reason why it is called a "current."

84. In the case of a copper and zinc plate being used, which of them is termed the positive plate, and why?

85. Is there any reason why we are to suppose that, when the two plates of an element are connected, electricity only flows in one direction?

86. Mention some of the principal metals any two of which can produce a current.

87. What is meant by the electro motive force, and how is this influenced? Can we produce a voltaic current by the use of two or more liquids, and how?

88. Describe what is known as Wollaston's battery, and the means employed to stop its action when the current is not wanted.

89. What are the poles or electrodes of a battery, distinguishing them from the plate, so as not to confound one with the other?

90. What causes the enfeeblement of the current in such batteries as those of Volta, Wollaston, and Hare, and can we by any means increase the intensity?

91. State the advantage a battery with two liquids has over one with only a single liquid. Describe any two batteries of the former kind.

92. What is the difference between a Bunsen's and Grove's battery?

93. In what does Smee's battery differ from that of Walker's.

94. Describe the sulphate of mercury battery devised by M. Marie Davy, and lately introduced into France.

95. Can you mention the value obtained for the electro-motive force of the most usual combinations, namely—

(1) Bunsen's elements,
(2) Grove's elements,
(3) Daniell's elements,
(4) Smee's elements,
(5) Wollaston's elements?

96. What do you understand by the tension of a battery, distinguishing it from the quantity of electricity which it disengages?

97. To obtain a more regular current, and at the same time more intense, what description of zinc should be employed in a battery? What objection is there to the use of ordinary commercial zinc?

98. Describe the construction of the dry pile, and state in what respects it differs from the voltaic pile.

99. What is Bohnenberger's electroscope?

100. With reference to Oersted's discovery, mention the *memoria technica* by which all the various directions of the needle under the influence of an electric current may be remembered.

101. What is the principle of the *galvanometer*, *multiplier*, or *rheometer?* and state for what purpose used.

102. What is the principle of the tangent compass, and for what description of currents is it best adapted?

103. What is meant by the thermal effects of electricity? Give an example.

104. Are these effects confined to thin wire, or can they be perceived in thick wire?

105. Describe the galvano-thermometer, and mention the three laws relative to the thermal effects of an electric current.

106. If a strong current is sent through a chain of platinum, and silver wire of equal size, why does the former become incandescent, while the silver shows no apparent signs of heat?

107. If a long thin platinum wire be raised to dull redness by passing a voltaic current through it, and if a part of it be cooled down by ice, what happens?

108. If, on the contrary, instead of applying ice, a part of the wire be heated by a spirit lamp, what would be the result?

109. Does the thermal effect depend on the size, or on the number of the plates, in a battery?

110. Describe an experiment by which the luminous effects of a voltaic battery can be obtained.

111. Of what is the voltaic arc formed, and what effect has a magnet when presented to it?

112. Mention some of the substances which are fused or melt when introduced into the voltaic arc.

113. In the case of the electric light, which of the carbon points wears away, and what is observed to occur with reference to the other, and what does the change indicate?

114. Describe the electric light, and mention some of its properties.

115. What, if any, effect has the electric current on the elasticity of metallic wires through which it passes?

116. Describe some chemical effects of the electric current; give three examples, including one with solution of sulphate of copper.

117. Illustrate by one of Davy's experiments the power of transmission possessed by an electric current in chemical decompositions effected by the battery.

118. State what you know of Grotthuss's hypothesis in explanation of the chemical decompositions effected by the battery.

119. What do you understand by the term "electrolysis?" Mention four of the laws of electrolysis.

120. When platinum electrodes which have been used in decomposing water are detached from the battery, immersed in distilled water, and connected with a galvanometer, the existence of a current is indicated which has the opposite direction to that which had previously passed: how is this phenomenon explained?

121. What is understood by secondary batteries?

122. On what principle did Grove construct his gas battery?

123. What is meant by the passive state of iron?

124. On what does the art of electro-metallurgy depend?

125. In what respects does electro-silvering differ from electro-gilding?

126. What two laws do the phenomena of parallel electric currents follow? Demonstrate by two examples.

127. Give the two laws of angular currents, and state how they can be demonstrated.

128. Demonstrate the law of sinuous currents.

129. Demonstrate the action of an infinite current on a current perpendicular to its direction.

130. Demonstrate the action of an infinite rectilinear current on a rectangular or circular current.

131. Describe the rotation of a finite horizontal current by an infinite horizontal rectangular current.

132. Describe the rotation of a vertical current by a horizontal circular current.

133. What has Faraday proved about the rotation of magnets by currents? Give an illustration.

134. Demonstrate the action of magnets on currents.

135. Does the earth in any way exercise a directive action upon currents arranged in a vertical or horizontal direction?

136. Should you answer the last question in the affirmative, perhaps you will name an apparatus by which it can be illustrated?

137. If the current on which the earth acts is closed, is the result a continuous rotation or a directive action in the case of a rectangular or circular current?

138. Mention an apparatus by which the answer to the preceding question can be shown. Illustrate by diagram.

139. What do you understand by a solenoid, and how is it constructed? Illustrate by diagram.

140. Are solenoids in any way similar to magnets, and in what respects?

141. In what respects, if any, do two solenoids traversed by a strong current, allowed to act on each other, differ from two magnets as regards attraction and repulsion?

142. What ingenious theory, based on the analogy which exists between solenoids and magnets, has Ampère propounded with reference to magnetic phenomena hitherto attributed to the existence of two fluids?

143. Explain by what means a bar of iron can be magnetised by an electric current.

144. A bar of soft iron in the shape of a horse-shoe, wound round with copper wire, can support a certain weight during the passage of the electric current through the wire, but loses that power immediately the circuit is broken. Explain the reason of this.

145. When a rod of soft iron is magnetised by a strong electric current, it is accompanied by a very distinct sound. Is this only momentary or continuous, and to what has this phenomenon been attributed?

146. By what means can two sounds be obtained? To what have these been compared by De la Rive?

147. In what way has Wertheim confirmed the hypothesis of a molecular movement in iron wires at the moment of their magnetisation and demagnetisation?

148. What do you understand by *currents of induction* or *induced currents?*

149. By what means can the inductive action of currents at the moment of opening or closing the circuit be shown?

150. What, if any, difference exists between a *primary* and a *secondary* coil, and through which of them is the current passed?

151. On what principle are electric clocks constructed?

152. Have any attempts been made to apply electro-magnetism as a motive force in machines, and how far have they succeeded? If not, what prevents its adoption?

153. In passing a current through the *primary* coil, in what direction and for how long is a current induced in the secondary coil?

154. At the moment circuit in the primary wire is opened, in what direction is the induced current produced in the secondary coil, and what is its duration?

155. In what respects can the last two phenomena be assimilated to those produced by statical electricity?

156. Describe an apparatus to show that induced currents can be produced by continuous ones.

157. The distance remaining the same, does a continuous and constant current induce any current in an adjacent conductor?

158. What principles may be deduced from the phenomena of primary and secondary currents?

159. What law has Lenz based on the induction produced between a closed circuit and a current in activity when their relative distance varies?

MAGNETO-ELECTRICITY.

160. What is magneto-electricity, and how is it generated?

161. If a considerable length of copper wire be wound round a wooden cylinder, the ends of the wire being attached to a galvanometer, how is the latter affected when either pole of a strong magnet is thrust into the cylinder, kept in it, and when withdrawn?

162. Can the needle be affected without introducing the magnet into the cylinder?

163. Mention what you know of magneto-electric induction.

164. Name an experiment to illustrate the development of magnetism by rotation.

165. Upon what does the direction of the current of electricity which is excited in a metal when moving in the neighbourhood of a magnet depend?

166. Describe Professor Forbes' experiment by which he obtained an electric spark from a natural magnet.

167. Can a spark be obtained from an artificial or electro-magnet? If so, how?

168. Describe the principle of the magneto-electric machine—Saxton's, for instance.

169. Are you aware of any arrangement for applying magneto-electricity to the production of light? If so, explain it.

170. Describe Wheatstone's magnetic exploder.

171. Explain the theory of magneto-electricity.

172. Supposing a bar of soft iron be placed in a bobbin covered with copper wire, the ends being attached to a galvanometer, and a magnet is suddenly brought in contact with, or drawn away from, the soft iron, can a deflection of the needle be obtained, and how long does it continue?

173. Can any and what effects be obtained by causing a strong magne to rotate rapidly in front of the extremities of the wires of an electro-magnet, in such a way that its poles act successfully by influence on the two branches of the electro-magnet?

