THE MUNICIPAL AND SANITARY ENGINEER'S HANDBOOK

H. PERCY BOULNOIS, C.E.

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BY

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PREFACE.

IN carrying out the many duties devolving upon a Borough Surveyor, it has so often been my wish to turn to a practical book of reference upon the many subjects connected with these duties, that I have written the following pages; and I trust that they will form a useful Handbook.

H. PERCY BOULNOIS.

PORTSMOUTH,
May, 1883.

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MUNICIPAL

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CHAPTER I.

THE TOWN SURVEYOR.

THE office of town surveyor was first legalised by the Towns Improvement Clauses Act 1847 (10 & 11 Vic. c. 34, s. 7),* although for some considerable period prior to this date similar appointments had been made in several of the more important English towns, notably in the case of Liverpool. In the following year the legal office of surveyor was confirmed by the Public Health Act 1848 (11 & 12 Vic. c. 63, *s.* 37), and it is now law under the Public Health Act 1875 (38 & 39 Vic. c. 55): that comprehensive statute, under which all Sanitary Acts are now included, and which Act will be frequently alluded to in the course of this book.

The clause which specially refers to the appointment of the surveyor is as follows :—

"Every urban authority shall from time to time appoint fit and proper persons to be medical officer of health, surveyor, inspector of nuisances, clerk, and treasurer: Provided that if any such authority is empowered by any other Act in force

* The section is as follows :—"The Commissioners shall appoint, subject to the prescribed approval, or where no approval is prescribed, subject to approval by one of Her Majesty's principal Secretaries of State, a person duly qualified to act as a local surveyor of the paving, drainage, and other works authorized under the provisions of this and the special Act . . . . . and the Commissioners with the like approval may remove any such surveyor."

within their district to appoint any such officer, this enactment shall be deemed to be satisfied by the employment under this Act of the officer so appointed, with such additional remuneration as they think fit, and no second appointment shall be made under this Act. Every urban authority shall also appoint or employ such assistants, collectors, and other officers and servants as may be necessary and proper for the efficient execution of this Act, and may make regulations with respect to the duties and conduct of the officers and servants so appointed or employed . . . " (38 & 39 Vic. c. 55, s. 189), and these officers (except the medical officer of health and the inspector of nuisances, when any portion of their salary is paid out of moneys voted by Parliament *to the powers of the Local Government Board*), may be removed by the urban authority at their pleasure, which was not the case when the appointment was first made in 1847.

Here it is necessary to state that for sanitary purposes England and Wales are divided into two divisions—viz. urban sanitary districts and rural sanitary districts, the former of these divisions being further subdivided into boroughs, where the urban sanitary authority is the mayor, aldermen, and burgesses acting by the council, and districts, which are under the authority of improvement commissioners or local boards; the rural sanitary districts are the areas of unions not included in urban districts, and they are under the authority of the guardians of the union.

It is my intention to deal more particularly with the duties of a surveyor acting under an urban authority, but the following section of the Public Health Act 1875 relates apparently to the appointment of a surveyor to a rural authority, although no mention is made in this or any other clause of the Act directly of such an officer by name, except that amongst the definitions of the Public Health Act the following appears :—

"'Surveyor' includes any person appointed by a rural

authority to perform any of the duties of surveyor under this Act" (38 & 39 Vic. c. 55, s. 4).

The clause I have above referred to is as follows:—

"Every rural authority shall from time to time appoint fit and proper persons to be medical officer or officers of health and inspector or inspectors of nuisances; they shall also appoint such assistants and other officers and servants as may be necessary and proper for the efficient execution of this Act . . . " (38 & 39 Vic. c. 55, s. 190).

The following clauses apply to officers of rural as well as urban authorities:—

"The same person may be both surveyor and inspector of nuisances . . . " (38 & 39 Vic. c. 55, s. 192).

"Officers or servants appointed or employed under this Act by the local authority shall not in any wise be concerned or interested in any bargain or contract made with such authority for any of the purposes of this Act . . . " (38 & 39 Vic. c. 55, s. 193).

"Before any officer or servant of a local authority enters on any office or employment under this Act by reason whereof he will or may be entrusted with the custody or control of money, the local authority by whom he is appointed shall take from him sufficient security for the faithful execution of such office or employment and for duly accounting for all moneys which may be entrusted to him by reason thereof" (38 & 39 Vic. c. 55, s. 194).

In addition to these clauses there are several regulating the receipt of money by officers, but these should not affect the town surveyor. Although in many places he has the onerous duty of paying workmen, certifying tradesmen's accounts, and other financial transactions, he ought under no circumstances to have anything to do with the receipt of money. Unfortunately, in some of the smaller towns the surveyor is also employed as rate collector; but as this is evidently a very improper proceeding, I shall not further allude to it in any manner.

It will be observed that in the foregoing clauses of the Public Health Act the word "surveyor" is always used, and thus this is the legal title of those holding such appointments. It is obvious, however, that, although this title may have well suited the office up to the year 1847, when it was made the legal title, the prodigious growth of municipal work during the last 35 years has made it necessary that some change should be made, and the title altered to that of "engineer," or some other similar suitable name. At the present time several different meanings and occupations are attached to the word "surveyor," as the following list will show:—"land surveyor," "district surveyor," "county surveyor," "road surveyor," "surveyor of taxes," "surveyor of customs," "quantity surveyor," "fire insurance surveyor," "Lloyd's surveyor," and a still more curious instance where an urban authority is itself dubbed "surveyor of highways" by the 144th section of the Public Health Act 1875; and the title of town surveyor as now applied cannot but lead to confusion and to perfectly erroneous impressions as to his work and duties.

Dr. Ackland, in a paper read before the Association of Municipal and Sanitary Engineers and Surveyors, at a district meeting held at Oxford, makes the following remarks on this point:—"In the Public Health Act 1875 (the summary of all health enactments) the name of 'engineer' does not once occur in the 343 clauses. He is still the old 'surveyor' we all remember, the plodding, energetic man of highways and byeways . . . but then the surveyor of the present day may be called on to advise on anything, from the form and cost of an earthen syphon trap to the calculation of work to be done by engines which are to supply half a million of persons with water; to be responsible for the construction of sanitary mechanisms, from a housemaid's sink to an intermittent downward filtration farm."

There can be but little doubt that it is absolutely necessary for the town surveyor of the present day to be a competent

civil engineer of great knowledge and varied experience, for he may at any moment be called upon to advise his corporation upon any of the following subjects, or to act in any one of the following capacities, in addition to the multifarious ordinary duties legally devolving upon him as surveyor under the Sanitary Acts :—

(1.) As engineer for sewerage and sewage works.

(2.) As engineer for water and gas works.

(3.) As engineer for canals, docks, harbour improvements, and river navigation, or for the protection of coasts against the encroachments of the sea, and the prevention of floods by rivers.

(4.) As engineer for the construction and maintenance of roads and bridges.

(5.) As engineer for the construction and maintenance of lines of tramways.

(6.) As architect for the construction of lunatic asylums, municipal offices, hospitals, abattoirs, mortuaries, baths and wash-houses, cemetery chapels, stables, police stations, and other similar works.

(7.) As landscape gardener for the laying out of public recreation grounds, parks, and cemeteries.

(8.) As quantity surveyor to make estimates of all works, and often (very improperly) to furnish bills of quantities to intending contractors.

(9.) As surveyor and valuer to advise his employers on the values, &c., of corporate or other property.

(10.) As land surveyor to make surveys of any size that may be required.

(11.) As accountant to examine and rectify the workmen's wages sheets, and all tradesmen's accounts for work performed or goods supplied.

The foregoing list is no exaggeration of the onerous duties of the town surveyor, and it seems to be a grievous mistake that this officer, whose importance in all practical sanitary

work cannot be over-stated (as without him no useful municipal work could go on) has been left unprotected by the Public Health Act of 1875.

In that Act both the medical officer of health and the inspector of nuisances have received Government protection, whereas the surveyor, the very officer of all others who necessarily is more likely to come into collision and to be unpopular with his employers in the faithful discharge of his duties, has been afforded no protection whatever, but has been left to the tender mercies of an annually changing body of municipal governors, "to be removable at their pleasure" (38 & 39 Vic., c. 55, s. 189).

On this highly important point I cannot do better than quote several passages from Mr. Lewis Angell's interesting address to the Association of Municipal and Sanitary Engineers and Surveyors on the occasion of their inauguration in the year 1873:*

"The 'town surveyor,' according to his opportunities, has done the country good service, but, surrounded as we have been with obstructions and difficulties, cramped and restricted by popular prejudices and private interest, subject to clamour and attack, without protection and without appeal, it is indeed surprising that we have accomplished so much. Had such officers been from the first judiciously selected, adequately remunerated, properly supported, and duly protected, our influence upon sanitary progress would have been more conspicuous and our office better appreciated.

"As engineers we do not pretend to a knowledge of medical science, but it is equally within the knowledge of the average sanitary engineer as of a medical officer of health that pure air, pure water, properly constructed houses, and an unpolluted soil are the cardinal conditions of health. These are mere sanitary axioms. The means by which such conditions are

* Vide 'Minutes of Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. i. p. 18.

attained are drainage, ventilation, water-supply, and other matters entirely within the functions of the engineer. It is the function of the sanitary engineer to prevent that which the medical officer of health is called upon to detect. . . .

"In many cases the unprotected surveyor may be required to report to a protected medical officer the negligence of his own employers. No local surveyor or engineer can be expected to give cordial and active assistance in compulsory sanitary work when he is conscious that his action would be opposed to the views or the interests of his employers, the public upon whom he is dependent. The existence of such a distinction between the medical officer and surveyor under the same board will produce a want of harmony in interest, and must lead to a divergence of action between the two departments. . . ."

And speaking of the multifarious duties of the town surveyor, Mr. Angell says: "Any one section of his duties would, under commercial circumstances, command fair pay according to its importance; but where cumulative duties are included in the same office, they demand constant attention, special knowledge, professional experience, and administrative ability; to which is added the anxiety which the responsibilities of public office always involve. Such a position in a commercial concern would receive high remuneration in proportion to the extent of the undertaking, but unfortunately, our work does not pay a dividend: it is all expenditure from which the town derives no return excepting in health and comfort, matters which are neither fairly assessed, nor duly appreciated; consequently, the municipal engineer is paid less for his professional knowledge than the contractor's agent whose work he directs."

Speaking further on the subject of Government protection, Mr. Angell says: "Surveyors appointed under the Towns Improvement Clauses Act were protected during the existence of the General Board of Health. Sir C. Adderley's

Public Health and Local Government Bill of 1872 proposed similar protection. Officers employed under the Poor Laws are fully protected as to position, emoluments, and superannuation. The administration of the Poor Laws and the Public Health Acts is now united in one department under the newly established Local Government Board: it is therefore in my opinion equally due to Local Board officers, that they also should be recognised and protected. Without such protection, sanitary legislation cannot, in the words of the Royal Sanitary Commission, be 'active and effective,' because local officers are too dependent on their immediate employers to be thoroughly efficient.

"In advocating protection let me not be misunderstood. I do not mean centralisation or the removal of that proper control which every local authority should maintain over its own officers. I would maintain intact the great principle of local government, which has been the bulwark of our social and political freedom. But local government may degenerate, and in small towns deteriorate into littleness: local affairs are too frequently avoided by those who are most fitted by intelligence and social standing to take part therein. I would simply control in the most constitutional manner the short-comings or excesses of local government as is already done in various other departments. I would require that local officers should be properly qualified and adequately remunerated; that in the honest discharge of their duties and during good behaviour they should be protected from the effects of ignorance, narrow prejudices, and interested clamour, and that they should have an appeal to a disinterested and judicial body, superior to local feeling. The demand is reasonable—I ask no more. . . . ."

To these admirable remarks by Mr. Angell on the present position of the town surveyor I can add but little.

I believe that the sole reason which is given why Government protection is not granted to the surveyor is the argument

used by those in authority, that if a surveyor disagrees with the corporation he serves, it is considered better that he should resign his appointment rather than be protected by the Local Government Board or other central office; but if this argument is sound, why does it not also apply in a similar manner to the medical officer of health or the inspector of nuisances? The real fact no doubt is, that in framing the Public Health Act of 1875, medical men were consulted and not engineers, and this is very apparent in many of the clauses, which will be fully considered in their proper places in this book.

The time will no doubt come when the necessity for some change in the position of the town surveyor will be apparent, and adequate protection will be afforded him; in the meantime let him strive, by attention to work, and by daily advancement in scientific knowledge, and in courtesy to those with whom he is associated, to make the position and power of the town surveyor felt and honoured as it should be throughout the kingdom.

CHAPTER II.

THE APPOINTMENT OF SURVEYOR.

WHENEVER a vacancy occurs in the office of surveyor to a town, or upon a sanitary authority determining to make such an appointment, the question is usually relegated to a committee or sub-committee to report upon the subject, to fix the amount of salary proposed to be given, and frame the duties of the office.

The following report is one that has lately emanated from an important English borough, and is given in full as a specimen of such reports, and as a guide on which a report could be framed; altered, of course, to such requirements as may be locally necessary :—

Report of the Special Sub-Committee as to the Surveyor.

(1.) Your sub-committee report that they have, in compliance with the resolution of the day of , carefully considered the steps to be taken with reference to the vacancy caused by Mr. ———'s resignation, and they have come to the unanimous conclusion that it is desirable that the office of surveyor should be continued.

(2.) Your sub-committee have also considered the duties which were assigned to the office of Mr. ———'s appointment, and they beg now to submit them, revised in accordance with the present circumstances of the department, and with the recommendations contained in this report.

(3.) Your sub-committee further recommend that the salary of the surveyor be fixed at £ . . per annum, and that advertisements be issued for candidates.

Duties of the Surveyor.

(1.) To have charge of the repairs of all highways, and to perform all duties devolving on the council as surveyors of highways.

(2.) To report from time to time to the committee superintending the same, the state of the several highways and lines of tramway, and as to the materials wanted or works necessary.

(3.) To prepare all plans, specifications, or instructions necessary in relation thereto, and as to the materials to be used therein, and to see that all works are completed according to contracts entered into.

(4.) To engage and dismiss under sanction of the committee all workmen employed at daily and weekly wages.*

(5.) To certify all accounts for work done, materials supplied, and wages due.

(6.) To have charge of all materials and implements.

(7.) To purchase or contract for, or hire all horses, carts, tumbrils, stones, flags, gravel, draining pipes, and proper implements and materials, and all other matters and things, at such prices and in such manner as the committee shall judge reasonable and expedient, and to sell or otherwise dispose of the same as he may be directed.

(8.) To have the entire charge and superintendence of the breaking up and repairing of all streets, for the purpose of laying or replacing gas and water pipes.

(9.) To inspect and report, in conjunction with the medical officer of health, upon slaughter-houses preliminary to licences being granted, and to make the plans and superintend the construction of any slaughter-houses which the council may hereafter erect.