174. Does a mass of copper exert any influence on the number of oscillations which a magnetic needle makes under the influence of the earth magnetism?

175. In what way does a plate of copper in rotation act on a magnet? Mention an experiment by which the phenomenon may be shown.

176. Suspend a cube of copper to a twisted thread, place it between the poles of a powerful electro-magnet. Can you (guided by the answer to No. 174) explain what happens at the moment when the thread is allowed to spin round with great velocity, and a powerful current is sent through the electro-magnet?

177. What explanation did Faraday give of all the phenomena of magnetism by rotation?

178. In what way do induced currents tend to destroy the motion which gives rise to them? Illustrate by Lenz's law; and is the action analogous to that of friction?

179. Can induced currents in metallic bodies in motion be developed by terrestrial magnetism?

180. Describe an apparatus by which terrestrial electric induction may be shown.

181. If a disc of copper is made to rotate rapidly between the poles of an electro-magnet, and the current invests the soft-iron poles with magnetism, does the disc meet with any resistance? And what happens if the rotation be continued?

182. What are Abel's fuses like, and can they be fired without the aid of a galvanic current?

183. Mention a telegraph instrument which can be worked by magneto-electricity, and explain its working.

184. Do you know of any other instruments or apparatus worked by magneto-electricity?

185. Mention the simplest mode of inducing electricity by means of magnetism.

186. It might have been inferred *à priori*, from the induction of magnetism by electricity, that electricity could be induced by magnetism: to whom is science indebted for the verification of this inference?

187. Is it only copper, or can any of the other metallic bodies put in motion close to a magnet, induce an electric current?

188. To what is the quantity of electricity induced by magnetism proportionate?

189. Has magneto-electricity been tried for electro-plating, and with what results?

190. Are you aware how the light at the Dungeness Lighthouse is maintained?

191. Upon what does the direction of the current of electricity which is excited in a metal moving in the neighbourhood of a magnet depend?

192. What is the direction of the electrical current when a metallic plate is caused to rotate in the neighbourhood of a magnet, or *vice versâ*?

193. Give the laws which regulate the magneto-electric force excited by magnetism in induction coils?

194. What, if any, difference is there between magneto-electricity and electro-magnetism?

195. Describe the construction of Clark's magneto-electrical apparatus.

196. What effect has a vertical horse-shoe magnet in rotation upon a copper disc suspended over it by threads of silver without torsion, and does any change take place when the magnet is made to rotate in the opposite direction?

197. What is the effect, if the disc (*vide* No. 196) presents breaks in the continuity, especially in the direction of the radii?

198. If any difference exists between the action of induced currents and friction (No. 178) to destroy motion, name it.

FRICTIONAL ELECTRICITY.

199. What is electricity, and how is it evoked?

200. Mention some simple means of exciting electricity by friction.

201. Can a solid body be electrified by friction with a liquid or a gas?

202. If a quantity of mercury in a dry glass be connected with a gold-leaf electroscope by a wire, and a dry rod of glass be immersed in it, what is observed if it be left there, and also when the rod is gradually withdrawn?

203. Name some substances which do not seem capable of receiving electric excitement by friction.

204. What is known with reference to the cause of the production of electricity by friction?

205. With reference to the preceding question, mention to what Wollaston attributes it.

206. Have we any authority for supposing that electrical phenomena may be produced *in vacuo*, or that they can be developed in an atmosphere of carbonic acid?

207. What is the difference between conductors and non-conductors, and is this distinction absolute?

208. Mention a few of the bodies which are conductors, semi-conductors, and non-conductors, arranging them in the order of their decreasing conductivity.

209. Under what circumstances does water, a good conductor, conduct very badly?

210. What, if any, change takes place in the conductivity of glass when red hot, or pulverised?

211. Does a dry or moist climate exercise any influence on glass as a non-conductor or insulator, and in what way?

212. Why is it that a conductor only remains electrified so long as it is surrounded by insulators?

213. Can you give any reason why the earth is called the *common reservoir* for electricity?

214. What is the obstacle to metals being electrified by friction? Give an illustration how this obstacle can be removed.

215. How can you account for the attraction that occurs between the leaves of a gold-leaf electroscope if, after it has been charged with electricity developed in a glass rod, a stick of sealing-wax rubbed with flannel be presented?

216. Are we to infer from the last question that there is but one kind of electricity?

217. State Franklin's theory of electricity.

218. And that of Symmer.

219. Which of the two theories is now generally admitted?

220. In electricity what do the signs + and — signify, and on what principle based?

221. Although the theory of two electric fluids is quite hypothetical, on what grounds is its general adoption justified?

222. Admitting the two-fluid hypothesis, state whether it is in virtue of the action the fluids exert on themselves, or in virtue of their action on the particles of matter, that the phenomena of attraction and repulsion take place.

223. Mention what you know regarding the law of the development of electricity by friction.

224. When two bodies are rubbed together, which of the fluids is decomposed?

225. As the electricity developed on a body by friction depends on the body rubbed, mention a few substances in such an order arranged that each becomes positively electrified when rubbed with any of the bodies following, but negatively when rubbed with any of those which precede it.

226. State some other cause than friction by which electrical excitement may be produced.

227. What do you understand by *pyro-electricity*?

228. When a crystal of tourmaline is warmed, and then allowed to cool regularly, what change in the polar properties is observed?

229. What do you understand by the terms "analogous pole" and "antilogous pole" in the phenomena of pyro-electricity?

230. Has the crystalline form of the mineral any connection with the phenomena of pyro-electricity?

231. Mention two or three minerals besides tourmaline which are pyro-electric.

232. In measurement of electrical forces, what two laws established by Coulomb regulate the attractions and repulsions of electrified bodies?

233. Give an idea what the torsion balance is like, and how used for experiments to determine the laws of magnetic attraction and repulsion.

234. From a series of experiments made by Sir W. Snow Harris, what exceptions, apparent or real, did he find to Coulomb's laws? (*Vide* No. 232.)

235. What does De la Rive remark with reference to these exceptions?

236. What did Davy, on repeating Snow Harris's experiments, discover?

237. Does the distribution of electricity depend on the extent of the surface, or the mass of a conducting body? To what extent, if any, does electricity penetrate into the interior?

238. Supposing that a thin hollow copper sphere be charged internally through an aperture provided for the purpose, what is observed on applying the proof plane? (The sphere being on an insulated stand.)

239. Take, for example, a hollow globe fixed on an insulated support; provide it with two hemispherical envelopes which fit closely, and can be separated with glass handles; charge the globe, and bring the two covers in contact: on removing them rapidly, will the electricity be found to have divided itself? If so, how, and where?

240. Does the form of a body exert any influence on the accumulation of electricity? If so, in the case of an insulated elongated ellipsoid, where would the electricity be found to have the greatest tension or tendency to escape?

241. What power does an electrified pointed rod possess? If, for instance, when the hand is brought near a point on an electrified conductor, a slight wind is felt, and in the dark a luminous brush is seen, explain the reason of this.

242. What happens if two conducting bodies are brought in contact when one is electrified and the other not, and what if they are not conductors?

243. Electrified bodies gradually lose their electricity even when placed on insulators: to what two causes is this due?

244. Are all substances conductors of electricity, or can you name any that may be considered insulators or non-conductors?

245. When is air a good conductor?

246. At a high tension the loss of one electricity is greater than the other, as discovered by Matteucci. State which.

247. How could a charge of electricity be retained in a body *in vacuo*?

248. Demonstrate the phenomena of electrical induction.

249. In what respects is the action of an insulated conductor charged with electricity analogous to that of a magnet on soft iron?

250. Is there any limit to the action of induction? If so, when is it said to have attained its limit?

251. State Faraday's theory of electricity by induction, and mention the experiment which he devised to illustrate the *polarisation* of the medium.

252. Is the inductive capacity of gases dependent on temperature or pressure?

253. With reference to the communication of electrity, what phenomenon is observed when the finger is presented to a strongly-electrified body, and what is the cause?

254. Explain by means of the laws of induction the phenomena of attraction and repulsion.

255. In what respects does the gold-leaf electroscope differ from the original pith-ball pendulum? Describe Bennett's.

256. What is the electroscope used for?

257. Could the electroscope be used as an electrometer, or measurer of electricity?

258. Describe the mode of working the electrophorus and its action.

259. Can you give the reason why the electrophorus, once charged, retains its electricity for months?

260. By what means is the retention of electricity in the electrophorus promoted?

261. Who was the first inventor of the electric machine?

262. Describe the electric machine.

263. Describe the action of the electrical machine, and state on what the action is founded.

264. Why is it that a spark cannot be drawn from the conductor of an electric machine till the plate is turned?

265. What advantages does a plate of ebonite possess over that of glass?

266. For what purpose are amalgams used in electric machines? How is the best prepared?

267. By what means can the loss of electricity from the electric machine be avoided?

268. As it is not possible to exceed a certain limit of electrical tension with the machine, can you say when this is attained?

269. Mention the three causes on which the loss of electricity depends?

270. How is the electric tension measured?

271. When the rotation of the plate is discontinued, the index falls rapidly if the air is moist, but slowly when it is dry. What does this show?

272. If Ramsden's electric machine only gives positive electricity, by what arrangement can it be made to give negative?

273. What are secondary conductors?

274. Describe Nairne's electrical machine, and state in what respects it differs from that of Ramsden.

275. By what means is electricity produced in Armstrong's hydro-electrical machine, and of what does the machine consist?

276. What accident led to the discovery of hydro-electricity, and to what is the development of this electricity due?

277. Does the addition of acid or saline solutions interfere in any way with the disengagement of electricity from the hydro-electrical machine? and what change takes place if turpentine is added to the boiler?

278. When a spark is drawn from the conductor of the electrical machine it varies in shape according to the distance of the object it strikes. Can you explain the cause of this?

279. Illustrate by diagram the action of the apparatus called "electrical chimes."

280. What is it that causes the electrical whirl or vane to revolve if placed on the conductor of an electrical machine when the machine is worked?

281. What follows if the flame of a candle is brought near a point

placed on the conductor of an electrical machine when worked, and is the effect the same if the taper is placed on the conductor, and a pointed wire is held near it?

282. What do you understand by condensers of electricity?

283. Can you explain the accumulation of electricity in condensers?

284. How would you effect the slow and instantaneous discharge of the condenser?

285. What two causes limit the quantity of electricity that can be accumulated by means of the condenser?

286. Of what does the fulminating pane consist? and describe how it is charged and discharged.

287. By whom, and where, was the Leyden jar first invented? In what respects does it resemble a condenser?

288. State by what two processes the Leyden jar can be charged internally with positive and then negative electricity.

289. On removing the movable coatings of a charged Leyden jar placed on a cake of resin they are found to contain very little electricity, and when placed on the table are reduced to the neutral state. When the jar is put together can a shock be obtained?

290. In the event of your answering the preceding question in the affirmative, state where the electricity is supposed to adhere.

291. Describe how Lichtenberg's figures can be drawn on a cake of resin, and state what this experiment illustrates.

292. Prove, by naming an experiment, that the electricity penetrates to a certain extent into the insulating substance placed between two metallic plates charged with electricity.

293. The residual charge varies with the nature of the substance. Is there any in gaseous or liquid insulators?

294. Faraday found that with glass and sulphur the residue was least of all. With what did he find it greatest?

295. Upon what does the charge that a Leyden jar can take depend?

296. How is an electrical battery arranged with Leyden jars, and does it take longer to charge a large battery than a smaller one?

297. Describe the universal discharger, and state for what it is used.

298. What do you understand by the term "charging by cascade?" and how would you proceed to do it?

299. Describe Lane's electrometer, and state on what principle it is constructed?

300. In what respects does Harris's unit jar differ from Lane's electrometer?

301. What do you know regarding the laws of electric charge?

302. In what does Volta's condensing electroscope differ from the ordinary gold-leaf electroscope? Describe how you would proceed to render very small quantities of electricity perceptible by this apparatus?

303. Name some of the effects of the electric discharge, distinguishing the *physiological*, *luminous*, *mechanical*, *magnetical*, and *chemical*.

304. Suppose a row of men holding hands; the first touches the outside coating of a charged Leyden jar, and the last at the same time the knob: what is the result, and how is it brought about?

305. As the colour of the electric spark varies with the nature of the conductors, and also with the nature of the surrounding medium, state

the colour between two charcoal points, two balls of silvered copper, and between knobs of wood or ivory; in atmospheric air at ordinary pressure; in rarified air and *in vacuo;* in oxygen, hydrogen, nitrogen, vapour of mercury, carbonic acid.

306. To what are the modifications in colour of the electric spark ascribed?

307. From what does the brush discharge derive its name?

308. What is the appearance of a spark when taken at short and long distances?

309. What shape does the discharge assume when the electricity in virtue of its high tension, issues from a conductor, no other conductor being near?

310. Mention some of the calorific effects of the electric spark.

311. When an electric discharge is sent through gunpowder it merely disperses it: what is necessary to insure its ignition?

312. How can the deflection of the magnetic needle be obtained by means of frictional electricity? State also how a steel wire can be magnetised by the same agency.

313. Mention an experiment by which the mechanical properties of an electric spark can be illustrated.

314. By what means can you illustrate the perturbation and sudden expansion which the electric discharge produces?

315. Enumerate a few of the chemical effects of the electric discharge.

316. Has the velocity of the electric spark been measured, and by what means, and with what result?

317. Some substances—such, for instance, as ebonite, silk, and gutta-percha—possess, within certain limits, the power of insulation: for what purpose is this power made available in electricity?

318. According to the present state of knowledge on the subject, can you name two of the *best conductors* and insulators?

319. If two persons stand on two insulated stools, and one strike the other with a well-dried cat's-fur two or three times, which of them will be *positively* electrified, and which of them *negatively?* or will only one kind of electricity be produced without the other?

320. Of the two instruments, electroscope and electrometer, which of them is used for measuring, and which for indicating the presence and kind of electricity?

321. What do you understand by the influence of excited bodies upon neutral conducting bodies at a distance?

322. What is Varley's multiplier? Describe it in a general way.

323. In what respects is the cylinder superior to the plate electrical machine?

324. State what you know about the theory of the electrical machine.

325. Is the electricity produced by the hydro-electric machine remarkable for its high intensity or quantity?

326. State in what respects the disruptive discharge at the end of a wire charged *positively*, and another *negatively*, varies.

327. How can the tendency of Leyden jars to spontaneous explosion when very clean and dry be diminished?

328. What is the velocity with which electricity travels through good conductors?

PRACTICAL TELEGRAPHY.

329. For what purpose are insulators fixed to telegraph posts or supports?

330. Why is it that in the case of a support or post, carrying two or more wires, a metallic support is preferred to a wooden?

331. Describe the best "earth plates" known to you, and how they should be employed to secure a good earth circuit, and explain what the *earth circuit* means.

332. In constructing a telegraph line is any care necessary in joining up the wire? Can you enumerate any of the inconveniences experienced through having a "faulty joint" in the circuit?

333. In order to establish telegraphic communication between two places, what is necessary in the way of conductors, earth circuits, &c.? Give rough tracing, showing how the electric current can be transmitted from one station to another.

334. Why is it better to use iron wire, suspended on poles, than buried wire covered with gutta-percha or india-rubber?

335. Has the gutter-percha covering of a cable ever been known to deteriorate when under water—in the sea, for instance. What do you know about the utility of india-rubber for telegraphic purposes?

336. Describe the best modes of preserving timber posts against decay and insects.

337. Is any advantage gained by lessening the number of telegraph supports, as regards strength or insulation of a line?

338. What precautions are necessary in constructing a line across public roads, &c., to prevent accidents to traffic or line?

339. What is the number of posts per mile recommended for a line of three, four, or six wires, and must the number of posts be increased for additional wires?

340. In constructing a line alongside of a railway or public road, which side of the road is to be preferred, with a view, as far as possible, to prevent accidents by the line being blown across by the prevailing winds?

341. How would you provide against the line giving way at angles or curves? Describe the three modes mentioned in Culley's "Practical Telegraphy."

342. What is the benefit of furnishing timber posts with an earth wire, and how should it be fixed to be of any use?

343. What, if any, care is needed in *insulation* when the smaller kinds of wire are used as conductors? and can you give the reason why a No. 1 or 4 wire conducts better than one of No. 8 or 16?

344. Mention whether soft or hard wire is the best for long and short spans, and state why one is better than the other.

345. Does temperature exercise any influence on the wire? If so, mention in what way.

346. What do you understand by the wire being *killed?* and does this add to the strength of the line?

347. Why should the number of joints or welds be reduced to a minimum?

348. What do you understand by galvanised wire, and for what purpose is the wire thus coated?

349. Mention some of the precautions necessary to prevent contact between the lines when the posts carry more than one wire, and on what account.

350. Where the wire is exposed to smoke, or the line is in the vicinity of the sea, the zinc coating does not protect it: what is recommended as the best paint for the wire?