(10.) To take all levels and surveys which may be necessary for the purpose of deciding on the best mode of draining the several districts, or any part thereof, or for the purpose of

* This seems to be an undue interference with the control which a surveyor should always have over his men.

fixing the levels and inclinations of any streets or roads, or in anywise relating thereto.

(11.) To carry out the scheme now in course of construction for the interception of the sewage of the borough, and any future scheme, for its precipitation, filtration, deodorization, or any other process which the council may adopt, either within or without the borough.

(12.) To superintend the construction and completion of all tramway lines and sidings which may be required.

(13.) To prepare, from time to time, schemes for the drainage of the several districts or any part thereof.

(14.) To prepare all such plans, sections, and specifications as may be necessary for the due execution of any flagging, paving, sewering, or other works required to be done, or for entering into any contracts in relation thereto, and to see that all works are executed in accordance therewith.

(15.) To measure up and duly certify the execution of all works, and apportion the cost to the parties chargeable therewith.

(16.) To see that all house drains, which may from time to time be carried into any public sewer, are made and connected in accordance with the regulations.

(17.) To give to the several contractors performing any works, orders for the same in writing only, keeping duplicates thereof, duly entered in a book to be kept by him for that purpose.

(18.) To prepare all plans, drawings, and estimates required, and to superintend the execution of all improvements.

(19.) To see that no encroachments be made on any highway or public place.

(20.) To advise on, and execute, all engineering works, and prepare all such plans, specifications, and estimates of, and take out quantities for, such sewers, buildings, bridges, and works as may be required, and to superintend the erection and execution thereof.

(21.) To have in his charge, and be responsible for, the proper management of all buildings and properties belonging to the corporation, or for the repair and maintenance of which the corporation is liable, except otherwise directed by the council.

(22.) To examine and report upon all plans and elevations of buildings proposed to be erected or altered upon land sold or leased by the corporation.

(23.) To inspect and report on plans of new streets to be laid out, of houses to be built, and of buildings to be erected or altered.

(24.) To see that all streets are properly named, and that the name plates are kept in good order.

(25.) To act as building surveyor in all matters relating to the execution of the Sanitary and Local Acts, and to examine and certify new houses as fit for habitation.

(26.) To examine all buildings in a condition dangerous to the public, to report thereon, and to take such steps as may be necessary to prevent accidents arising therefrom.

(27.) To prepare all plans and sections for deposit, pursuant to Standing Orders, with respect to all street improvements, tramways, gasworks, waterworks, or other works, unless otherwise ordered by the council, and to prepare all other surveys, plans, and sections required.

(28.) To attend the meetings of the several committees when required.

(29.) To prepare all returns relating to his office that may be required by the Government.

(30.) To attend in London or elsewhere when required, without extra charge, excepting only his travelling and hotel expenses.

(31.) To keep accurate permanent records and plans relating to all properties purchased, leased, or sold, or in possession.

(32.) To devote the whole of his time to the duties of his office, and not to be engaged in any other office, business, or employment whatever.

(33.) To report from time to time all and every matter connected with any branch of his office which, in his opinion, may require the attention of any committee, and take their instructions thereon."

Clauses 18 and 20 in the above list of duties are very comprehensive, and as a rule a town surveyor's duties may be summed up in a very few words—"to do anything that he is requested." It is, however, better that some definite instructions should be laid down, and those which I have given may be taken as a fair specimen of what such duties may be.

Unlike the medical officer of health, who by Act of Parliament is required to hold a diploma of competency,* it is open to anyone to apply for and obtain the appointment of a town surveyor. This is no doubt unfortunate, as some test of merit is desirable, and of late years the necessity of some examination as to competency has been much discussed.

In order to meet this requirement, the Sanitary Institute of Great Britain has instituted examinations and granted certificates of competency for both town surveyors and inspectors of nuisances. The following particulars of these examinations, and the reasons given for their necessity, may be of interest, and are given in full.†

Examination of Local Surveyors and Inspectors of Nuisances.

The great and increasing importance of the duties devolving upon local surveyors and inspectors of nuisances in connection with the various statutes relating to Public Health and the Sale of Food and Drugs Act, has led the council of the Institute to establish voluntary examinations for local surveyors and inspectors of nuisances, and for persons desirous of becoming such, or of obtaining the certificate of the Institute.

* "A person shall not be appointed Medical Officer of Health under this Act unless he is a legally qualified medical practitioner" (38 & 39 Vic. c. 55, sec. 191).

† *Vide* 'Calendar of the Sanitary Institution of Great Britain for the year 1880.'

Each examination occupies a portion of two days. On the first day the examination of surveyors is continued for four hours, viz. from 2 to 4 and 6 to 8 P.M. and consists of written papers only. Inspectors of nuisances have two hours' written examination on the first day, viz. from 4 to 6 P.M. On the second day the examination for both classes commences at 11 A.M., and is *viva voce*, with one or more questions to be answered in writing if deemed necessary. A certificate of competence signed by the examiners is granted to successful candidates.

As rural sanitary authorities are able under the Public Health Act 1875 to obtain almost all the powers of urban sanitary authorities, it is not considered advisable to make any distinction in the examination of the two classes of surveyors.

As one person may, under the Public Health Act 1875, be both local surveyor and inspector of nuisances, candidates wishing to obtain the double qualification may enter for both examinations on the same occasion.

Candidates are required to furnish to the council of the Institute satisfactory testimonials as to personal character, and to give two weeks' notice to the secretary previous to presenting themselves for examination, stating whether they wish to be examined as surveyors or inspectors of nuisances, or as both.

The fee for the examination must be paid to the secretary, by post-office order or otherwise, at least six days before the the day of examination. On receipt of the fee a ticket will be forwarded admitting to the examination.

The fees payable for the examination are as follows :—

For Surveyors	£5 5 0
For Inspectors of Nuisances	2 2 0

Unsuccessful candidates are allowed to present themselves a second time for one fee.

Syllabus of Subjects for Examination for Local Surveyors.

"*Laws and Bye-Laws.*—A thorough knowledge of the Acts affecting sanitary authorities, so far as they relate to the duties of local surveyors; also of the model bye-laws issued by the Local Government Board.

Sewerage and Drainage.—The sanitary principles which should be observed in the preparation of schemes for, and the construction of sewerage works; the ventilating and flushing of sewers and drains; the internal drainage and other sanitary arrangements of houses, privies, water-closets, dry-closets, and the removal of refuse; the sanitary details of builders' and plumbers' work.

Water Supply of Towns and Houses.—The sanitary principles which should be observed in the preparation of schemes for, and the construction of water-works; the various ways in which water is likely to become polluted and the best means of ensuring its purity.

Regulations of Cellar Dwellings and Lodging Houses.—General principles of ventilation; the amount of air and space necessary for men and animals; the means of supplying air, and of ensuring its purity.

Highways and Streets.—The sanitary principles which should be observed in the construction and cleansing of streets and roads.

EXAMINATION PAPERS, NOVEMBER 6, 1879.

Questions for Surveyors, November 6, 1879, 2 *to* 4 *o'clock.*

1. Define street; state the law applicable to every description of street in an urban sanitary authority district, and the rights and obligations and duties of sanitary authorities, owners and occupiers therein.

2. What are the relative advantages of circular and egg-shaped sewers; in what case are they respectively preferred?

3. Give a specification of a water-tight sewer. Describe

and give a sketch of the form of man-hole which you consider best adapted for ordinary town sewers, and state the rule which you adopt for determining the amount of ventilation to be afforded in a main street sewer.

4. In what way does the size and shape of the sewer affect the velocity of sewage flowing through it? If a nine-inch pipe sewer, laid at an inclination of 1 in 200, gives a velocity of 3 feet per second, what velocity will it give when laid at an inclination of 1 in 800, the pipe running full in each case? Will this velocity suffice to keep it clear from deposits? Describe the various modes which may be resorted to for flushing sewers.

5. Give a description of the process termed intermittent downward filtration. State what area of land you would require, with a gravelly soil, for applying this method of purifying sewage to a town with a population of 1000 inhabitants, and state the arrangements you would adopt for dealing with the rain-water falling on the roofs, yards, and streets.

November 6, 1879, 6 *to* 8 *o'clock.*

1. In reporting upon the source of water supply for a town, what are the points to which you would direct your attention?

2. Give a sketch of a D trap, an S trap, a P trap, and a pan water closet (plan of a dwelling-house annexed).

3. Criticise the arrangements of this residence as to position of rooms, walls, doors, fire places, windows, &c., from a sanitary point of view.

4. Describe the drainage arrangements shown on the plan. Say whether they are satisfactory; if not, in what way are they faulty?

5. Sketch on the plan any other system of drains which you would think preferable.

6. Describe in detail the arrangements necessary for the

water supply of the residence, a bath being fixed in the room over the serving room, a W.C. on the first floor over that on the ground floor, and a housemaid's sink near.

It is, of course, open to consideration whether the Sanitary Institute of Great Britain is the proper authority to hold these examinations or not; but there is no doubt that some such examination is necessary, and would be welcomed by nearly all town surveyors in order to more firmly secure their positions; and the Sanitary Institute is entitled to every credit for having taken the initiative step in the matter.

Under the present system of appointment to the office of town surveyor those seeking that office must be prepared to work hard to obtain it, and to give up some considerable time to its acquisition. Tact, patience, and perseverance are indispensable qualities when seeking such appointments, and the following suggestions on this matter may be of use.

The appointment usually rests finally with the whole body of the town council or corporation, even if a sub-committee or committee has been appointed in the first case to make some selection of candidates. The candidates thus selected by the committee are usually requested to appear before the whole body of the town council, who then make the appointment from amongst them.

The first thing a candidate should do when he hears of a vacancy occurring in the office of a town surveyor, or sees an advertisement requiring a surveyor's services, is to obtain fresh testimonials from those persons of position and influence for whom he has worked or who know him professionally. These testimonials, with any very good old ones (but not too many of either), should be sent by post to the town clerk or person mentioned in the advertisement, with a formal, carefully-worded application for the appointment.

If canvassing is not prohibited, a list of the members of the town council, with their addresses, should then be procured,

to whom printed copies of the application and testimonials should be sent, accompanied by an autograph letter asking that the application and testimonials should be read.

This should be followed up (if possible, immediately), by a journey to the town and a personal visit to each member of the council or corporation, not necessarily for the purpose of soliciting a vote, but with a view to making the acquaintance of the members of the corporation and to identify the applicant with his testimonials; and in these visits great tact and patience are necessary. It is also of importance to seek and obtain all the outside influence that is possible, in order to bear upon the members of the corporation, by means of letters of introduction, and informal testimonials as to eligibility for the appointment, and personal character and position, &c.

Canvassing on behalf of oneself is extremely unpleasant and harrassing work; but wrong as the system may appear to be, it is not easy to see how, in municipal government, any other method can be adopted, and the visit of the candidate to each member gives the latter an opportunity of asking him questions and satisfying himself as to his qualifications, and thus he will not feel he is acting blindly when he gives his vote in favour of that candidate whom he thinks, after a personal interview, the most suitable for the appointment.

CHAPTER III.

THE SURVEYOR'S DUTIES.

IT will be observed on reference to the list of the duties of the surveyor, given in the preceding chapter, that the first on the list is as follows :—

"To have charge of the repairs of all highways, and to perform all duties devolving on the council as surveyors of highways."

The necessity for these duties are obvious when we turn to the Public Health Act 1875, and read the following sections :—*

"Every urban authority shall within their district, exclusively of any other person, execute the office of and be surveyor of highways, and have, exercise, and be subject to all the powers, authorities, duties, and liabilities of surveyors of highways under the law for the time being in force, save so far as such powers, authorities, or duties are or may be inconsistent with the provisions of this Act ; every urban authority shall also have, exercise, and be subject to all the powers, authorities, duties, and liabilities which by the Highway Act 1835, or any Act amending the same, are vested in and given to the inhabitants in vestry assembled of any parish within their district.

"All ministerial acts required by any Act of Parliament to be done by or to the surveyor of highways may be done by or to the surveyor of the urban authority, or by or to such other person as they may appoint" (38 & 39 Vic. c. 55, s. 144).

"All streets being or which at any time become highways

* For full particulars and explanations of the various Highway Acts see 'The Powers and Duties of Surveyors of Highways and of other Authorities with regard to the Management of the Public Highways,' by Alex. Glen, M.A., etc.

repairable by the inhabitants at large within any urban district, and the pavements, stones, and other materials thereof, and all buildings, implements, and other things provided for the purposes thereof, shall vest in and be under the control of the urban authority. The urban authority shall from time to time cause all such streets to be levelled, paved, metalled, flagged, channelled, altered, and repaired as occasion may require; they may from time to time cause the soil of any such street to be raised, lowered, or altered as they may think fit, and may place and may keep in repair fences and posts for the safety of foot-passengers. Any person who without the consent of the urban authority wilfully displaces, or takes up, or who injures the pavement, stones, material, fences, or posts of, or the trees in, any such street shall be liable to a penalty not exceeding five pounds, and to a further penalty not exceeding five shillings for every square foot of pavement, stones, or other materials so displaced, taken up, or injured; he shall also be liable, in the case of any injury to trees, to pay to the local authority such amount of compensation as the court may award" (38 & 39 Vic. c. 55, s. 149).

The duties thus devolving upon the town surveyor by reason of these sections and the orders of the council are very considerable. The following table gives a list of the principal subjects which will require his attention; all of which will be considered in due course in this book.

List of Duties devolving upon a Town Surveyor as "Surveyor of Highways."

(1.) The construction and maintenance of highways or streets, including—

(*a.*) Roads formed of broken stones or "metal," commonly called macadamised roadways;

(*b.*) Streets paved with granite cubes or setts;

(*c.*) Streets paved with wood;

(*d.*) Streets paved with asphalte.

(2.) The construction and maintenance of footwalks or footpaths, including the different materials of which these are formed.

(3.) The breaking of stone for road metal.

(4.) Steam rolling.

(5.) The necessary notices and specifications under the 150th Section of the Public Health Act 1875, for the purpose of compelling private streets to be properly sewered, levelled, paved, metalled, flagged, channelled, lighted, and made good.

(6.) The lighting, cleansing, and watering of streets.

(7.) The naming and numbering of streets.

(8.) The planting of trees along the sides of footwalks.

(9.) Obstructions caused by builders' rubbish or by hoardings and scaffold poles; and also by dangerous or defective cellar coverings.

(10.) The damage caused to footpaths by allowing water from private premises to flow over them, and the nuisance caused by defective rain-water gutters or shutes.

(11.) The damage caused to roadways by the laying or removal of gas and water mains and services, and the surveyor's powers and duties in connection therewith.

(12.) The importance, especially in old towns, of laying down improved building lines of frontage in the narrower or crooked streets.