351. Are you aware why the wire should be kept clear of trees or branches? When this is not possible, how is the wire usually protected?

352. Why is steel, or the so-called homogeneous iron wire, better suited for long spans than stranded wire?

353. Do spiders' webs cause any inconvenience on the lines, and in what way?

354. What injurious effect has dirt or smoke on insulation and insulators, and how can it be remedied?

355. Why is it that, after a smart shower of rain, the insulation of a line is improved?

356. What are the difficulties met with in securing good insulation for a line on the sea-coast?

357. What are earth currents or deflections, and how are they caused?

358. Is the direction of the earth current determined by the actual course of the wires or not, and are they in any way connected with the earth plates? When are these currents sufficiently strong to affect the telegraph?

359. When communication is stopped by these currents, by what means can it be restored?

360. What is the difference between earth current and earth battery?

361. Into what classes can the apparatus employed to transmit intelligence by means of electricity be divided?

362. Describe Bright's bell telegraph, and the single-needle telegraph.

363. Trace the connections of a Morse instrument.

364. Describe Wheatstone's alphabetical instrument; also that of Siemens.

365. How is Wheatstone's automatic system worked, and is there any gain in the speed of signalling by this over any of the other systems?

366. By what agency is the telegraph worked, frictional or dynamical electricity?

367. What is voltaic or galvanic electricity?

368. Could a current of electricity be produced by using two plates of the same metal, and both attacked equally by the acid? If not, explain why.

369. Describe the "Britannia" joint, and state why it is to be preferred to a twisted joint, both as regards strength and conductivity.

370. Can you say why a joint should be soldered?

371. What is the best method of terminating a wire, in lieu of twisting it, to prevent its breaking?

372. Name the best solution known to you for soldering a joint, and mention any precautions necessary in soldering hard wire joints.

373. Do you know of any remedy to stop the noise caused when wires are set in vibration by the wind?

374. What is the benefit of securing the line wire to the insulator? and mention the best way of doing it.

375. Why is it necessary to examine the bindings from time to time?

376. What objection is there to using sulphur as a cement for fixing bolts into insulators? Name any other cement known to you.

377. Can you give the reason why porcelain insulators are sometimes protected with an iron cap, and whether there is any objection to it?

378. How would you test the line for *insulation* and *continuity?*

379. Can you mention the French method of testing for insulation and continuity?

380. What, if any, precautions are necessary in regulating the battery power when taking tests?

381. Why is it that tests taken at opposite ends never agree?

382. What is meant by *units of resistance?*

383. How do you *take the constant* of the instrument, and what is understood by this?

384. How can you prevent the disturbing action of masses of iron, of the electro-magnets of instruments, and of currents passing through wires under the signal table or desk, when testing with a tangent or any other horizontal galvanometer?

385. Describe the *differential galvanometer*, and the mode of testing by it.

386. Describe *Wheatstone's balance*, and method of testing.

387. What is the *shunt* used for in testing?

388. Give an example how ordinary tests can be reduced to units of resistance.

389. What is the law of variation as regards the tension of two wires of different gauge, the span and dip being the same for each?

390. If it be required to increase the distance between two posts, and yet to preserve the same tension in the wire, how would the dip be influenced?

391. The span between two posts being the same, how would the dip vary?

392. Where is the tension least in a wire between two posts? and supposing that the length be under 150 yards, would the same law hold good?

393. Why should wires put up in summer be strained less tightly than those in winter, and what objection would there be to putting them up too slack in winter?

394. Supposing a wire to be pulled up perfectly straight, would the tension differ? and if so, in what part?

395. Why are more wires broken in winter in short spans than in long ones?

396. What is the expansion of wire per mile for every ten degrees of heat?

397. Supposing a wire to be pulled up in mild weather to a dip of 14 inches, what strain in pounds will it take when the temperature is at 25°?

398. What is the law for the leakage of electricity in wires when the insulation is good and equal throughout the circuit tested?

399. When would a circuit of many instruments test better than a direct circuit, in which there are none except at the terminal stations?

400. Why, when testing a wire for resistance by putting the distant end to the earth, is the result apt to be interfered with by *deflections?*

401. Mention some of the principal faults in a circuit, and the result caused by them respectively.

402. What do you understand by a line making *partial earth?* Illustrate by diagram. And how would the signals be affected at the receiving and sending station?

403. When one wire touches another, how would the current be affected?

404. What effect does damp weather have on the working of lines?

405. How would you test for faults at a station—for earth, contact, disconnection, partial disconnection, and intermittent faults?

406. What is the technical name for the most accurate test?

407. Describe the method of finding the distance of a contact.

408. What is a *shunt*, a *pecker*, a *short circuit*, and the *local circuit?*

409. Describe one of the latest needle instruments.

410. Name the principal faults to which a needle instrument is subject.

411. What is a printing telegraph? Describe one of the latest.

412. Describe the Morse instrument.

413. How is the working by relay performed with the Morse instrument?

414. In order to increase the power of permanently-magnetised armatures, and to lessen their liability of losing their polarity, how would you magnetise them?

415. Upon what does the length of the *mark* in Morse's telegraph depend?

416. How is the spark in relays prevented?

417. Describe *Varley's double current key.*

418. What is the principle of transmission by two stations at the same time upon a single wire?

419. What are the principal faults to which the Morse apparatus is liable?

420. Describe the *lever switch.*

421. Name and describe the instrument by which any two circuits are connected.

422. Describe Clark's double-shunt differential galvanometer.

423. Of what does a submarine telegraph cable consist generally?

424. State the difference between a gutta-percha cable, and one made with Hooper's core.

425. How many attempts have been made to lay a cable across the Atlantic? State some of the causes which led to failure.

426. Besides the *resistance* of the conductor, what other difficulties have to be overcome in signalling through cables or long underground lines?

427. Upon what does the speed of a cable depend?

428. How is the test for the quality of copper for conductors carried out?

429. Give the modes for finding out the resistance of a mile of wire of any size at any temperature.

430. Is there any and what difference of resistance in a wire just drawn, and after it is annealed?

431. State how you would connect two lengths of a solid wire and of stranded wires.

432. What do you understand by the *core* of a cable, and what is the dielectric?

433. What is meant by *conductive resistance* and *inductive capacity?*

434. Of gutta-percha and Hooper's india-rubber which has been found to be the best insulator, and to stand the heat?

435. Explain electrification or absorption in connection with cable-testing.

436. Is it necessary to allow any time to elapse between the application of the current and the observation in testing for insulation or inductive capacity?

437. Has temperature any effect on the insulating properties of the dielectric? and has any allowance to be made for it in testing a cable?

438. Name some of the effects of pressure on insulation. State, if you can, the improvement noticed in the Atlantic cable.

439. Enumerate the precautions necessary when testing a cable, and how you test for insulation, continuity, and resistance.

440. Does a faulty cable test alike with the positive and negative current? If not, what is the difference?

441. Describe the charge and discharge test.

442. Describe *joint-testing* by Clark's method, and state the principle of the test.

443. What do you understand by testing the insulation of cables by half-charge? Describe how Clark does it.

444. Describe by diagram the connections necessary for a discharge test, and the alteration necessary for a charge test.

445. Why is it advisable to put the cable to earth for some hours before testing?

446. Which of the tests—the ordinary insulation or the discharge—should be taken first when both are used, and why?

447. How is the time of fall to half-tension calculated by one observation?

448. What is the best method of leading wires into stations? Is it necessary to cover the gutta-percha, and why?

449. Explain the different modes of laying street or underground wires?

450. Can defective gutta-percha wires be brought into use? If so, by what means?

451. Why is great care necessary in testing covered wire?

452. Mention one or two of the methods for jointing covered wire.

453. Is the *tension* or quantity of electricity increased by adding cells to a battery?

454. Describe any two batteries used for telegraphic purposes.

455. What is the effect produced by a faulty porous cell?

456. Does any ill effect follow when the zinc of a battery is allowed to touch the porous cell?

457. Why is it necessary to *insulate* the battery boxes or troughs, and what is the best way of doing this?

458. In the event of there being a bad cell in the battery, how would you bridge it over?

459. How can the forming of crystals on the sides of a battery cell, when the water has become charged with sulphate of zinc, be prevented? and state why they should be guarded against.

460. What is the deposit that collects on the zinc plate of a battery called, and how is it produced?

461. Is the deposit mentioned in the last question of any value?

462. State the reason why the zinc cell of a battery should be larger than that containing the copper?

463. What is the principle of the "gravity" battery? Describe it.

464. Describe Muirhead's battery, also Siemens' modification of Daniell's.

465. Where a constant battery current is required, how can it be obtained by aid of the so-called Belgian globe reservoir?

466. Name some of the precautions necessary in preparing a Daniell's or other battery?

467. How can copper plates that are very dirty be easily cleaned?

468. In recharging a battery, can the old liquids be used again?

469. Name the faults likely to occur in a battery?

470. State how the purity of sulphate of copper and zinc can be tested.

471. Mention some of the *units of resistance*, with their values.

472. In what way does the purity of metal affect its resistance?

473. Give the resistance per mile of some of the iron wire generally used—Nos. 4 and 8, for example.

474. Do homogeneous metal and steel offer greater or less resistance?

475. In a circuit does the *tension* of the current vary? If so, where is it the greatest, and where zero?

476. How can the resistance that a battery offers be modified?

477. Explain the principle of translation working by means of single and double current.

478. Describe translation between the single and double current systems.

479. Describe the methods of testing by means of Wheatstone's balance.

480. What is the electrometer of Milner or Peltier like, and how used?

481. Describe the construction of Thomson's reflecting galvanometer and portable electrometer.

482. Why is it necessary to keep in water, or soak for some hours, covered wire, before it is tested?

483. Name one or two methods of testing roughly for insulation in covered wire.

484. If covered wire proves defective, how can the fault be discovered?

485. Explain how a small fault in a wire too defective to be used, and not readily found by the distance tests, can be made worse, and a bad wire made better for a time.

486. Describe how a fault can be discovered in a tunnel or under ground.

487. Describe the instrument called the *wire-finder*, and the mode of working.

488. Can covered wire too defective to work under ground be made available for a tunnel or out-door work, and how?

489. Is there any and what difference in the manner the circuit is completed by means of the earth, and by a return wire?

490. How does Gavarret explain the action of the earth as a conductor, and what results, with reference to resistance of the earth, did Matteucci obtain with plates buried at different distances apart? and how does the resistance vary with the depth of the plates?

491. Is there any limit to *size* and *distance* of plates when the resistance remains constant?

492. Is it advisable to use one earth plate for all the circuits in an office? If not, state the objections.

493. How can an earth plate be tested?

494. When using gas or water pipes for earth, why is it better to connect both?

495. What causes a permanent current sometimes to appear on the instrument on connecting up a short circuit of less than ten miles?

496. Name some of the best material for telegraph insulators, and one or two of the best shapes, with reasons for the preference.

497. Give the reason why insulators should be carefully tested before being put up, and the mode of testing.

498. Have we any means of preventing spiders' webs inside of insulators?

499. Can a piece of kite string thrown across the line wires cause any inconvenience?

500. Mention some means of preventing *weather contacts* between lines.

501. Suppose *partial earth* to exist ten miles from A, and there is a station at B, seventy-three miles further, which will receive the weakest signals, and why?

502. Mention some of the consequences, when the line wire is down, on dry and wet ground, on rails, in water, or touching a tree, and state how these faults can be traced by testing.

503. Give the most convenient formula for finding out or calculating the effective current or strength of signals when a fault exists on a line.

504. How can a person travelling along a line of telegraph discover a fault? and what apparatus would be required for the purpose?

505. What law explains the method which has been proposed for signalling across rivers without wires? and how is this effected?

506. In increasing the *size* or *number* of plates in a battery, the best method of providing for loss of current arising from defective insulation?

507. How can a convenient portable battery for testing purposes be formed?

508. Why is it that single-fluid batteries are useless for telegraphic correspondence in general?

509. Describe a secondary battery, and state for what purpose it is well adapted?

510. What is the objection to placing old batteries in series with new ones?

511. Describe the principle of Wheatstone's bridge, and the mode of testing by it.

512. State Preece's method to show the mathematical law of the fall of charge from full to half tension in testing cables.

513. Give Jenkins's formula for calculating the resistance of the core of a cable.

514. Name the methods for determining the *specific resistance* of the insulator and the *leakage* of a cable.

515. What do you understand by the *inductive* or *electrostatic capacity?* and what influence has this on the speed with which a cable can be worked?

516. Give Thomson's formula for determining the specific inductive capacity of a cable.

517. Describe how a cable can be tested by means of a condenser and shunt.

518. Can the distance of a fault in a cable be measured the same as in an ordinary line?

519. What produces the *cable current* in a broken cable, and how can it be discovered?

520. Name some of the methods for testiug a cable not already mentioned by you.

521. Describe the principle and action of electric alarums.

522. Enumerate the telegraph instruments worked by magneto-electricity, and describe one.

523. Describe Bright's acoustic telegraph and Froment's French alphabetical telegraph.

524. Describe the principle and working of Wheatstone's universal dial telegraph.

525. What are *current-changers?* Describe Wheatstone's.

526. Describe the construction and principle of an electric clock.

527. What is the difference between Bain's printing telegraph and that of Morse.

528. By what law is speed of transmission in cables similar in all respects, except length, governed?

529. Would there be any difference in the specific resistance of the conductor of two cables, one being twice the length of the other?

530. Why is there a loss of speed in a cable if the conductor is too small, the diameter of the core being fixed?

531. Supposing the conductor is too large, why is the speed lowered, the conditions being the same as in the previous questions?

532. What are the advantages of great purity of copper in a cable?

533. Upon what does the working of submarine cables chiefly depend?

534. On what law does the signalling through cables of the same length vary?

535. How does the speed of signalling vary through cables of the same inductive and conductive resistance?

536. How would you express algebraically the law for gutta-percha cables, supposing L = length of wire expressed in knots, R = resistance of conductor expressed in ohms per knot, I = inductive capacity of the cable gutta-percha being taken as unity?

537. How could a cable be positive in one part of its length, and negative in another?

538. By what instrument could you ascertain when the current in a cable varies?

539. In comparing the speed of two cables, what would be the best instrument to use?

540. Of what use is the *curb-key?*

541. How could the rapidity of transmission be increased when two sections of the cable are connected?

542. When one plate of a condenser is charged, the other being to earth, what action takes place?

543. How would you insure the relative magnetic force of horizontal needles by the time occupied by the needle in performing a fixed number of vibrations?

544. How is the strength of currents compared?

545. If a current be split between the wires of the galvanometer, and a wire attached to its two terminals, in what manner will the electricity distribute itself?

546. Supposing the conditions to be the same, and the shunt be exactly equal to the galvanometer in resistance, how would the current divide itself, and what would be the deflection of the needle?

547. How would you find the resistance of a battery?

548. Describe the method of comparing the tension of batteries now in common practice.

549. How would you obtain the tension of a whole battery in terms of that of one or more cells?

550. How could the full tension of a battery be rigorously obtained?

551. Describe Gangain's tangent multiplier.

MISCELLANEOUS.

552. As the power of a horse-shoe magnet is tested by the weight it can support, state the formula Hacker gave for this weight.

553. Mention some means of obviating the deviation of the compass needle on board ships, and give the reason of this deviation.

554. What appearance do diamagnetic and paramagnetic liquids assume when a drop is placed on a watch-glass laid upon the poles of a magnet?

555. Does the nature of the machine in which a body under examination moves exert any influence on the nature and amount of the magnetism it exhibits? Give examples.

556. Are substances which are conductors or semi-conductors of frictional electricity equally so for the electricity of the galvanic battery? If not, state the reason.

557. Do you know why green glass is better adapted for insulators than flint glass?

558. Can the term "non-electric" be applied to *any* substance, or are all substances electrics?

559. If the amount of the electricity induced by an electrified body on surrounding conductors is equal and opposite to that of the inducing body, say how it can be proved.

560. How can you illustrate that *induction is universal in its action?*

561. Give the specific inductive capacities of some of the more important non-conducting substances, taking that of air as unity, according to Sir W. S. Harris's table.

562. What were Faraday's ideas about conductors and non-conductors, or insulators?

563. From the terms *vitreous* and *resinous* electricities do you under-

stand that when a body is excited it is always electrified with one species of electricity? For example, is glass always *vitreously* electrified?

564. What is meant by the *specific inductive capacity* of an insulating body?

565. Is the distribution of electricity on the surface of an insulated sphere uniform when it is surrounded partly by air, and partly by sulphur or lac? If not, state the reason.

566. What are *electrics* and *dielectrics*?

567. Account for the phenomenon of return charge or residual electricity when a Leyden battery has been charged a long time, and is discharged.