(13.) The examination of all plans of proposed new streets or buildings.

(14.) The supervision of all new streets and buildings whilst their construction is in progress.

(15.) Dealing with all buildings in a condition dangerous to the public.

Each of the foregoing list of duties will be dealt with in separate chapters in addition to other matters which will be treated, but before closing this chapter a few words upon the subject of "meetings" may be of use.

It will be observed upon reference to the list which I have

given of the duties of the surveyor, that there is one which says, "To attend all meetings of the board, and committee meetings, except where his attendance has been previously dispensed with; to attend upon the chairman when so required."

The result of this order is that a very large percentage of the surveyor's time has to be devoted to attendances at long meetings of the Board or town council, and at the numerous committee and sub-committee meetings which are appointed under it.

This work is doubled where, as in some towns, the corporation and their committees sit in a dual capacity, viz. as the council proper, and the council as the urban sanitary authority; this generally involves two ordinary meetings of the whole body each month, and probably at least six committee meetings a week, leaving the surveyor but scanty time to look properly after his works.

With regard to these committee meetings it is necessary that each should have some distinguishing title descriptive of the class of work over which it has jurisdiction, and in selecting names for them the following list may be of some service:—Finance Committee, General Purposes Committee, Law and Parliamentary Committee, Surveyor's Committee, Land and Estates Committee, Rates and Taxes Committee, Streets Committee, Lighting and Cleansing Committee, Navigation of Port Committee, Public Grounds Committee, Sanitary Committee, Drainage and Sewerage Committee, Markets Committee, Properties for Sale Committee, Works Committee, Water Committee, Gas Committee, Watch Committee, Health Committee, Library Museum and Arts Committee, Baths Committee, Parks, Gardens, and Improvement Committee, Streets Improvement Committee, etc. etc.

The surveyor should always endeavour to be punctual in his attendance at the council meetings and those of the committees, as to be late is always looked upon with dis-

favour. His reports should as much as possible be in writing, so that there should be no misunderstanding as to what his advice is on any subject. To save trouble and expense it is well that all drawings of new schemes should be first submitted to a committee in pencil, as they are frequently much altered; this is very vexing if they have been neatly and highly finished. It must not be forgotten that the gentlemen who form municipal bodies give their time gratuitously, and everything should be done to save it as much as possible. It is an excellent plan and a great convenience, if a surveyor will have a series of named and numbered pigeon holes in his office corresponding to his committees, in which to place all papers, drawings, correspondence etc., which he intends to bring up to the next meeting of a committee; thus saving himself flurry at the last moment before the meeting, in endeavouring to find the papers he wants. With his varied duties, correspondence, interviews, meetings, inspections, investigations, reports, drawings, and calculations, the motto of a surveyor's office should be "method."

CHAPTER IV.

TRAFFIC.

BEFORE a surveyor can decide upon the best material with which the streets of his town shall be paved, it will be well to consider the question of the class of traffic they will have to bear.

It must be remembered that three distinct interests have to be considered in dealing with this question, viz. (1.) The rate-payers, upon whom the cost of construction and maintenance of streets falls. (2.) The owners and employers of horses and vehicles who principally use the streets; and (3.) The inhabitants of the adjoining premises, who would be annoyed if the material selected were unduly noisy or dirty. In addition to these considerations, much depends upon local circumstances; the class of trade upon which the welfare of a town is dependent must not be lost sight of. A pavement suitable for a busy, pushing manufacturing city may not be suitable for a quiet agricultural or cathedral town, or for a town which is used as a health resort. Again, the question of the most adaptable materials must be considered, and the climate and physical character of a town should enter largely also into this question.

To condense the requirements of a good roadway into as small a compass as possible, the following may be given as some of its principal requisites :—

(1.) It must not be extravagantly costly in its first construction.

(2.) It must be durable and require the least possible amount of repairs at the least cost.

(3.) It must be safe, firm and hard, with an even face and yet giving sufficient foothold to horses.

(4.) It must be as noiseless as possible.

(5.) It must be so constructed as to be quickly laid down and repaired when broken up for water, gas, drains, or other purposes.

(6.) It must be of strong foundation, so as to carry the heaviest weight without subsidence.

(7.) It must be of such a shape as will throw off all surface water at once.

(8.) It must be of such materials as will make a minimum of dust or mud.

(9.) It must be easily cleansed.

(10.) It must be non-absorbent of impurities or moisture of any kind.

(11.) It must give easy traction upon its surface.

(12.) It must not cause jolting to the traffic.

(13.) It must not injure horses' legs or hoofs.

Of the above requirements No. 1 affects the ratepayers alone; Nos. 3, 11, 12, 13, affect the traffic only, except that the occupiers of shops are indirectly affected by them; No 4 affects both traffic and occupiers, and No. 10 affects the occupiers principally. The remainder of the requirements affect all three interests.

With reference to the wearing effect of traffic upon the surface of the roadway, no standard has yet been arrived at by which this can be determined with accuracy. In France a great number of observations and experiments have been made from time to time by the engineers of the Ponts et Chaussées, but their practice has been to count the number of "collars" passing a given section of a roadway in a given time, irrespective of the weights, speeds, or number of wheels such collars may be drawing. Mr. Deacon, the former Borough Engineer of Liverpool, has, however, reduced traffic to a standard of tons per yard width of roadway per annum. This he

effected by having the traffic in any street carefully watched for a certain definite time, the number of vehicles, their character and approximate weight being noted as well as the number of horses by which they were drawn, and their number of wheels.

The effect of the traffic thus tabulated, arranged, and reduced to ton yards per annum, can be ascertained upon any roadway, and Mr. Deacon has given the results of his observations in a valuable paper on the subject of street carriage pavements which he read before the Institution of Civil Engineers.*

Sir John MacNeill has estimated that 80 per cent. of the total wear of a road is due to traffic, the remaining 20 per cent. being due to atmospheric causes. Of this 80 per cent. 60 per cent. he considers is due to the action of horses' hoofs where the traffic is fast, and 44·5 per cent. where the traffic is slow. General Morin estimates the wear of a road due to horses' feet to be two-thirds of all causes. There can be no doubt that the action of horses' feet, shod as they are with heavy iron shoes with long toe pieces and heels, must have a destructive effect upon the surface of a carriage-way, and this may be easily observed when watching the ruts formed by any continuous line of traffic in a roadway.

The following remarks from a report of the Society of Arts on this subject may here be of interest. "It may be "mentioned that as respects the horses' shoes, attention has "long been called to its defects by Sir Francis Head and "others, but Sir Joseph Whitworth now points out the achieve-"ment of a decided and important improvement, which will have "a large effect in road conservancy, as well as the reduction of "noise. The improvement consists in the fastening of a rim of "hardened steel, of about half-an-inch square, to the horses' "feet, and letting the frog grow to its natural size. One effect

* *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lviii.

" is to reduce by five-sixths the weight of the old shoe, or in " other words to reduce by five-sixths the weight of the iron " hammers constituted by the common horses' shoes, pounding " the road surface, and creating road dust and dirt, and dis- " tributing it about. The saving in this respect, as well as the " reduction of noise by the reduction of the weight of rim, and " also the saving of road wear, would warrant the imposition of " the stimulus of a tax, or a toll upon heavy horses' shoes to " hasten this removal." *

Up to the present date, however (1883), no general change has been effected in the manner of shoeing horses, notwithstanding these admirable remarks of Sir Joseph Whitworth upon the subject.

With reference to the question of traction upon roads General Morin, in his ' Expériences sur le Tirage des Voitures,' states that the resistance to the rolling of vehicles upon solid metalled roads and pavements is proportional to the weight and inversely proportional to the diameter of the wheels. On solid roads he states that the resistance is nearly independent of the width of the tires when they exceed 3 or 4 inches, but on a compressible face it decreases in proportion to the width of the tire; the resistance further increases with the velocity on hard roads, but does not do so when they are soft.

The following table is almost universally now adopted as showing the traction upon level roads formed of different materials, asphalte being taken as the standard of excellence in this respect.

Asphalted roadway	1·0
Paved roadway, dry and in good order	1·5 to 2·0
,, ,, in fair order	2·0 ,, 2·5
,, ,, but covered with mud	2·0 ,, 2·7
Macadamised roadway, dry and in good order ..	2·5 ,, 3·0
,, ,, in a wet state	3·3
,, ,, in fair order	4·5
,, ,, but covered with mud ..	5·5
,, ,, with the stones loose ..	5·0 ,, 8·2

* *Vide* Report of the Society of Arts on the application of Science and Art to street paving and street cleansing of the metropolis, 1875.

There are four forces constantly at work tending to destroy the momentum of vehicles passing along a roadway: they are gravity, collision, friction, and the resistance of the air.

The first of these is lessened by easy gradients in a road, the second can be overcome to a great extent by evenness of surface, the third by hardness, and the fourth, as well as all the others, by giving sufficient foothold to the animal drawing the vehicle.

Another excellent table* prepared from experiments made by Mr. Amos on different descriptions of pavement in the City of London may be useful, and is here given :—

Road Material.	Speed in Miles per hour.	Draught in lbs.	Fraction of Load.	Tractive Force in Decimals of the Load.
Gravelly Macadam in a side street	6·945	126·6	$\frac{1}{45·3}$	·0219
	3·45	114·322	$\frac{1}{50·3}$	·0197
Granite pitching by side of tramway	5·15	70·963	$\frac{1}{81·1}$	·0123
	3·196	41·932	$\frac{1}{137·3}$	·0072
	2·557	47·572	$\frac{1}{121}$	·0082
Granite Macadam "freshly laid"	4·239	262·886	$\frac{1}{21·9}$	·0456
	2·775	242·726	$\frac{1}{23·7}$	·0421
Asphalte Pavement ..	5·025	91·525	$\frac{1}{64·9}$	·0158
	3·56	69·753	$\frac{1}{82·5}$	·0121
	5·687	84·268	$\frac{1}{68·3}$	·0111
Wood Pavement ..	3·932	118·163	$\frac{1}{48·7}$	·0205
	3·278	102·412	$\frac{1}{56·2}$	·0177
	3·827	100·066	$\frac{1}{57·5}$	·0173
Macadam road, very good on Victoria Embankment	6·65	109·06	$\frac{1}{52·7}$	·0181

* Ibid.

The following table from Law's 'Rudimentary Treatise on Civil Engineering' shows the force required to move a load of a ton weight on different descriptions of roadway, the limiting angle of resistance, and the greatest inclination which should be given to the road being also stated.

Description of the Road.	Force in lbs. required to move a ton.	Limiting angle of resistance.	Greatest inclination which should be given to the road.
		° ′	
Well laid pavement	33	0 50	1 in 68
Broken stone surface on a bottom of rough pavement or concrete	46	1 11	1 ,, 49
Broken stone surface laid on an old flint road	65	1 40	1 ,, 34
Gravel road	147	3 45	1 ,, 15

As a matter of fact, however, the gradient of a macadamised road should not, if possible, exceed 1 in 20,* experience having shown that a horse, unless the hill is a very long one, is able to draw his ordinary load for a level up such an inclination, whereas, if it is steeper he is sometimes stopped altogether, even though the carter tries the zigzag route so as to obtain an artificial ease of gradient.

The table given in 'Molesworth' upon the same subject is too well known to be repeated, and another table may be found in Sir Henry Parnell's work on roads, which gives a comparison between the draught necessary on a well-paved road at 2, on a well-made, clean macadamised road at 5, whereas on a wet and muddy gravel or flint road it rises to 32!

* Experiments made by the direction of the French Government on the tramway between Sèvres and Versailles, showed that a horse on a level tramway draws three-and-a-half times the weight, at the same speed and with the same expenditure of power, that he can do on an ordinary road. Up a gradient of 1 to 100, he is capable of drawing 2·25 times the weight he can do up the same gradient on an ordinary road, and up a gradient of 1 to 25 he can draw one-and-a-half times the load he can do under similar circumstances on the ordinary road.

Mr. T. D. Hope, of Liverpool, assuming the power of traction at 100, gives the following table :—

	Weight drawn.
Level macadamised road	27 cwt.
,, granite pavement	30·5 ,,
,, wood ,, ...	54·75 ,,

And Lieut. Crompton has given the resistance of wheels in lbs. per ton on different surfaces as follows :—

Very good pavement	35 lbs.
Good macadam	60 ,,
Ordinary ditto	90 ,,
Newly-laid gravel	200 ,,
Soft grass land	300 ,,
Newly-laid metal	440 ,,

Here "newly-laid metal" comes out very badly, and points to the necessity of rolling, of which I shall speak in a future chapter.

Whilst on the question of wheel resistance, it may be well to note that the small front wheels of a waggon cause considerably more harm to a macadamised road than the larger hind wheels. In the smaller diameter any loose stone or obstruction is pushed along in front for a considerable distance, often tearing up the surface of the road, whereas in the other case the stone is forced into its place or crushed as under a roller.

On the question of "safety" to traffic, Mr. Haywood, the eminent Surveyor of the City of London, has caused several most complete observations to be made from time to time, the results of such observations being detailed by him in various reports. Amongst other useful information compiled by him, he has ascertained that a horse will travel 446 miles upon a roadway paved with blocks of wood without a fall, 191 miles upon asphalte, and 132 miles upon granite setts. I cannot do better than give verbatim his remarks upon this point :—

"Slight rain makes both asphalte and wood more slippery than they are at other times. On asphalte the slipperiness

begins almost immediately the rain commences, wood requires more rain before its worst condition ensues. The slipperiness lasts longer upon wood, on account of its absorbent nature, than it does upon the asphalte; when dry weather comes after the rain, when asphalte is in its most slippery state, and the horses fall on it very suddenly, *on wood their efforts to save themselves are more effectual;* wood also is frequently in that peculiar condition of surface in which horses slip or glide along it without falling. A small quantity of dirt upon asphalte makes it very slippery, wood requires a large quantity. Slipperiness can be temporarily cured on both pavements; on the asphalte by sprinkling it with sand, on the wood by sprinkling it with gravel. The result in both cases is dirt. *The sand thrown on asphalte helps to wear it out, the gravel thrown on wood tends to preserve it.* When a horse falls on asphalte it has difficulty in getting up; on wood it rises more readily."*

In streets crowded with traffic, the constant stopping and starting, especially on any surface that is slippery, is very trying to horses. Attention has lately been directed to this point with a view to the storage of some power in a vehicle, either by the compression of a spring in stopping or by some other mechanical means, in order that in starting the driver may at will liberate this power so as to assist the horse in overcoming the inertia of his load. These trials, however, have not at present met with much success.

Before closing this chapter on traffic, it will be well to point out that nearly all vehicles travelling rapidly can pass each other safely if allowed a clear space of eight feet; hence all roadways should, if possible, be made of a width between the kerbs of some multiple of eight: a convenient width for the footpaths, so far as foot-passenger traffic is concerned, is found to be one-fifth of the entire width of street. It is scarcely

* 'Report on accidents to Horses on Carriageway Pavements,' by William Haywood (1874).

necessary to add that vehicles pass each other on the left side, pedestrians on the right. It is not easy to assign a cause for the former beyond custom, except that the whip is held in the right hand, and in consequence free play is given for its use as the driver sits on that side and can watch his wheels in passing. In France and other countries the right side is the "rule of the road." In the case of pedestrians it is perhaps more convenient for many reasons to pass on the right side, one being that the umbrella or parasol is always carried in the right hand, which is also used to remove the hat when bowing, and another because one's tendency in passing any obstacle is to give way with the left shoulder. For regulating the traffic and for the protection of foot passengers, "sanctuaries," as they are termed, have often to be constructed by surveyors in broad streets or awkward centres of traffic, and it is well to place a lamp-post on these sanctuaries, on which may be advantageously fixed a notice, "Keep to the Left," so as to regulate vehicular traffic. On the lamp-posts at the edge of the footpaths it is also sometimes customary to fix small enamelled iron plates bearing the inscription on both sides, "Keep to the Right," so as to regulate the pedestrian traffic.

Of the danger to life and limb to pedestrians in London much has frequently been said, and no wonder, when we consider the number of persons who are daily injured and sometimes killed according to the Registrar-General's returns. Some years ago it was proposed to erect light iron bridges over the most dangerous crossings approached by winding stairs, but "time is money" in the mighty metropolis, and the scheme was abandoned because it was felt that most persons would prefer the risk of being run over rather than spend the time in ascending and descending the necessary steps for this purpose.

CHAPTER V.

MACADAMISED ROADWAYS.

I DO not propose in this work to speak of any of the engineering operations necessary to lay out or construct long lines of connecting roadways, as that is a duty which seldom falls to a town surveyor to perform, and there are a great number of treatises and books upon the subject already published. The object of this chapter will be to give some information and hints upon the construction and maintenance of what are known as macadamised roads, suitable for urban and suburban traffic.

There can be little doubt that roadways of this description are expensive luxuries where the cost of their maintenance, owing to excessive traffic or other causes, exceeds 2*s.* per square yard per annum, but they are often necessary luxuries when the requirements of the locality are considered, a point to which I drew attention in the preceding chapter upon "Traffic." For purposes of what may be styled "pleasure traffic," macadamised roadways are unequalled when well constructed and maintained, but there are many objections to them which will be considered in their place in this chapter.

The word macadamised is, as is well known, derived from one John Loudon Macadam, who in the year 1816 first took up the question of putting broken metal upon a road instead of the boulders previously used.* His name, being rather a

* The first road "engineer" in this country was John Metcalf of Knaresborough, who was born in 1717, and who, although totally blind, was the first person to introduce a methodical system of road repairs. *Vide* 'Roads and Road Makers,' by Henry Alexander Glass.

peculiar one, has been attached to this description of road ever since.

As a matter of fact, the "macadamised" roadways of the present day are constructed after a method introduced by Thomas Telford as an improvement upon Macadam's principles, and a perusal of the two following specifications will, I think, show that there is not very much difference between the method introduced by Telford and that followed at the present time.

*Specification of a Roadway as designed by Thomas Telford more than fifty years ago.**

"Upon the level bed prepared for the road materials, a bottom course or layer of stones is to be set by hand in form of a close, firm pavement; the stones set in the middle of the road are to be seven inches in depth; at nine feet from the centre five inches; at twelve feet from the centre four inches; and at fifteen feet three inches. They are to be set on their broadest edges lengthwise across the road, and the breadth of the upper edge is not to exceed four inches in any case. All the irregularities of the upper part of the said pavement are to be broken off by the hammer, and all the interstices to be filled with stone chips firmly wedged or packed by hand with a light hammer, so that when the whole pavement is finished there shall be a convexity of four inches in the breadth of fifteen feet from the centre.†

"The middle eighteen feet of pavement is to be coated with hard stones to the depth of six inches. Four of these six inches to be first put on and worked in by carriages and horses; care being taking to rake in the ruts until the surface becomes firm and consolidated, after which the remaining two inches are to be put on.

* *Vide* 'A Treatise on Roads,' by Sir H. Parnell (1833).

† The total width of roadway being thirty feet.

"The whole of this stone is to be broken into pieces, as nearly cubical as possible, so that the largest piece in its longest dimensions may pass through a ring of two and a half inches inside diameter.

"The paved spaces on each side of the eighteen middle feet are to be coated with broken stones or well-cleaned stony gravel up to the foot path or other boundary of the road, so as to make the whole convexity of the road six inches from the centre to the sides of it, and the whole of the materials are to be covered with a binding of an inch and a half of good gravel free from clay or earth."

If the above specification, written more than fifty years ago, is compared with one of the present date, it will be seen that there is a strong resemblance between them.

Specification of a Roadway as now executed.

The cross section of the roadway *when finished* is to be an arc of a circle, with a rise of 1 in 27 from kerb to the centre of the roadway each way.* The roadway, when consolidated and finished, to be 12 inches in depth at the gutters and 15 inches at the centre, diminishing gradually from this point right and left to the depth named. The gutters to be 2 feet in width, formed of stone setts 6 inches by 6 inches, and laid in sand, on a firmly consolidated surface of small broken stone or gravel.

The earth road-bed on which the surface formation is to rest is to be excavated to the required depth, and when graded and shaped to its proper form, it is to be thoroughly and repeatedly rolled with a steam roller, and all depressions which then appear are to be filled with the same material as the road-bed, and rolled until the whole be uniformly compact and firm.

* It is necessary to give a new roadway more convexity than it will have when finished, for however carefully it is raked or attended to when being rolled, the top is sure to flatten and spread towards the haunches.

On the road-bed thus formed and compacted, a bottom layer of stone of a depth of 8 inches at the centre of the road, and gradually diminishing to 6 inches at the kerb, is to be set by hand, to form a close, firm pavement. The stones are to be laid, with their largest side down, in parallel lines across the street, breaking joint as much as practicable.* The width of the upper part of the stone not to be more than 8 inches, nor less than 6 inches. The stone not to exceed 15 inches in length. After being set closely together, the stones are to be firmly wedged by inserting a bar in all possible places, and placing between them stones as nearly as possible of the depth of the pavement, until the whole is bound in position. Projections of the upper part of this course are to be broken off, care being taken not to loosen the pavement; and no wedging is to be done within 20 feet of the face of the work being laid. The small interstices are to be filled in with stone chips firmly wedged with hammers. The whole is to be thoroughly rammed and settled to place, and all undue irregularities of surface broken off.

On the foundation course must be laid an intermediate layer of broken stones, varying in size from 3 inches in their greatest diameters to 1 inch in their smallest diameters. These irregular-sized stones may be either the "tailings" of the screened stones, or may be raked from the quarry, and placed on the roadway without being machine-broken; but they must nevertheless be so laid as to compact solidly, and must be clean broken stone, free from dust and dirt, and within the dimensions given above. This intermediate course must be 4 inches in depth at the centre of the roadway, gradually decreasing to 3 inches in depth at the gutters; it is to be thoroughly rolled with the steam roller until it be firm, compact, and solid. On its upper surface it must be identical

* Instead of parallel lines it is sometimes well to place these stones diagonally from centre to kerb or "herring-bone" fashion, thus greatly facilitating the under drainage.

in rise and form to the cross-section of the finished pavement, as specified above. In the laying of this course of stone a small quantity of binding material is to be used, sufficient only to fill up the crevices, and render this portion of the pavement solid. Preferably the binding is to be of fine screened gravel or sand, which is to be sufficiently watered during the process of rolling, so that the "licking up" of the road material, and its adherence to the rolling-wheels may be prevented.

On the intermediate course is to be laid the surface layer of broken stone.* It must be 2½ inches in depth, and the stones must be practically uniform in quality, and as near an approach to a cube in form as possible. Each stone used in this layer must have passed through a 2½-inch circular hole, and all stones that are wedge-shaped, and do not approach uniformity of measurement on their sides, are to be taken from the road with properly shaped rakes, and no stones allowed to remain which are not sound, strong, and equable in size and quality of material. The stones are to be raked into an even layer, and the steam roller passed over them twice or thrice. After this a quantity of fine screened gravel or sand is to be thrown on and sufficiently sprinkled to moisten the mass without "licking up." The rolling is then to be continued (working the roller backwards and forwards, gradually from the gutter to the crown), with an occasional light watering of the pavement, until the cross-section be exact according to specification, the interstices filled in, the roadway firmly compacted and solid, and all excess of binding removed from the surface of the finished pavement." †

* In metalling a road it is better to put on the coats gradually, than to give the whole thickness of metal at once.

† The method adopted in Chicago, U.S.A., for forming their roadways is as follows :—The road bed is prepared of the proper contour and well-rolled with a 15-ton steam roller until it is even, firm, and compact ; on this bed rubble stone is carefully placed by hand with its broadest surface downwards, then 12 inches of metal are added 6 inches at a time, thoroughly rolled to bond it well,

Telford's object was the complete separation of the road metal from the subsoil by a firm and regular foundation, and this system has ever since held its ground. The advantages to be gained in constructing a roadway in this manner may be summed up as follows:—

(1.) Economy of construction, as a considerable quantity of metalling is saved; only 3 inches of properly broken stone and a little binding material being necessary, the foundation of the roadway (which really carries the traffic) may be made of a quality of stone unsuitable for road metal, or even of bricks or stones from old buildings that are being pulled down.

(2.) The prevention of the rising up or "spewing" of the clay or other soft material on which the roadway rests.

(3.) A solid foundation is secured which will successfully resist the weight and percussion of the traffic.

(4.) The increased facility for the drainage of the roadway water being ruinous to it.*

Instead of forming a paved or "pinned" foundation for macadamised roadways, sometimes what is called "hard core" is placed at the bottom of the road upon the surface formation.

This "hard core" is made of very heterogenous materials, often the waste products of the house refuse depôt, and con-

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it is then topped with 4 inches of crushed trap rock or some other equally hard stone, which will not disintegrate through the action of the weather, nor pulverise under the pressure and wear of vehicles upon it; this is again thoroughly well rolled so as to compact and bind it together.

* "If roads be kept dry they will be maintained in a good state with proportionally less expense. It has been well observed that the statuary cannot saw his marble, nor the lapidary cut his jewels without the assistance of the powder of the specific materials on which he is acting; this, when combined with water, produces sufficient attrition to accomplish his purpose. A similar effect is produced on roads, since the reduced particles of the materials, when wet, assist the wheels in rapidly grinding down the surface." Parnell's 'Treatise on Roads,' 1883. More modern writers have likened macadamised roadways to "stone mills on which the stones are ground into dust when dry, or mud when wet."

sists of ashes, old pots and pans, meat tins, old bottles, shells, and a variety of similar articles; sometimes the core is made of burnt ballast, but in no case does it make so good a foundation as stones set by hand.

Concrete has also been employed as a foundation with great success, but it is very expensive, and is seldom used except under streets paved with either granite, wood, or asphalte, of which I shall speak hereafter; for if the traffic was so great as to necessitate the use of concrete for a foundation it would surely be better to give the roadway a more durable surface than macadam.

The following tables, howing the thickness of the foundation and metalling of broken stone roads, is from a paper on roadways, read to the Association of Municipal and Sanitary Engineers, by Mr. James Hall, Borough Surveyor of Stockton, and may be of use to those who would like to know what proportions to use.

	Pinned Foundations.			Broken Stones.		Concrete.	
	Pinning.	Covering.	Metal.	Under.	Upper.	Concrete.	Metal.
	in.	in.	in.	in.	in.	in.	in.
Country roads ..	6	3	4	9	4	4	3
Suburban ,, ...	9	3	5	9	6	6	5
Town streets	9	6	5	15	6	10	5

Chalk has sometimes been used for the bottom of a roadway, but where this is likely to be affected by frost it is the worst material that can be used, as it is likely to blow up the roadway.

With regard to the annual outlay upon macadamised roadways, the following comparative tables* prepared by Mr. Ellice Clark, the then Surveyor of Derby, may be of interest.

* *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lx.

Description of Pavement.	Original cost per square yard.	Annual Outlay.					
		Interest.	Sinking fund 3 per cent. compound interest.	Maintenance.	Scavenging.	Gravel.	Total.
	s. *d.*	*d.*	*d.*	*s.* *d.*	*s.* *d.*	*d.*	*s.* *d.*
Wood pavement	15 1·5	7·5	10·1	0 1·0	0 2·7	5·0	2 2·3
Val de Travers compressed asphalte	18 0·0	9·7	..	0 3·6	0 0·4	..	1 1·7
Granite setts 7 inches by 3 inches laid over a layer of 12 inches of cement concrete	17 9·0	9·6	0·5	0 1·3	0 2·5	..	1 1·9
Macadam in south of England	4 9·0	2·1	..	3 6·0	1 0·0	..	4 8·1

Material.	Load of Mud per area.	Traffic per Annum per yard of width.
	superficial yards.	tons.
Macadam	344	25,000
Granite setts ..	500	50,000
Wood	1666	25,000
Asphalte	4000	500,000

The following is a table of the cost of streets in Paris per square yard per annum.*

Description of Pavement.	Maintenance.	Cleansing.	Total.
	s. *d.*	*s.* *d.*	*s.* *d.*
Stone Pavement ..	0 4·50	0 3·37	0 7·87
Macadam	0 9·25	0 7·31	1 5·26
Asphalte	0 10·20	0 4·17	1 2·37

The cost of maintaining macadamised roadways as compared with that of granite setts has been said to be as high as 5 to 1 and that this cost if capitalised for 12 or 13 years will equal the first expense, interest on money, and the necessary repairs for a granite paved roadway.

* *Vide* 'Annales industrielles de Paris,' Oct. 21st and Nov. 4th, 1877.

The following table gives the cost per annum per square yard for the maintenance of macadamised roadways in different places, so far as I have been able to collect them :

	s.	*d.*		*s.*	*d.*	
Bristol		4	to	1	0	
Charing Cross (London) ..				5	0	(now paved)
Exeter		6	,,	2	6	including cleansing
Glasgow					8½	
Leeds		10	,,	1	2	
Liverpool		2	,,	2	6	
Manchester		6	,,	1	8	
Merthyr Tydfil					4½	
Newcastle	1	3				including watering
Paris		9½	,,	10	9	
Parliament Street (London)				3	6	repairs only
Regent Street (ditto)				3	7	(now paved with wood)
Stockton		9	,,	1	6	
Sheffield	1	8	,,	2	0	
Wakefield				1	0	all paved streets now.

In Birmingham the macadamised streets have worn down 6 inches in one year, with a traffic of 2484 vehicles passing in 10 hours.