568. Explain how lateral induction increases the resistance to transmission of electricity, even by the best conductors.

569. Describe Harris's system of lightning conductors for ships.

570. What, if any, difference is there between an *electrical* and *magnetic* storm?

571. How do armatures preserve the magnetism in magnets?

572. When magnets are laid aside, in what position should they be kept to prevent a weakening of the magnetism?

573. Mention some experiments by which the operation of magnetic induction may be illustrated.

574. Name the different qualities of steel recommended for artificial magnets—(*a*) for large massive single or compound magnets of the straight bar form, (*b*) single and compound horse-shoe.

575. How is thermo-electricity produced, and on what does it depend?

576. Have the thermo-electric properties of metals any connection with their voltaic relations, or with their power of conducting heat or electricity?

577. What is desirable in forming a thermo-electric pile or series? and at what part of the metal must heat or cold be applied to develop electrical currents?

578. Of what two substances did Nobile and Melloni construct their thermo-electric pile or battery?

579. On what principle has Wheatstone constructed his thermo-electric pile? What effects do sixty of his elements produce? Mention some, and state to how many of Daniell's cells this electro-motive force is equal.

580. What did Peltier discover about the absorption and generation of heat when electricity traverses a compound metallic conductor from bismuth to antimony, or *vice versâ*?

581. By what ingenious experiment did Tyndall confirm Peltier's observations?

582. If two bars of bismuth and antimony be soldered across each other at right angles, and touched with the conducting wires of the battery, so that the current will pass from the bismuth to the antimony, what will be produced?

583. Explain how an electric current can be produced by means of a fused salt.

584. When bismuth and antimony are made use of in a thermo-electric series, which is positive and which negative?

585. Thermo-electric currents cannot be ascribed to contact or chemi-

cal action: to what cause does Becquerel attribute them? Can they be produced in a single metal?

586. Does the crystalline form of metals influence thermo-electricity?

587. What effect has an electric current on the nerves of the senses?

588. Describe how an electric current can be produced by muscular contractions.

589. Name some of the electric fishes, and the means they possess of generating electricity.

590. Has electricity been detected in plants? If so, quote some examples or proofs.

591. What are chronoscopes, and are they worked by electricity or magnetism? Give some details.

592. Is there any and what difference between chronoscopes and chronographs? Describe the latter.

593. On what principle are electric thermometers constructed?

594. Describe Hemming's electric target, and Siemens' electric log.

595. In what way has electricity been employed in breaks for railway trains?

596. Describe the electric self-acting boiler feed and the electric hydrostatimeter.

597. Has electricity been employed in engraving machines? If so, describe one.

598. Describe the electric loom.

599. What are induction coils? Describe Ruhmkorff's.

600. How many *microhms* = $2\frac{1}{2}$ *ohms?* and how many *ohms* = 1 *megohm*?

601. Is the *volt* a measure of *tension* or *resistance?* and state how many *microvolts* = a *megavolt.*

602. What do you understand by a *farat* of electricity?

603. Quote the unit of current, of work, of head, and the electro-chemical unit.

604. Of what use is the condenser in Ruhmkorff's coil?

605. How is lateral induction brought about in Ruhmkorff's coil?

606. Describe Ritchie's arrangement of Ruhmkorff's coil.

607. Describe the phenomenon of the spark in air caused by the induced current.

608. What effect does hydrogen have on the spark?

609. How can ozone be produced by the induction spark?

610. What takes place when the induction spark is sent through ammoniacal gas?

611. How is the spark introduced through gaseous compounds?

612. What colour does the spark assume in oil, in alcohol, and in turpentine?

613. What effect is produced by the discharge from the induction coil in highly-rarefied air?

614. How can a light be obtained in a vacuum tube with only one pole of the secondary wire of an induction coil? and how can the light be made to bifurcate?

615. Name some methods of rendering visible the stratification of the electric spark.

616. How did Gassiot succeed in obtaining vacua so perfect that no luminous discharge can be observed through the tube?

617. What is the physical cause of the stratification?

618. How can electrical discharges from the induction coil be applied to purposes of illumination?

619. Describe the mode of discharging Leyden jars and condensers by the induction coil.

620. Why should one cell give as large a deflection as any number that may be connected in circuit where there is an infinitely small resistance?

621. How is the quantity of electricity doubled in a battery?

622. Supposing it to be required to produce the greatest effect with 120 cells, and that the line has a resistance of 80 ohms, what would be the best way to place them?

623. What is the disadvantage in making up a "quantity battery" by connecting batteries of small plates side by side?

624. Why is it much better to use one plate of 32 square inches than two of 16 square inches placed side by side?

625. Why does the vertical galvanometer need no adjustment?

626. Why should needles properly balanced for England be wrong if sent to Australia?

627. How would you explain the cause of the indicating needle of a *vertical* galvanometer varying from time to time?

Examination Papers.

628. State what you know regarding the action of the earth as a magnet.

629. What is meant by magnetic induction? Explain magnetic induction in accordance with the theory of magnetic fluids.

630. An electrified body is placed before you, and you are required to determine the quality of its electricity: how would you do it?

631. Describe the electrophorus, and explain its action.

632. Describe the Leyden jar, and explain its action.

633. Describe and explain the experiment which led to the discovery of the Leyden jar.

634. Describe the electrical machine. State how it is excited, and in what way the prime conductor is charged.

635. When a strip of silver is placed upon the tongue and a strip of zinc underneath it, on bringing both into contact, a peculiar sensation is experienced: what is its cause?

636. Describe some simple means of generating a voltaic current. Supposing a current to flow through a wire, how would you prove its existence there?

637. Describe the battery of Grove, and state clearly the functions of the two fluids employed in this battery. Describe all the chemical actions that occur in the battery where the current flows.

638. State what you know regarding the chemical effects produced by the current outside the battery.

639. State what you know regarding the relation of the heat developed within the battery to that developed without it.

640. I hand you a piece of magnetic iron ore, and ask you to show as many as possible of its phenomena. I wish you especially to illustrate both its attractive power and its polarity: how will you proceed?

641. Describe the gold-leaf electroscope properly arranged to give no fallacious indications. What does it indicate immediately? Show that if enclosed merely in a dry glass shade, it may show divergence where it ought to show none.

642. Explain how to charge a Leyden jar, and how to give a shock to several persons by means of it. Show how, by aid of an insulating stand, a Leyden jar may be charged resinously on its inside coating by means of a common electrical machine with its rubber insulated.

643. State the law according to which the force between two electrified and perfectly insulated bodies varies according to the distance between them, supposing this to be great in comparison with the greatest dimensions of each. Example—If the force be equal to the weight of $\frac{1}{10}$ of a grain at 2 inches distance, what will it be at 8 inches?

644. If a magnetised steel needle be supported so as to to have freedom to turn in a horizontal plane, how does it place itself in this country (England) with reference to the true north and south line? How at Calcutta? If perfectly free to turn about its centre of gravity, in what position would it rest in either locality? Modify the answer to the last question to suit it to any magnetised mass of steel, such as a horse-shoe magnet.

645. I wish you to illustrate the declination and the inclination of the magnetic needle: how will you proceed? You are also required to point out the analogy between the earth's action and that of a steel magnet: how will you do it?

646. Two bar magnets are placed parallel to each other with their north ends turned in the same direction. Show by a sketch the way in which iron filings will arrange themselves when scattered over the two north poles. Reverse one of the magnets and show the arrangement of the filings. Explain, finally, why the iron filings should arrange themselves in the ways indicated.

647. You are required to illustrate fully the action of magnets upon each other, and to state the general laws to which your experiments conduct you. You are also required to illustrate the magnetism of iron as distinguished from that of steel: how will you proceed?

648. You are required to show that the proximity of an electrified body decomposes the neutral electricity of an insulated conductor into positive and negative: how will you proceed? State the positions in which the two electricities are found, and how their presence there is proved by experiment.

649. Connecting a feebly-charged condenser with a gold-leaf electroscope, the leaves diverge and collapse under certain conditions. What are they? Why do the leaves diverge and collapse? Show by a sketch the way in which the condenser must be connected with the electroscope.

650. Support a disc of brass on a common drinking glass, and electrify it. I wish you to show how the electricity is distributed over the surface of the disc: how will you proceed? What will be the result of your experiments? If, instead of a disc, a body ending in a sharp point be employed, a limit beyond which you cannot further charge the body is sooner reached than in the case of a body which does not end in a point. Explain this.

651. Describe what occurs when a charged Leyden jar with movable

coatings has its coatings removed. State the manner in which you would make the experiment which answers this question.

652. Describe the simplest form of voltaic battery.

653. Describe Grove's battery, and that of Daniell. Explain the chemical action that takes place in the cell of the latter.

654. Explain why in neither Daniell's nor Grove's battery is there any evolution of hydrogen, or any other gas, as long as the liquids and metals are in proper condition.

655. If a little sulphate of copper gets into the liquid next to the zinc in a Daniell's battery, what injurious consequences result?

656. Explain the decomposition of water by the galvanic battery. If a zinc plate be substituted for one or other of the platinum plates, what chemical, if any, difference will be produced in the result?

657. State what you know of Ohm's law. Apply it to find the arrangement of 12 cells, each having 60 units of internal resistance, so as to give the strongest current through a wire whose resistance is 1,000 units.

658. Describe a practical method for measuring the intensity and the resistance of a Daniell's battery.

659. You are furnished with a magnet and bar of steel: how are you to magnetise it? State in the language of the theory of magnetic fluids what occurs during the act of magnetisation.

660. State your grounds for supposing an ordinary magnet to be an assemblage of molecular magnets.

661. You are required to compare and express numerically the comparative strength of two bar magnets: how will you do it?

662. There are two bodies, A and B; the one, A, electrified with positive electricity, while you are not certain whether the other is electrified or not. Why is it that the attraction of B by A furnishes no safe test that B is negatively electrified?

663. Describe in a general way the distribution of electricity in the case of a conical conductor, a spherical conductor, and a pewter pot.

664. You are furnished with two sheets of tin foil, a plate of glass, and a gold-leaf electroscope, and are required to illustrate by means of these the principle and action of the Leyden jar: how will you do it?

665. Describe some of the effects which would enable you to state whether a voltaic current was passing through a wire or not.

666. Describe some one means of determining the strength of a voltaic current.

667. How do you determine the law according to which the magnetism of an iron bar surrounded by a coil of copper wire increases in strength as the voltaic current sent through the wire increases in strength?

668. When a voltaic current circulates, various chemical actions occur. What are they in the case of the battery of Grove? Heat is evolved in the battery itself. Is it always the same for the same amount of chemical action? If not, what circumstances cause the amount to vary?

669. Describe an artificial magnet and its principal properties.

670. Describe the precautions necessary to magnetise a bar by means of other permanent magnets, and state by what other means a bar may be magnetised.

671. Describe the dipping-needle, and say at what part of the earth the dip of the needle is the greatest.

672. What is meant by the *variation of the needle*, *magnetic meridian*, and *magnetic pole*?

673. What perturbations is a freely-suspended needle subjected to if kept in the same place of observation?

674. What is meant by magnetic storms?

675. How can electricity be produced by the aid of permanent magnetism?

676. How can magnetism be produced by means of electricity?

677. Can we shield a magnet from the influence of the earth's magnetism? and if so, state how.

678. How can magnets be demagnetised?

679. What is meant by diamagnetism? and state some of the discoveries of Faraday as regards the effect of magnetism on metals, light, glass, &c.

680. Describe the principal means of producing or exciting electricity, and give an example illustrative of the production of electricity by each means; and state whether there is any difference between the electricity so produced.

681. What are the principal laws of attraction and repulsion of small electrical bodies, free to move, and brought within the influence of each other, as regards attraction or repulsion, the force with which this takes place, and the effect of altering the distances between the bodies, or of altering the quantity of charge in each?

682. Describe what you consider is meant by the terms *density of electricity*, *tension* or *potential*, *electro-motive force*, *quantity of electricity*, *strength* or *intensity of current*, *electro-static capacity*, and *specific inductive capacity*.

683. What would be the distribution of a given quantity of electricity —say represented by 100—in two Leyden jars or plates, the interior and exterior coatings of which are respectively connected together, supposing one jar or plate, A, to have double the surface of coating, but glass of only half the thickness, of the other jar or plate, B?

684. Describe what is generally termed "the charging of a conductor by induction."

685. Describe a gold-leaf electroscope and pair of condensing plates: explain the use of them, and explain the action.

686. Describe a line galvanometer, a Daniell's battery, and an electro-magnet.

687. What is the relation that exists between electro-motive force, resistance, and "strength" or "intensity" of current, known as Ohm's law? and give four examples.

688. Suppose we have two batteries of 10 cells, of equal electro-motive force, each cell having 1 unit resistance, how should we connect them up —in series or parallel—to obtain the maximum strength of current— firstly, with a line of 100 units resistance; secondly, with a line of 5 units resistance?

689. Illustrate geometrically, and to scale, the distribution of the tensions in a voltaic circuit, where the circuit consists of a battery of 5 cells, the first of which has 10 units resistance, and all the others 5 units each, the electro-motive force of the first cell being 10 units of

electro-motive force, and that of each of the others 15 units, the resistance of the line being 50 units, the zinc plate of the first cell of the battery being connected to earth, the copper plate of the last cell to line, and the distant end of the line to earth. Scale, 10 units resistance to the inch; 5 units electro-motive force to the inch.

690. Could we charge a conductor, and discharge it, and perform all the ordinary electrical experiments in a closed room of perfect conducting matter, if the room were insulated from the earth? and would the room be externally electrified by any of the experiments carried on within?

691. If the rubber of an electrical machine be insulated from the earth, but connected only to the interior of a Leyden jar, and the prime conductor connected to the interior of another exactly similar and equal jar, the exterior coatings of the jars being connected together, can any charging of the jars take place? and if so, what is the maximum extent, in comparison with the charge, that could be obtained in a single jar charged in the ordinary way from the same machine?

692. You are required to arrange a tangent compass and a voltameter (where chemical decomposition measures the strength of the current) in the same circuit, and to state the relation which subsists between the deflexions of the compass needle and the quantities of gas generated when currents of different strengths are sent through the circuit.

693. You are required to construct a voltaic cell, to name the metals and liquids you employ, describe their mode of construction, and to state the chemical actions which occur in your cell.

694. State all that you know regarding the relation subsisting between the strength of a current which produces an iron electro-magnet and the strength of the magnet which it produces.

695. Give a description of some one form of the electric telegraph.

696. Describe some one form of a magneto-electric machine by which currents are produced without chemical action.

697. Some days ago, on bringing my watch near a powerful magnet, it suddenly stopped. I wish to ascertain whether I have permanently magnetised the works: how am I to proceed?

698. I want to determine whether the magnetic force of the earth diminishes sensibly as I ascend in a balloon: how am I to proceed?

699. Describe clearly and fully what you mean by magnetic induction, and explain it by reference to the theory of magnetic fluids.

700. You are required to construct an electro-magnet: how would you proceed?

701. Is the attraction of a magnet for soft iron a true measure of its strength? If not, how would you propose to measure the strength of a magnet?

702. You are required to construct and suspend a coil of copper wire so that when a current flows through the coil it shall behave as a magnet: how will you do it?

703. When a voltaic current flows, heat is generated in the battery: what is the origin of this heat?

704. When a voltaic current is sent through a thin platinum wire, the wire is heated: state what you know regarding the relationship of the heat thus developed outside the battery to the heat developed at the same time within it.

705. A point is placed on the prime conductor of an electric machine:

on placing the hand above the point a wind is found to issue from it when the machine is worked: what is the origin of this wind? Devise an apparatus in which this wind may be caused to produce rotation.

706. Describe fully some one form of the electric machine, and explain how the prime conductor is charged.

707. You have access to the insulated silk rubber of a plate-glass machine, but not to its prime conductor, and you are required to charge a Leyden jar with *positive* electricity from the rubber: how will you proceed?

708. You are required to fire a mine by the spark of a Leyden jar: what precautions will you take to render the ignition of the powder certain? State the grounds of your precautions?

709. In the Alps a hissing sound is frequently heard issuing from the points of rocks, and from the ends of the long sticks which are carried by travellers: what is the cause of this sound?

710. Describe a simple apparatus for the generation of induced currents.

711. You have access to the N. pole of a permanent magnet, and are required to magnetise a strip of steel which has the letters N. and S. already marked upon its ends: how will you magnetise it so that these letters shall indicate truly the poles of the strip of steel?

712. A sphere of hard steel of great coercive force, and a sphere of soft iron possessing no coercive force, are suspended successively above an electro-magnet; a series of currents, represented in strength by the Nos. 1, 2, 3, 4, 5, are sent round the magnet: will the attractions exerted on the two spheres vary in the same proportion? If not, state and explain the difference.

713. The strength of a current may be determined from its magnetic action, and from its chemical action. Explain both methods.