With reference to the great cost of maintenance in Paris, the following particulars * may here be given ;

"The surface of the street is picked by gangs of men, metal from 2½ to 9 inches in thickness is then laid on, a coating of sand is then spread upon it, it is watered and rolled at per kilometre ton, that is, at per ton weight of roller per kilometre travelled, at a cost of about 15·33*d.* per ton mile for the first 250,000 ton miles, and at reduced rates for additional service. The materials used for the roads are flints costing 4*s.* 6½*d.* per cubic yard for light traffic roads ; for medium traffic, hard millstone at 11*s.* 4*d.* ; and for the heaviest and greatest traffic, porphyry at 15*s.* 9*d.* The average total cost of maintenance of the streets is 1*s.* 8½*d.* per square yard per annum for the first-class roads, and 1*s.* 1½*d.* for the lighter traffic ; the highest cost for mainten-

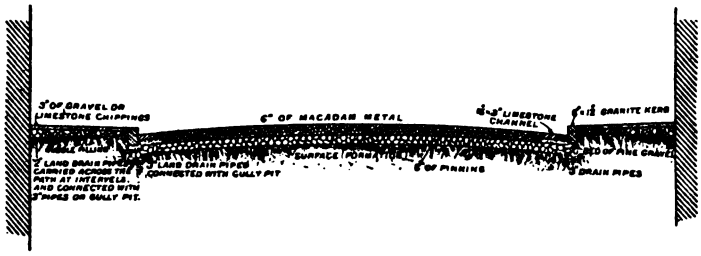
* *Vide* 'Annales industrielles de Paris.'

ance is as high as 10*s.* 9*d.* per square yard, the lowest 9¼*d.* per annum."

It may be well to mention that 73 per cent. of the streets in Paris are paved, 5 per cent. are coated with asphalte, and 22 per cent. are macadamised.

The contour, or best form of cross section that should be given to a roadway, has often exercised the minds of engineers, but for all practical purposes evenness of surface and regularity of section in a macadamised roadway are of more importance than the slight difference between straight lines and curves, which might only tend to confuse the workmen. Formerly it was the practice to employ a complicated gauge in the form of a straight-edge fitted with plummet or level and sliding bars, but a good eye, assisted by a long straight-edge and spirit-level and three boning rods, is generally found to be sufficient, and if the centre of the roadway is kept level with the heel of the footpath, a sightly cross-section is generally the result; or say 6 inches to 9 inches higher in centre of a roadway 30 feet in width between the kerbs, 3 inches to 4 inches where it is from 18 to 20 feet in width.

The following detailed section of a macadamised roadway is one which I am in the habit of specifying for suburban



districts, as it is easily set out and constructed, and answers all purposes most admirably.

The total width of street is 36 feet, of which the roadway takes 24, leaving a footpath 6 feet in width on each side.

The surface of the finished roadway is a segment of a circle, the crown being level with the heels of the footpaths on each side; the formation surface is parallel with it, and of course the depth of this and the thickness of foundations and metal must depend upon local circumstances. It will be seen that the haunches are drained with 3-inch common drain-pipes. This may be omitted if the ground is thoroughly dry, but it is often a great help to a road.

The paths, kerbing, and channelling will be described in their respective chapters.

It must be borne in mind that on a perfectly level road a more convex section is necessary than on a gradient.

It is wrong to make the sides of a roadway weaker than the centre, especially in streets with shops on each side, or on hills where drags are likely to be used. On hills, too, be it remembered, the channels should take the surface water; any ruts from wheel tracks acting as watercourses are disastrous. Hauling timber on a macadamised roadway is also very damaging.

The great objections to macadamised roadways are as follows:—

(1.) They manufacture too much mud and dust.*

(2.) They are too absorbent.

(3.) They are very noisy and damaging to vehicles and horses when fresh metalled.

(4.) They constantly require mending, but never seem quite sound.

(5.) They are frequently encumbered by men and carts engaged in either repairs, cleansing, or watering.

(6.) They are very expensive to maintain and cleanse.

(7.) They are bad for a horse to fall upon, as such falls generally damage the knees.

* A report of the Paddington Vestry on "wood and other pavements," (1878) states macadam as a mud producing material is twelve times worse than wood, and six times worse than granite cubes.

The following notes upon the maintenance of macadamised roadways may here be of service :—

(1.) Roads should be inspected in wet weather, as hollows and other imperfections are then easily detected; a hollow place extends very rapidly if neglected.

(2.) All ruts should be filled in at once. If there are three parallel, the centre rut should be first filled in; the traffic is thus slightly diverted, as a horse will avoid new metal.

(3.) Ruts should not be allowed to form; the surface of the road ought never to lose its regular section.

(4.) A road should be thoroughly repaired directly it shows the least sign of being fairly worn all over.

(5.) The right season of the year for repairs is the autumn, although where a steam roller can be used almost any time will do. If the surface of the road is very hard it should be "lifted" * previous to repairs.

(6.) All loose stones should be picked off at once or put together in hollow places upon the roadway, as, if allowed to remain, they are not only dangerous to horses, but are liable to be crushed, or to be forced through the skin of the roadway, thus causing it damage.

(7.) Water lodging upon a road does great mischief, but it should not be let off by digging a trench with a pickaxe to the side of roadway, as is sometimes done.

(8.) A roadway when very dry sometimes suffers through disintegration of the surface.

(9.) Scraping the mud off a roadway may damage it by loosening stones; sweeping the surface when wet is best.

(10.) A heavy shower does a road good by washing it; a

* This is also sometimes called "stocking" or "chequering," and consists of making furrows across a roadway with a sharp pickaxe, about a couple of inches in depth, thus removing any irregularities, and also allowing the new metal to bed properly.

continuous drizzle, especially after frost, is very ruinous to a roadway.

(11.) A good cleansing is sometimes worth a coat of metal.*

Bituminous Roadways.

In some towns in England bituminous or asphalte macadamised roadways are made. This consists in mixing ordinary coal tar with the road metal ordinarily employed for macadamised roads, only it must be borne in mind that the metal employed must be limestone or some other soft material, otherwise it will not wear down evenly with the tar, and thus a lumpy surface will be produced in course of time.

The method of mixing is by heating the stone, which has of course been previously broken to the required size, and then thoroughly mixing and incorporating it with the tar. This is then carried to the roadway, is spread in the ordinary manner and well rolled to the proper contour, a surface being afterwards given to it by a coating of about 2 inches thick, composed of a similar mixture, the stones of which are of much smaller size.

Another method is to place about 6 inches of the broken metal described above upon the necessary foundation. Upon this a boiling mixture composed of about 50 gallons of creosote oil and 1 ton of pitch is poured until every interstice is filled with the mixture. Whilst this is still warm, a thin layer of small broken stone is spread upon the surface and well rolled; more small stones or chippings are added, and the whole is rolled until the surface of the roadway has attained its proper contour and presents a perfectly smooth and clean appearance, little inferior to that of real asphalte.

* In Birmingham, good cleansing is said to have reduced the amount of metal necessary for the maintenance of the roadways from 20,000 tons per annum to 13,000 tons.

Dry weather is essential whilst this class of roadway is in course of construction, and they require careful watching, as, upon the skin becoming broken, the whole roadway soon breaks up. They have, however, many advantages over ordinary macadamised roadways when finished, not the least of them being their imperviousness to moisture, and the ease with which they are cleansed.

CHAPTER VI.

ROAD METAL AND BREAKING.

THE only true test of the fitness of any stone for use as a road metal is by an experimental trial upon a certain length of roadway; but in making the first selection for such trials it is well to make the following investigations :—

(1.) Ascertain from local persons, such as masons, quarrymen, and others, their opinion of the qualities of the stones in the neighbourhood.

(2.) Make a trial of the stone for toughness. This can be done by setting a good stone-breaker to work upon a heap of the stone as quarried and carefully watching how much he can break in an hour.*

(3.) Ascertain what power the stone has to resist abrasion. This is done in France by putting the broken metal into a revolving cylinder and then carefully noting by weight what the cubes lose by contact with each other. Another plan may be adopted by pressing the stone against a grindstone with a uniform pressure, and noting the loss caused by such contact.

(4.) The power to resist compression may be easily ascertained by placing small cubes in an hydraulic press and noting under what pressures each cube will crush.

(5.) The effect of weather is not easily ascertained artificially, although it is suggested that a good test may be made by soaking the stone in a saturated solution of sulphate of soda; and then on exposure to the air, if soft, it is said the stone will disintegrate as if under the action of thaw succeeding frost.†

* Toughness is not all that is required. Leather would be very difficult to break with a hammer, but it would not make a good road metal.

† I have tried this experiment, but without success, except on such soft stones as were evidently unfitted for use as a road metal.

The specific gravity of a stone is no criterion whatever as to its fitness. Clay-slate has a higher specific gravity than a tough flint, and yet the former is almost useless as a road metal; the latter, on the contrary, often making excellent roadways.

The qualities necessary for a really good road metal are hardness, toughness, not easily decomposed or affected by the weather, and at the same time the stone when broken ought to have some power of cohesion without the necessity of much binding material. The question of cost I put aside at once, as it is well known that the best road metal is always the cheapest where there is much or heavy traffic.

Local circumstances must to a great extent determine what stone to use upon a roadway, but the following list may be of use:—

Syenite.—This is a granite in which hornblende takes the place of mica, and is an excellent road material; the darker the colour the more durable it is found to be.

Granite.—This should have more felspar than quartz, and have as little mica as possible; the closer the grain the better. Coarse-grained granites soon decompose.

Trappean Rocks.—Some of these are excellent for road metal. Basalts of dark colour and close grain should be selected. Greenstones with similar characteristics are good; as is also Whinstone.

Gneiss.—Is inferior to granite; it has mica in layers and is not a good road metal.

Clay Slates.—These are useless, as they crumble on exposure or degenerate into mud.

Limestone.—The Metamorphic, Silurian, and Carboniferous limestones may be used if crystalline in appearance, but the Lias and Oolitic are of little use.*

* Many hundreds of miles of roadways in this country are made with limestones; they often make an excellent surface, as they possess a considerable power of binding together, but weather and very heavy traffic affect them considerably: as they all have a strong affinity for water, their very power of thus cementing themselves together causes a quantity of dust in dry, and mud in wet weather.

Sandstones.—Some of these, if cherty or containing a large percentage of iron, may be used; but as a rule they are quite unfitted for use as a road metal.

Flints.—These, if tough, make excellent roadways; but unfortunately they are sometimes too brittle for heavy traffic. Surface-picked flints are better than those from a quarry.*

Pebbles.—These are found on sea shores and river beds. They are composed of very various rocks, and are much water-worn and rounded; when broken they sometimes answer very well if mixed with gravel to bind them.

Gravel.—This, if of a flinty character, and not too much mixed with earthy matter, makes good roads for light traffic, if carefully watched or well rolled during formation. Pit gravel should always be screened through wire screens of 1½ to 1¾ gauge, and the small can be used for footpaths.

In some places it is difficult to obtain any natural stone for the purposes of road metal; in these cases slag from blast furnaces or ordinary clinkers from furnaces are sometimes used. Oyster shells are used on the roadways near the Gulf coasts† and charcoal in Michigan, United States.‡ I have myself made a most excellent roadway with coral on the coast of Jamaica, and no doubt many strange materials have been, and still are, used for this purpose.

"I never mix" is an adage that should be followed by surveyors as regards road metal. Do not mix a soft material with one that is harder for either construction or maintenance of a roadway; the effect is what is known as a "bumpy" road, arising from the fact of the soft stone wearing faster than the hard. The hardest metal should be kept for the top or surface layer of the roadway.

As an instance of the extreme difficulty besetting the question of the best material for road metal, I will here give a

* A flinty or quartzose stone seems to harden with exposure. This is notably the case in pebbles; old pebble paving taken up and broken makes a most hard and durable road metal.

† 'Roads, Streets and Pavements,' by Q. A. Gillmore, p. 10. ‡ *Ibid.*

table showing the comparative coefficients of quality assigned to them by the engineers of the French Department of the Ponts et Chaussées.*

COEFFICIENTS OF QUALITY OF ROAD MATERIALS.

Granitic gravel	23·8
Quartz gravel	21·4
Trap	20·0
Quartz	10·0 to 25·0 (in one instance 4·8)
Basalt	12·0 ,, 20·0
Porphyry	10·0 ,, 20·0 (in one instance 5·0)
Quartzite	11·0 ,, 18·0
Devonian schist	16·0
Schist	4·0 to 12·0
Sandstone	12·0 ,, 16·0
Granite	6·0 ,, 20·0 (generally 10·0 to 12·0)
Syenite	12·0
Gneiss	9·0 to 12·0
Silicious pebbles and gravel	8·0 ,, 19·0 (in one instance 6·0)
Silex	8·0 ,, 16·0
Chalk flints	7·0 ,, 11·6
Silicious limestone	6·0 ,, 18·0 (generally about 10·0 to 12·0)
Compact limestone	14·0
Magnesian limestone	16·0
Carboniferous limestone	9·0
Oolitic limestone	5·0 to 12·0
Lias limestone	5·0 ,, 10·0
Juranic limestone	5·0 ,, 8·0
Limestone	5·0 ,, 12·0
Mean of all France	10·63

It will be seen by the above table how different are the results obtained from materials of the same character.

Breaking stone for the purpose of using it as a road metal was, until comparatively recent years, always effected by hand; now, as in other cases, machinery has stept in and somewhat supplanted manual labour. Hand-broken road metal, however, still finds favour with road surveyors; it is better broken, and in some districts, the occupation finds employment for persons who otherwise would be thrown on the rates for support.

In breaking stone by hand the breaker sits and strikes the

* *Vide* 'The Maintenance of Macadamised Roadways,' by Thomas Codrington, p. 33, a most excellent work upon this subject.

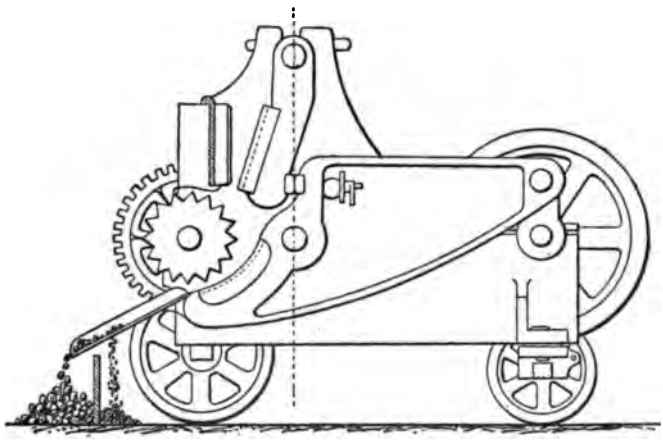
stone with a small cast-steel chisel-faced hammer, weighing about one pound, at the end of a long, straight-grained but flexible ash stick.* The breaker also has another hammer, weighing about five pounds, with which he reduces the size of the large stones before breaking them into the proper size for road metal. This latter size is often a matter of choice, some engineers preferring it to be broken so small as will pass through a ring of only 1½ inch in diameter; others are content with 3 inches, especially where the roads are steam rolled. An old method of gauging used to be "such a size as the stone breaker could put in his mouth," but this was unsatisfactory to all persons concerned, and "to pass all ways through a ring of 2½ inches internal diameter" is now the size most generally adopted.