714. Give a clear sketch of the theory of magnetic fluids, including the hypothesis of coercive force.

715. A long coil of copper wire is placed with its axis N. and S.; a current of electricity is sent through the coil, the direction of which in the upper portion of the coil is from E. to W. Describe the action of this coil on a magnetic needle.

716. Give a brief sketch of Ampère's theory of molecular currents.

717. A flat coil of copper wire, wound from the centre to the circumference in the direction of the hands of a clock, is placed on a table, and its two ends are connected with a galvanometer, consisting of a single magnetic needle; the N. pole of a magnet is brought down on the coil. State and explain what occurs; state and explain also what occurs when the magnet is separated from the coil; state also how the needle is affected.

718. Describe and explain some one form of the electro-magnetic machines used for medical purposes.

719. You are required to determine the quality of the electricity excited by the friction of flannel and gutta-percha: how will you do it? In your answer you must not confine your attention to the gutta-percha alone.

720. Describe and explain the Leyden jar, including in the explanation a description of the experiment which led to its discovery.

721. A body positively electrified is placed before you; you are not allowed to touch this body, but still you are required to charge by

means of it your own body with negative electricity: how will you do it?

722. If you cannot answer the preceding question, state what you know regarding the phenomena of electrical induction.

723. State what you know regarding the phenomena of terrestrial electrical magnetism, explaining the terms "dip," "declination," "inclination," "horizontal," "intensity," and "total force."

724. Explain the phenomena of magnetic induction by reference to the theory of magnetic fluids.

725. Describe the positions taken up by a small magnetic needle or a small rod of iron when it is suspended from a fibre, and carried round a bar magnet. Deduce these positions from the forces acting on the rod. Apply your reasoning to the explanation of the magnetic curves.

726. Explain the phenomena of electric induction by reference to the theory of electric fluids.

727. Describe the discovery and give the explanation of the Leyden jar. Devise and describe some new form of the jar.

728. Describe to me one form of the electric machine. State how the prime conductor is charged, and give the reason why points are employed on the prime conductor.

729. Describe accurately the part played by the nitric acid in Grove's or Bunsen's battery. State also what occurs in the cell containing the zinc and dilute sulphuric acid.

730. A tangent compass and a chemical voltameter are placed in a circuit. State the relation of the deflections of the compass to the quantities of gas generated in the voltameter when a series of currents of different strength are sent in succession through the circuit.

731. State the law of Ohm, which expresses the relation of strength of current, electro-motive force, and resistance.

732. Give the formula which expresses the relation of heat, resistance, and strength of current. Describe some experiment which illustrates the effect ofresistance on the development of heat.

733. Describe some means of making and breaking contact in a voltaic circuit by a self-acting apparatus.

734. Given such an apparatus, and a coil of copper wire in which two insulated wires run side by side: you are required to connect the contact-breaker with the coil, and also to connect your person with it, so as to get a succession of shocks from currents of induced electricity. Give, if you can, a sketch of the arrangement.

735. What do you understand by magnetic polarity? Is the power of a magnet concentrated at its poles? if not, how is it distributed?

736. Describe the action of pointed lightning conductors on charged clouds. Explain the construction and motion of the so-called electric mill.

737. On what fact was the discovery of bodies into electrics and non-electrics founded? Prove by an experiment the error of this classification?

738. Describe the electrophorus, and give the theory of its action.

739. In order to produce the spark of the electrophorus a mechanical force is expended. Wherein does it consist? State the relationship subsisting between this force and the chemical process going on in the body during the exertion of the force.

740. Give some examples of the magnetic power of the electric current.

741. Describe an apparatus in which water may be decomposed by an electric current, and the constituent gases of the liquid collected separately. What are these gases, at what places are they disengaged, and what are their volumetric relations?

742. When the circuit of a voltaic battery is closed, heat is generated in every cell: what is the origin of this heat?

743. In what relationship does the heat developed by a current within a voltaic battery stand to that developed at the same time outside of the battery?

744. When iron filings are scattered round a magnet they arrange themselves in curved lines. Give a clear explanation of the production of these curves.

745. There are two theories of magnetism: the one, that of magnetic fluids; the other, that of molecular currents. Give a brief but clear statement of both themes.

746. You are required to arrange an experiment whereby the convulsions of a frog's limbs by the "return shock" shall be demonstrated.

747. An iron core is surrounded by a helix, through which an electric current passes. Assume a direction for the current, and show by a sketch the polarity excited in the bar. State what you understand by the directions of the current.

748. Whence have arisen the terms "electro-positive" and "electro-negative?"

749. What is meant by the term "polarisation," as applied to voltaic electricity? How does polarisation affect the current from a pair of metals immersed in a single liquid? What is the use of the two liquids in Grove's battery.

750. (*a.*) Why does either rubbed glass or rubbed sealing-wax attract a small metal ball hung by a fine wire from a gas-pipe, whereas the former repels a small fragment of rubbed glass hung by a dry silk fibre, while the latter attracts it? (*b.*) When a piece of paper jumps to a piece of rubbed sealing-wax, it is caught on the end of a thin dry glass rod before it reaches the sealing-wax, and is tested by a proper electroscope. With which kind of electricity is it found charged? (*c.*) An uninsulated can of water is allowed to flow out (by a hole or pipe) in a fine stream, breaking into drops and falling into a second can, perfectly insulated, at a great distance below: a stick of rubbed sealing-wax being held near the place where the stream breaks into drops, what is the electrical effect on the insulated can?

751. (*a*). A thin bar or needle of steel magnetised in the ordinary way is supported with perfect freedom to move horizontally round its middle point: what position does it take in this country? What follows if it is turned through any angle from this position, and then left to itself? (*b.*) Another similar bar is brought into various positions near it: describe the phenomena. (*c.*) A wire conveying a powerful electric current is brought into a position above it, and parallel to the direction in which it rests when undisturbed: what results?

752. Why does a galvanic battery of very large plates give a stronger and more constant current through a metal wire of moderate dimensions

than another battery of the same kind, and of the same number of plates, but smaller? If the comparison is made, with two batteries of moderate dimensions, but with several miles of very fine wire, why is it that the larger plates show no sensible advantage?

753. State Oersted's discovery in electro-magnetism. If in the neighbourhood of a long horizontal telegraph wire, running magnetic north and south, four magnetic needles be hung above it, below it, and level with it on its two sides, how will they act if an electric current is sent through the wire in either direction for a time, and then reversed, and kept flowing in the opposite direction—each needle being free only to turn horizontally? [The mutual magnetic action between the needles is supposed to be insensible.]

754. Explain fully any form of galvanometer and its object. Why would a galvanometer, with its needle free to be deflected without limit, be inconvenient for use in an ordinary telegraphic "needle" instrument?

755. Explain what is meant by lines of magnetic or electro-magnetic force. Describe in a general way the lines of force in the neighbourhood of (*a*) an electrified conducting globe not sensibly influenced by any other electrified bodies; (*b*) a thin steel bar magnet; (*c*) a circular ring, through which an electric current is maintained; and illustrate by diagram in each case.

756. If a bar of copper be held at right angles to two parallel copper bars, and pressing on them, in what position relatively to the direction of the dipping needle must the parallel bars be held, so that when they are connected with the electrodes of a galvanometer, and when the first bar is moved along them, the current observed may be a maximum with the given velocity of the motion?

757. A magnetised bar is hung by a fine thread, or otherwise supported, so as to have perfect freedom to turn horizontally about its centre, and a large solid block of copper is fixed very near it, above or below; when deflected and left to vibrate, it is found to come to rest much sooner than when the copper block is removed. What is the nature of the ultimate dynamical effect or energy generated as the equivalent to the energy of vibration lost? If a ball of copper is turned very rapidly between the poles of a powerful magnet, it is found to become heated; by what intermediate agency is this effect produced?

758. When a piece of common commercial zinc is dropped into water acidulated with sulphuric acid, what takes place? Explain the chemical affinity and substitution which cause the phenomena. If a plate of amalgamated zinc or of perfectly pure zinc, with a fragment of copper or platinum attached to it, be used similarly, what is observed? Explain in a general way the course of the electric currents developed in this second case.

759. Why is it that if an iron ship be coppered below water, every part of the iron moistened by the sea is rapidly eaten away? Show that no vitreous or other paint or varnish applied in any way to either the copper or the iron surface can protect more of the iron surface than it covers, unless it prevents altogether, or nearly so, the access of sea-water to the copper, or insulates the copper from metallic connection with the iron.

760. Show how the hypothesis of two electric fluids is applied to explain the electrification of an insulated conductor by influence.

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