Mr. Codrington says† "a good stone breaker will break 2 cubic yards of hard limestone to the ordinary gauge in a day, and some men will break more. Hard silicious stones and igneous rocks can only be broken at the rate of 1½ or of 1 cube yard per day; of some of the toughest, such as Guernsey granite, a man can only break on an average half a cube yard per day. River gravel, field stones, or flints, which are already of a small size, can be broken at the rate of 3 or 4 cube yards per day."

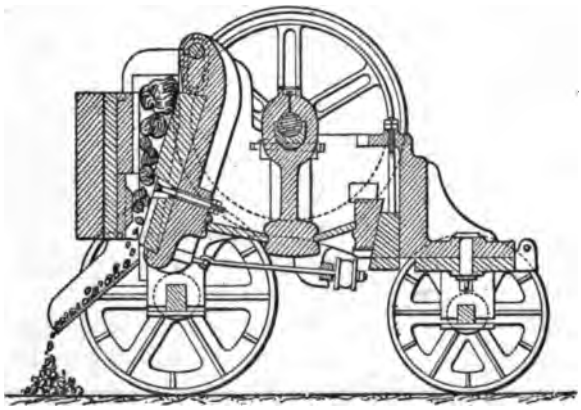
This may be taken as fairly representing a day's work, the price for breaking however must vary considerably in different localities on account of the variety of the stones to be broken and the value of labour; in some districts the road metal does not cost more than 1*s.* per cube yard, in others 2*s.* 6*d.* and 2*s.* 8*d.* is not considered too high, and it was to meet and reduce this great expense that steam stone-breaking machines have been introduced. These machines are known as "Ellisons," "Newall and Archer's," "Hope's," and "Blake's,"

* Mr. W. Bold considered a hammer weighing 1¼ lb. of an elliptical form, pointed at the ends, the area of each end being about $\frac{1}{100}$th of a square inch, to be the most suitable to break hard stones. *Vide* 'Minutes of Proceedings, Institution Civil Engineers,' vol. i. (1840) p. 50.

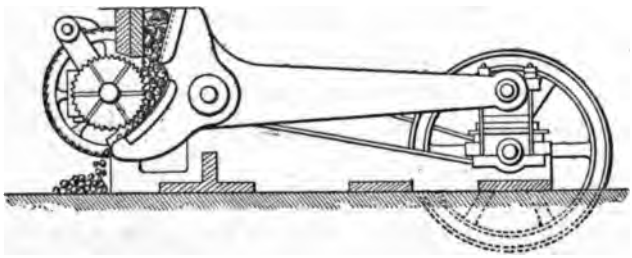
† 'The Maintenance of Macadamised Roads,' by Thomas Codrington, p. 38.



"ARCHER'S" STONE BREAKER.



"BLAKE'S" STONE BREAKER.



"NEWALL AND ARCHER'S" STONE BREAKER.

the latter being that which is best known and most generally used in this country.

The foregoing illustrations will give a general idea of the manner in which the stone is broken or crushed between strong iron jaws; in all cases a revolving perforated screen is necessary (not shown in the drawings) to separate the stone broken to proper gauge from that which is too large, and also from the spalls or chippings.

The Blake's or "Blake Marsden's" machines are of various sizes and weights; the following particulars with respect to them, as advertised, may be of use.*

Size of machine at mouth, showing what size of stone each machine will take.	Approximate quantity of road metal broken per hour.	Nominal horse-power required.	Total weight of machine with wheels, axles, horse shafts, automatic screening apparatus, etc.	Price of* machine complete.
inches.	cube yards.	H.P.	tons cwt. qrs.	£ s. d.
10 × 8	3½	3	5 6 0	157 0 0
12 × 8	4	3	5 11 0	167 0 0
15 × 8	5	5	6 19 0	200 0 0
15 × 10	6	6	8 5 0	220 0 0
20 × 10	8	8	10 2 0	265 0 0
24 × 13	12	10	15 5 0	390 0 0
24 × 17	13	14	16 2 0	415 0 0
24 × 19	14	16	19 17 0	440 0 0
30 × 13	14	16	16 2 0	440 0 0

Mr. Till, the Borough Engineer of Birmingham, speaking of the work done by one of Blake's machines in 1874, says:† "The stone-breaking machine at Holliday Street will break on an average 40 tons of ragstone per day, at a cost, exclusive of wear and tear of machine, of 10½*d.* per ton, but it produces

* No doubt the price of the machine varies with the price of iron, etc.

† *Vide* 'Report of the Borough Surveyor of Birmingham to the Paving and Street Improvement Sub-Committee,' p. 11.

16 per cent. of dust or fine stone; of the remainder one-fifth has to be rebroken by hand, the whole is very irregular in size and very flaky in comparison with hand-broken stone. The machine is much more efficient in breaking granites or pebbles. It has, however, been found very useful during the last two years, in consequence of the difficulty of obtaining labour."

Mr. Jacob, the Borough Engineer of Barrow in Furness, read an excellent paper on the subject of stone-breaking machinery to the members of the Association of Municipal and Sanitary Engineers, at their meeting in Manchester in 1875,* giving a full description of one of Blake's machines, to which I will refer my readers.

Mr. Codrington† gives the result of breaking whinstone in a 16-inch by 9-inch Hope machine, from which it appears that the total cost, including wages, coal, oil, cottonwaste, etc., wear and tear of machinery, and, I presume, interest on first cost of machine, was about 1*s.* per cube yard. This effected a saving of 10*d.* per cube yard as compared with the same stone broken by hand, and the machine broke 40 tons of stone per diem.

To make a stone-breaking machine pay, it is necessary:

(1.) To give it nearly constant work.

(2.) That the stone to be broken shall be too tough to break economically by hand.

(3.) That the machine shall be at the quarry, so as to save the expense of much handling.

(4.) To exercise care in feeding, to give it a sufficient supply without allowing an undue quantity of stone to pass in at one time.

(5.) As about 20 per cent. of grit or dust is produced, this

* *Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers,' vol. ii. p. 76.

† *Vide* 'The Maintenance of Macadamised Roadways,' by Thomas Codrington, p. 41.

must be used for foot-paths, or as a binding material for roads, or in asphalte or tar paving.

In addition to the grit which is produced, a great many long and thin pieces of stone pass through the machine, which have to be again broken by it before they could be used as road metal; and having once taken this form, they will frequently pass several times through the machine before they get properly broken.

The wear and tear of a stone-breaking machine is very considerable, as can be easily imagined; it has been known to reach as high as 62·5 per cent.* of the first cost of the machine in one year. The objections to stone-breaking by machinery are principally:

(1.) In some districts labour can be successfully employed in this manner.

(2.) Hand-broken stone is sharper in fracture, as it is done by a blow and not by gradual pressure, whereas machine-broken stone is often flaky or with rounded edges, and frequently each stone may be cracked and shaken by the pressure.

(3.) Want of uniformity in the size of the stones.

The smaller the stone is broken the heavier a cubic yard of it will weigh, as the percentage of vacant space between each stone will be less. It has been found by experiment, however, that 55 per cent. of ordinary road metal is solid, so that the weight of a cubic yard of it can easily be ascertained in the following manner.†

Multiply the weight of a cubic foot of any stone by 27 to bring it to a cubic yard, and then multiply this by 0·55: the result will be the weight of a cubic yard of the same stone when broken for metalling.

* *Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers,' vol. ii. p. 82.

† *Vide* 'The Maintenance of Macadamised Roadways,' by Thomas Codrington, p. 45.

A cubic yard of Guernsey granite broken to pass through a 2½-inch ring has been weighed, and gives an average of 1 ton 3 cwt. 2 qrs.

	tons	cwt.	qrs.
A cube yard of flint weighed	1	1	3
,, ,, pit gravel weighed	1	4	3
,, ,, limestone weighed	1	3	0

A cubic yard of ordinary broken road metal will, when properly spread, cover an area of about 30 square yards of surface of a roadway.

The following specimen specification for the supply of stone either unbroken or broken may be of use.

Specification for the Supply of Road Metal.

(1.) The road metal must at all times be clean and free from clay or other dirt, and fully equal to the sample; if required to be broken, each cube must have a square face and sharp edges, and pass all ways through a 2½-inch ring.

(2.) The metal must be delivered in *(name of town)* free of all charge to the corporation, either at a railway station or at one of the depôts of the corporation, at the option of the contractor, such option to be declared in the tender.

(3.) The metal must be supplied on the order of the borough engineer in such quantities as he may specify, and must be delivered within the time specified in the order. The contractor shall not be required to supply and deliver more than tons in any one week; but the corporation will be at all times ready to take the metal in larger quantities.

(4.) The bill of lading or railway invoice shall be taken as *primâ facie* evidence of the weight of metal supplied; but the corporation retain the right to test the accuracy of such bill of lading or railway invoice, by passing the metal over a weighbridge as it is received.

(5.) Metal delivered at a depôt by carts shall be measured when broken and paid for at the rate of cwt. per cubic yard.

(6.) The corporation retain the right to reject all metal which shall not be equal to the sample, or at their option to pay a reduced price according to its value.

(7.) Quarterly payments will be made by the corporation on the certificate of the borough engineer, and within one month from the date of such certificate.

(8.) The borough engineer shall be the sole judge as to the fitness of the metal supplied, and his certificate, in writing, shall be conclusive evidence upon the point as between the corporation and the contractor.

(9.) If the contractor shall make default in the supply and delivery of road metal in accordance with the terms of this specification, and within the time specified for the purpose in the order of the borough engineer, the corporation shall be at liberty to obtain such road metal as they may deem fit and necessary from another source, and any excess in price or other loss they may consequently incur, shall be recoverable by them from the contractor as liquidated and ascertained damages.

(10.) Tenders must be sent in only on the prescribed form, and the person tendering must insert in his tender the name of two persons who will join him in a joint and several bond to the corporation in the sum of *l.* for the due performance of the contract.

(11.) Each person tendering must send to the office of the borough engineer a sample of the road metal he offers, accompanied by a full description, and the name and position of the quarry from which it is produced; such sample to be not less that one cwt. in weight, and to be retained by the corporation in the event of the tender being accepted.

(12.) The corporation do not bind themselves to accept the lowest or any tender; and they further retain the right to reject a contractor in the event of his failing to find sureties to their satisfaction in compliance with the 10th condition.

(13.) The word "corporation" shall mean the mayor,

aldermen and burgesses, of in their capacity as the urban sanitary authority for . The word "contractor" shall mean the person whose tender is accepted, and who has signed these conditions; and the words "borough engineer" shall mean the engineer to the said corporation for the time being.

Since writing this chapter my attention has been directed to a stone-breaking machine which is said to substitute a "knapping" for that of the usual crushing motion which is so generally the great defect in these machines: I allude to that known as "Baxter's patent knapping-motion stone breaker," by which a rapid jerk or blow is given instead of the slow crushing movement, thus (it is contended) causing less waste from dust and chippings, and also less strain of the machinery and less power to drive it.

CHAPTER VII.

ROAD ROLLING.

THE march of civilisation has decided that road rolling is a necessity for macadamised roads, instead of allowing the stones of which they are composed to be worn in by the traffic, as was formerly the custom. In Calcutta bullock rollers were used so long ago as the year 1855, and it was the cruelty of this operation that suggested to Mr. W. Clark the necessity for a steam roller* the outcome of which was the well-known roller as manufactured and supplied by Messrs. Aveling and Porter of Rochester, and now so generally used throughout this country, as well as in American and other foreign towns.†

Steam rolling saves money as well as suffering, and the legislature have recognised the importance of a sanitary authority becoming possessed of a steam roller by permitting money to be borrowed for the purchase of a roller as for a permanent work. (Sect. 234 Glenn's Public Health Act 1875, footnote to Sub. Sect. (1).)

Mr. Albert W. Parry, the Borough Surveyor of Reading, has prepared some tables on the subject of steam road rollers, from information he received on this subject, in answer to some questions he addressed to the surveyors of a number of towns a few years ago. It appears from this tabulated statement that thirty-three 15-ton steam rollers were in use, six 10-ton rollers, one 21-ton roller, one 8-ton roller, one 9½-ton roller,

* *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lviii. p. 95. (The first steam roller was made in the year 1864.)

† The first steam roller used in England was, I believe, in the year 1872; in Paris about 1864.

one 14½-ton roller, one 17-ton roller, and one 25-ton roller; this latter not being much used, as it was found to be too heavy.

The average gross cost per annum of necessary repairs to the rollers, other than those which could be effected by the men in charge of it, amounted to 35*l.* 12*s.* The number of men employed to attend to the roller and cost of labour per day varied considerably, from one case (South Shields) where "one engine-man at 26*s.* per week, and an old scavenger with the flag" were found to be sufficient; to another (Gloucester) where the cost per day is stated as follows: "one man works the engine at 5*s.* per day, one boy with signal flag, 1*s.* 8*d.*, two men spreading gravel or sand at 3*s.*, two men watering and sweeping to keep water from running off in channels."

Some of the older rollers require a steersman as well as a driver, and the Locomotives Amendment Act requires two men with flags, but this is seldom really necessary. The sweepers, spreaders and sprinklers should be taken as irrespective of the actual cost of the roller, which may therefore be assumed to be the wages of the engine-man, say 5*s.* per diem, and a boy or old man with a flag at 2*s.*, thus making a total for labour of 7*s.* per diem.

The fuel that is consumed by a 15-ton roller seems to be from 3 to 5 cwt. of coke per diem, common gas coke being generally used, though steam coal would no doubt answer equally well, some of the smokeless Welsh descriptions being of course necessary.

With regard to the question "When not used for rolling roads, to what other use (if any) do you put the engine power?" there are not many towns that use the machine for any other purpose than rolling, but the following uses may be enumerated to which the machines have been applied:— Driving a stone-breaker, a mortar-mill, a saw-bench, a chaff-cutting machine, a bean-crusher, etc. It has also been used in connection with pumping, and to produce the necessary

power for the electric light, and it is frequently employed as a traction engine.

The driving rollers usually have provision by which spikes may be fitted into holes in their faces, in order that they may be used for lifting or chequering roads. These, however, apparently do not answer; the working of a machine in this manner is said to shake and strain it considerably, and the holes in the rollers, which are plugged with wood when not in use, are objectionable, as these plugs wear out and the road metal gets into the holes, and the surface of the road is picked up as the rolling proceeds; besides this, the spikes seem to have no effect unless the surface of the roadway being operated upon is soft.

With reference to the use of binding material, the most commonly used and that which receives most favour is road grit or scrapings,* sharp sand is also employed, as well as gravel if clean, and also stone chippings and screenings; these should be of the same material of which the road is made, if possible, and no doubt *newly* constructed roads require more care in the binding material than simple repairs. The steepest gradient upon which a roller will act appears to be 1 in 9 in Blackburn, with a 15-ton roller, but this must require a very heavy pressure of steam, and 1 in 14 seems to be a gradient that gives no trouble to roll either up or down; in going down hill, of course it is a mere question of sufficient break power.

The number of superficial yards rolled per day must vary extremely with circumstances: the class of material, the amount of binding and water used, the gradient and pressure of steam maintained, and the amount of rolling considered necessary,† being amongst the various influences. From the above returns I find that the number of square yards rolled

* This should be collected and "weathered" so as to get rid of mud and any organic matter in it.

† In Paris 3 to 3·75 ton miles of roller are applied to every cubic yard of metal; in America 5 ton miles are thought necessary.

varies from 500 to 3000 per diem, the average for 42 towns being 1105 square yards per diem.

The cost per square yard rolled, including all charges, may be assumed to be between ½*d.* and 1*d.*, and the cost of binding material about 3*d.* per square yard. With reference to the necessity of binding material, the following facts are interesting.

Mr. Wm. H. Grant, Superintending Engineer of the New York Central Park, in his report upon the park roads, says :* "At the commencement of the macadam roads, the experiment was tried of rolling and compacting the stone by a strict adherence to Macadam's theory, that of carefully excluding all dirt and foreign material from the stones, and trusting to the action of the roller and the travel of teams to accomplish the work of consolidation. The bottom layer of stone was sufficiently compacted in this way to form and retain, under the action of the rollers (after the compression had reached about its practical limit) an even and regular surface; but the top layer, with the use of the heavy roller loaded to its greatest capacity, it was found impracticable to solidify and reduce to such a surface as would prevent the stones from loosening and being displaced by the action of waggon-wheels and horses' feet. No amount of rolling was sufficient to produce a thorough binding effect upon the stones or to cause such a mechanical union and adjustment of their sides and angles together, as to enable them mutually to assist each other in resisting displacement. The rolling was persisted in with the roller adjusted to different weights up to the maximum load (12 tons) until it was apparent that the opposite effect from that intended was being produced. The stones became rounded by the excessive attrition they were subjected to, their more angular parts wearing away, and the weaker and smaller ones being crushed."

"The experiment was not pushed beyond this point. It

* *Vide* 'Roads, Streets, and Pavements,' by Q. A. Gillmore, p. 89.

was conclusively shown, that broken stones of the ordinary sizes, and of the very best quality for wear and durability, with the greatest care and attention to all the necessary conditions of rolling and compression, would not consolidate in the effectual manner required for the surface of a road while entirely isolated from and independent of other substances. The utmost efforts to compress and solidify them while in this condition after a certain limit had been reached, were unavailing."

From the foregoing it is very evident that some description of binding material is essential in making a road under a roller. Where traffic is allowed to consolidate a road it is different, as then the stones are knocked about and are sufficiently abraded against each other to form a binding material for themselves. Too much binding material or too much water should not be used in forming a road with a steam roller. It is unfortunately frequently the case that a road is made quickly only to go to pieces with the traffic in a few weeks. The surface of a well-constructed macadamised roadway should after being rolled look almost like an encaustic pavement. If there is too much binding material in the joints of the stones, the first heavy rain washes it out and the surface of the roadway quickly goes to pieces.

The following description of the manner in which it is recommended that the roller should be applied is taken from an excellent little pamphlet on Steam Road Rolling, by Messrs. Aveling and Porter, the well-known makers of steam-rollers, and although local circumstances must guide the surveyor in all his works, the particulars may be of use :—

"In the best practice the roadway is excavated, graded, and properly formed to a depth of 14 inches from the level of the gutters, with a cross section conforming to the cross section of the road when finished ; it is then thoroughly and repeatedly rolled with the steam roller, all depressions being carefully filled and rolled before the stone is put on. On the

bed thus formed and consolidated a layer of stones 8 inches thick is set by hand, and rammed or settled to place by sledge hammers, all irregularities of surface being broken off and the interstices wedged with pieces of stone. The intermediate layer of broken stone, of a size not exceeding 3 inches in diameter, is then evenly spread to a depth of 4 inches and thoroughly rolled, and this is followed by rolling in half-an-inch of sand. The surface layer of stone, broken to a size not larger than 2 inches diameter, and to a form as nearly cubical as possible, is then put on to a depth of 3 inches, thoroughly rolled, and followed as before by sand, also rolled. Finally, a binding composed of clean, sharp sand is then applied, well watered and most thoroughly rolled with the steam roller, until the surface becomes firm, compact and smooth, the superfluous binding material being swept off and removed."

And the following account of the method adopted in the United States at Hartford may also be of interest.*

"The surface of the road is excavated to a suitable depth —say, 18 inches; preparing the form for the pavement with the precautions as for a common pavement; 4 inches of gravel and proper drainage where required, provided blocks of stone of any irregular shape are selected for the pavement, of about 7 inches in thickness. The blocks are set by hand with great care, as closely in contact at their base as practicable. The surface between the blocks is filled with chippings of stone carefully laid in. A layer of broken stone, 4 inches thick, is laid over this pavement. The road-covering thus prepared should be rolled with the steam roller until the upper layer has become perfectly compact and consolidated. The second layer, about 3 inches in depth, is then laid on; a coating of clean coarse gravel, 1½ inch thick, termed 'binding,' is spread over the surface, and the whole well rolled as before, and you have the requisites of a good road—viz., clean, hard, and even at all seasons. No road should be considered made

* *Vide* Aveling and Porter's pamphlet on 'Steam Road Rolling,' p. 32.

until it is completely rolled. A road made in the manner above described, and kept perfectly clean, hard, and even, with materials of a good tough quality, would show extremely little wear on the surface; indeed, it has been found in France to be less than ½ an inch in a year, on a road of great traffic."

In the neighbourhood of New York the steam roller is used as follows:—

Two and a half inches of trap rock is laid and lightly rolled until the stones have become a little compacted, then coarse screenings are added, and it is again rolled; after this a layer of about 2 inches of stones are added and rolled with coarse screenings as before. Fine screenings or stone dust is then applied, and the roadway is then rolled until every interstice is filled up; it is then well watered and again rolled.

With reference to the employment of the steam roller in repairs of roads, the following description is given of the method adopted by the Surveyor to the Tottenham Local Board, near London.*

"When a road becomes so full of holes or so worn as to require coating throughout its entire length and width, it should be hacked completely over and raked into a segmental form in its transverse section to remove irregularities, and so that the road may have a fall from the crown to the channel of not less than one inch to a yard. It should then be coated with stone broken as nearly cubical as possible and to an uniform gauge. When spread it should be slightly coated with gravel screenings, or the grit sweepings from the roads, which are equally suitable for the purpose when in proper condition. The road should then be watered and rolled, beginning with the road at the channels, and ending at the crown of the road, until a smooth surface is obtained, more stones being added to fill up any inequalities that may exist, until the whole is consolidated. By constantly sweeping the grit

* *Vide* Aveling and Porter's pamphlet on 'Steam Road Rolling,' p. 33.

from the sides to the crown of the road as the roller passes over, every stone is thoroughly grouted into its bed."

Mr. R. Read, the Surveyor of Gloucester, says: * "The road should be thoroughly well lifted and the metalling spread in three-inch layers evenly, and rolled once or twice before the gravel or other binding material is spread; then spread gravel or sand evenly and well watered with fine distributor until the stone is entirely covered, and the sand does not adhere to the roller. Dam up the road channels to prevent water and sand running off into sewers and let men scoop up the water, and throw it back on the road, as it collects in the gutters."

In all cases the sides should be rolled first to such a degree of firmness that when the roller passes over the centre or crown of road, its weight, which tends to spread the metal or make it work off towards the sides, may be resisted by their consolidation.

With reference to the effect of the weight of steam road rollers upon roadways, it may be well here to compare that of a 15-ton roller with other burdens that a road has to bear, taking each case at per inch of width of tire.

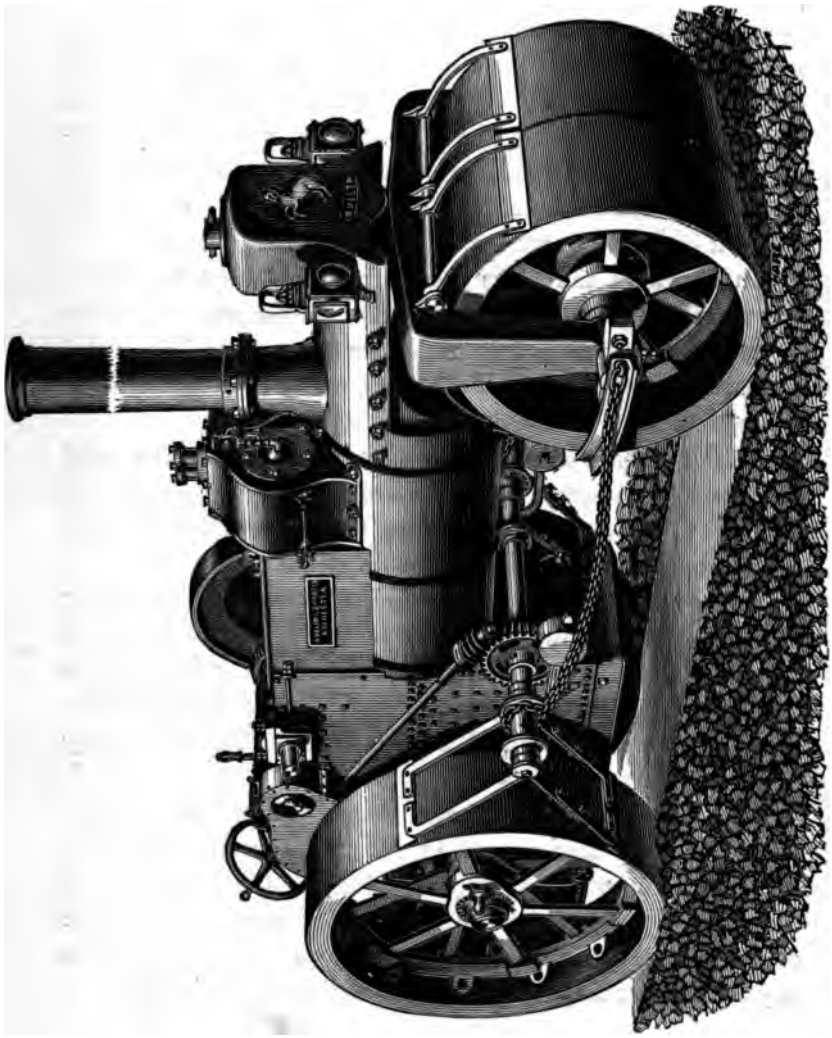
An ordinary loaded two-wheeled cart presses with a weight of about 9 cwt. per inch width of tire, a loaded wagon about $7\frac{1}{2}$ cwt., a 9-ton traction engine about $3\frac{3}{4}$ cwt., and a 15-ton steam road roller about $3\frac{1}{2}$ cwt. So that as far as the surface of the roadway is concerned, a roller affects it the least of any of the above loads.

It has, however, been found that where rollers of more weight than 15 tons are used,† not only are they unwieldy, but, from their great weight, the solidity of the foundation of the roadway may be interfered with, and also there is great danger of damaging gas or water mains and services, besides any cellars that may be constructed under the roadway.

* *Vide* 'The Use of Steam Rollers,' by A. W. Parry, Reading.

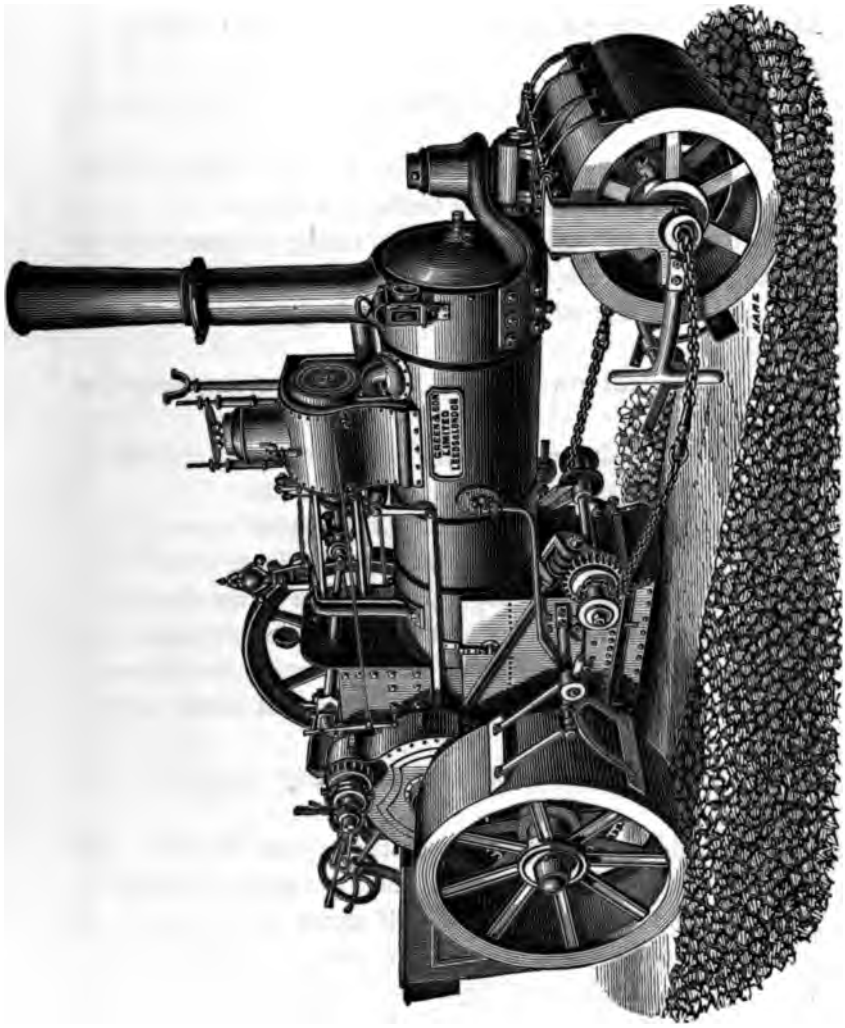
† Some road surveyors contend that for gravelled roads 6-ton rollers are heavy enough, for macadam roads 12-ton rollers.

The steam rollers which are principally used in this country, are those manufactured by Messrs. Aveling and



MESSRS. AVELING AND PORTER'S 15-TON STEAM ROAD ROLLER.

Porter, and those by Messrs. Green and Sons, drawings of both of which are here represented.



MESSRS. GREEN AND SON'S 15-TON STEAM ROAD ROLLER AND TRACTION ENGINE COMBINED.

In Paris the Gellerat steam roller is used, and another is also known, which is manufactured by Messrs. Morland and Sons.

A 15-ton steam roller costs about 650*l.* in the first place, the cost of working it &c., has been given in the early pages of this chapter.

The advantages of steam road rolling may be summed up as follows :—

(1.) The saving of wear and tear to vehicles and horses. Roads should be made *for* the traffic, and not *by* it.*

(2.) Economy ; as it is said that a saving of from 30 to 50 per cent. is effected by reason of the roads being better made thus obviating the necessity for such frequent sweeping and scraping.

(3.) The roads can be made or repaired at any season of the year.

(4.) The avoidance of cruelty to horses, cattle, and sheep, as in the case of newly metalled unrolled roads.

(5.) A saving of road metal. (*a*) Because it need not be broken so small. (*b*) Because there are no loose stones to be kicked about and lost. (*c*) Because there is no abrasion of the stones, only one surface of the stone being exposed. (*d*) Because no ruts can be formed in which water can lie to rot the stone. (*e*) Because a thinner coating of metal can be employed.

(6.) The roller can be advantageously used for other purposes.

(7.) Rolled streets have a better appearance, they are easier of traffic as having more evenness of surface and superior hardness, and it is contended that if steam rollers were more general there would not be such an outcry for other descriptions of pavement for roadways.

(8.) The steam roller soon finds out the good from the

* Traffic in making a roadway is apt to grind off the sharp edges and spoil the metal before it is set.

bad metal for roads, it is also contended that it also does this with respect to the gas and water mains, the latter, however may be looked upon as a rather doubtful advantage.

(9.) The avoidance of the necessity of the continued employment of men raking the metal into the ruts.

In Mr. Paget's valuable little pamphlet upon the subject of steam rolling* may be found the following remarks :—

"One of the main advantages attending the rolling of roads by steam-power, consists in the diminished proportion of mud or soluble matter which is then incorporated in the structure of the road surface. If the surface of an ordinary road that has not been rolled is broken up and the material washed, it is found that as much as half of it is soluble matter, mud, dirt, and very fine sand; the stones, having only been thrown loosely upon the road, have lain so long before becoming consolidated by the traffic, and have undergone in the meantime such extensive abrasion that the proportion of mud, dirt, and pulverised material in the metalling is increased to that extent, and the stones are really only stuck together by the mud. This accounts for the fact that although an unrolled macadamised road may indeed, after long use, have a surface that is pretty good and hard in dry weather, and may offer then a very slight resistance to traction, yet it will quickly become soft and muddy when there is any rain. By the employment, however, of a steam roller upon the newly-laid metalling of a macadamised road the stones are rolled in and well bedded at once, and the surface is thus consolidated into a sort of stone felt, capable of resisting most effectually the action of ordinary traffic, and containing the smallest quantity of soluble matter to form mud in wet weather."

Having given the advantages of steam road rolling, I will now proceed to give the disadvantages.

* 'Report on the Economy of Road Maintenance and Horse Draught through Steam Rolling, with special reference to the Metropolis,' by Frederick A. Paget, C.E., etc. etc., London 1870, to which I refer my readers for many scientific and useful facts upon this subject.

(1.) The first cost; this to a small borough or town is often the great stumbling block. It is a pity that two or three of them could not join, and procure one between them at joint cost, thus avoiding the individually heavy burden.

(2.) The risk of damage to gas and water mains and services; or even of cellars under the streets in some of the older towns.

(3.) The interference to traffic whilst the roller is at work; the result is generally unsatisfactory if, to avoid this, the machine is worked during the night.

(4.) The noise and smoke.

(5.) The risk of frightening horses.

(6.) If too heavy a roller is used, the foundation of the roadway may be injured or the metal may be crushed instead of bedded.

(7.) The necessity of using so much binding material and water.

Before closing this chapter it will be necessary to say a few words upon rollers drawn by horses.

These are always unsatisfactory: they are expensive to use, as a large team of horses and a number of attendants are necessary; they are difficult to turn, and the horses' feet displace almost as many stones as the roller compresses into their beds.

They cannot be of greater weight than 10 tons, even when on the hydrostatic principle, and they are clumsy and difficult of manipulation.

If a roller is to be used at all, let it be a steam road roller of the most modern description, and of the best manufacture.

CHAPTER VIII.

PITCHED PAVEMENTS.

IT has been asserted that where a roadway has a traffic exceeding 1000 vehicles per diem, that to maintain it as a macadamised roadway is not economical.* However that may be, it is unquestionable that for very heavy traffic blocks of hammer-dressed stone, laid upon a concrete or hard gravel bed, have been in use for a great number of years, and indeed the Romans, who were great road makers, introduced the system (the Archaic, as it is sometimes called) into this country more than 2000 years ago; the size of the paving stones was, however, much larger than modern science finds necessary.

There is no doubt that a roadway paved with granite or whinstone setts, upon a hard concrete foundation, presents a most enduring pavement, costing but a few pence per annum in repairs† and cleansing, and in other respects it answers nearly all the requirements of traffic except in two very important particulars—it becomes very greasy and slippery under certain conditions of the weather after having been laid any time, and it is an intolerable nuisance in any great thoroughfare, from the incessant din and clatter arising from the wheels of vehicles and the iron shoes of the horses striking upon it; so great is the noise in some thoroughfares thus

* Birmingham in 1854 had not, I believe, a single mile of paved streets; the principal ones are now nearly all paved with granite setts, and over 20,000 square yards were so paved in 1880.

† It is said that the cost per annum per square yard of granite paved roadways is but 3*d.*, whereas the same cost for macadamised roadways under the same circumstances is 1*s.* 6*d.*

paved, that tradesmen are compelled to keep their doors and windows tightly closed in order that they may be able to conduct their business, and it is known to injuriously affect the nerves and health of persons who are obliged to live in the vicinity of such streets. It is a bad pavement too for horses to travel upon, the jar upon the legs of the unfortunate animals soon telling upon them.

Great improvements, however, have in recent years been introduced to correct these faults. The setts are now made very narrow, about 3 inches in width, or 4 setts to 14 inches including the joints: this gives a better foothold for the horse, the hoof having but a little way to slip before being arrested by a joint; it also lessens the noise, and helps besides to prevent the edges of the stones becoming worn or the pavement wearing unevenly.

Running the joints with an asphaltic composition instead of ordinary grouting has also materially conduced to deaden the noise.

Taking the question of cost into account—and cost of this description of paving, be it remembered, is considerably affected by weight, when carriage of the stone has to be considered—the following sizes of stones may be taken as satisfactory.*

Depth	6 to 8 inches
Width	2½ ,, 3 ,,
Length	5 ,, 9 ,,

The following table,† showing the number of square yards that 1 ton in weight of different sizes of granite setts will

* In Paris after considerable research into the question, the engineers of the Ponts et Chauseés, decided that the size of the paving stones, which used formerly to be 9 inches square should be 4 inches wide by 6½ inches long by 6½ inches deep, the stone that is used being a grit sandstone, from the forest of Fontainebleu.

† *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lviii. p. 66.

cover, may be of use, but this must vary with the specific gravity of the stone employed.

Depth.		Width.		Square yards.
5 inches	×	3 inches	covers	4½
6 ,,	×	3 ,,	,,	3½
4 ,,	×	4 ,,	,,	5½
7 ,,	×	3 ,,	,,	3

The question of the best class of stones to employ as a paving material must to a great measure depend upon local circumstances, but it is important to select such stones as are very hard and durable, but which will not wear smooth and slippery nor round by reason of the chipping off of their edges.

Nearly all granites are suitable for this work, but Carnarvonshire syenite* is said to be the best material that can be used, although, being denser than granite, it is heavier and consequently more expensive.

At one time large quantities of paving stones were used in London and Liverpool which were brought from Bombay and China, as ballast for ships trading between those ports.

Mount Sorrel from Leicestershire and the Welsh stones are said to wear slippery† as well as porphyry, whereas the presence of felspar in the granite always keeps it rough under traffic.

Of the granites, that from Dalbeattie in Scotland is said to be the best.

The table on the next page, prepared by Mr. Walker in 1831, showing the wear of different stones, may be of interest.

* Syenite is a hard, greenish-grey metamorphic rock, composed principally of silica, alumina, and lime, in conjunction with magnesia, iron, etc. Its specific gravity is 2·96.

† Mr. Boyle, District Surveyor of Manchester, says: "I would caution you against the use of the old blue Penmaenmawr stone as being an extremely slippery stone, and one which makes a dangerous pavement." *Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers,' vol. iii. p. 58.

TABLE SHOWING THE RESULT OF EXPERIMENTS MADE BY MR. WALKER ON THE WEAR OF STONES IN 1830–31, A PERIOD OF 17 MONTHS.

Name of stone.	Superficial area in feet.	Original weight.	Loss of weight by wear.	Loss per superficial foot.	Relative losses.
		cwt. qrs. lbs.			
Guernsey	4·734	7 1 12·75	4·50	0·951	1·000
Herm	5·250	7 3 24·25	5·50	1·048	1·102
Budle	6·336	9 0 15·75	7·75	1·223	1·286
Peterhead (blue) ..	3·484	4 1 7·50	6·25	1·795	1·887
Heytor	4·313	6 0 15·25	8·25	1·915	2·014
Aberdeen (red) ..	5·375	7 2 11·50	11·50	2·139	2·249
Dartmoor	4·500	6 2 25·0	12·50	2·778	2·921
Aberdeen (blue) ..	4·823	6 2 16·0	14·75	3·058	3·216

The Aberdeen granite as at present laid in the City of London, 3 inches wide by 9 inches in depth, has a life of about 15 years.* In the City of Durham whinstone setts of the same width last 17 or 18 years, in Manchester similar granite setts last 15 to 20 years. On this subject Mr. Deacon, the then Borough Engineer of Liverpool, has collected some most valuable information, and I refer my readers to a paper read by him before the Institution of Civil Engineers in 1879,† for a great deal of useful information on this and other subjects connected with roadways.

Various methods have been adopted for constructing granite paved streets, some of which I will proceed to describe.

One of the first really good granite pavements introduced into London was that known as the "Euston Pavement," and it was constructed in the following manner: The foundation was shaped to the intended surface of the finished roadway; upon this a layer of coarse gravel was spread 4 inches in thickness, this was well rammed,‡ and upon it was

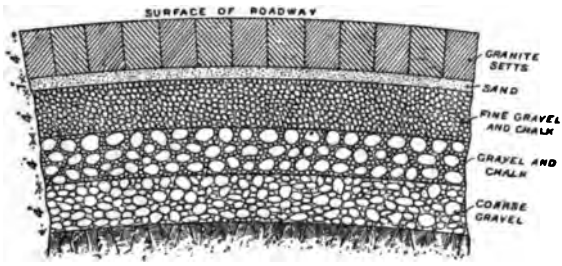
* The old granite paving of London used only to last eight years. *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. ix. p. 222.

† *Vide* 'Street Carriageway Pavements,' by George Frederick Deacon, M. Inst. C.E., 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lviii. p. 1 *et seq.*

‡ The pavior's rammer is about 55 lb. in weight, with an iron ring at its foot; this is swung with some dexterity between the legs, and is allowed to fall with great force upon the earth or stones it is in use upon.

spread 4 inches of gravel mixed with a small quantity of chalk to bind it; this again being well rammed, upon it was placed a similar layer only composed of finer gravel, and upon this foundation the stones were placed, being bedded upon about an inch of fine sand. The stones used were Mount Sorrel granite, which were hammer-dressed and squared, 3 inches in width by 4 inches in depth; they were set close together at right angles with the lines of the kerb, they were then thoroughly rammed by the pavior. The whole surface was afterwards covered with screened gravel which was allowed to find its way into the joints and thus steady the entire pavement.

The following section will explain this.



In many cases the foundation is simply formed by shaping the soil to the required contour, and covering this with 3 or 4 inches of gravel or cinders, which is afterwards either rammed or consolidated by the traffic; upon this the setts are placed as closely as possible, the joints are then filled with fine gravel well worked in with a "cramming iron," the whole surface being then covered with a grouting of lime and sand, which is brushed into the joints with a stumpy broom.*

* The usual specifications for the Guidet paving blocks (in New York) require that they shall be of granite, equal in hardness to the Quincy granite, of durable and uniform quality, each measuring not less than 3½ nor more than 4½ inches in width on the upper surface or face, and not less than 10 nor more than 15 inches in length, and not less than 8 nor more than 9 inches in depth. Blocks of 3½ inches in width on the face to be not less than 3 inches in width at the base; all other blocks to measure on the base not more than 1 inch less in width or in length

In Leeds, Manchester, Salford, and many other important cities, I believe the foundations are formed in the manner just described, but of greater depth, the grouting also is a bituminous mixture, which I will presently describe, instead of the ordinary lime grouting.

The paved streets of Manchester are proverbial for their excellence, which is attributable to the manner in which the foundations of the streets are consolidated by the traffic before any setts are placed on them; in many cases the old macadamised surface of a street being utilised as a foundation, this process being almost identical with that recommended by Sir Henry Parnell fifty years ago.*

Where the traffic is heavy, however, a firmer foundation even than this is necessary, and up to the present time no better foundation has been introduced than that of good Portland cement concrete. This should be at least 9 inches in thickness, and be composed of one part of Portland cement, two parts of clean sharp river sand, and four parts of clean river ballast, or broken stones, or other suitable material. The surface of the concrete, after having been placed in position, should be smoothed over with the shovel, so as to present the proper convexity and have an even surface for the granite setts to be bedded upon.

Another description of foundation now very extensively used where the traffic is heavy, is that known as "Bituminous Concrete," which is made as follows:

The ground being excavated to the proper depth and contour, broken stone as for macadam is spread for a depth of

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than on the face. The blocks are set upright in close contact on their edges in courses, with the longest dimensions and the continuous joints running across the street, breaking joints lengthwise of the street.

The ends of the blocks are dressed off so as to give close joints in the direction of the draught, while the broad vertical sides of the blocks are left rugged or uneven, or with the split rock-face so that the continuous joints running across the street are somewhat open. *Vide* 'Roads, Streets, and Pavements' by Q. A. Gillmore, p. 157.

* *Vide* 'A Treatise on Roads,' by Sir Henry Parnell, p. 130.

6 or 9 inches; this is then levelled and thoroughly rolled with a light roller, a boiling mixture of pitch and tar, or creosote oil is then poured over the whole surface until every interstice is filled, when a thin layer of small broken stone is spread upon it, and then well rolled until it consolidates.

It may be well to observe here that in all works involving concrete foundations and paving in streets, the traffic should be entirely stopped if at all possible. Streets paved half at a time are never quite satisfactory, and the concrete should have at least a week to set before the pavement is placed upon it.

Upon a foundation of either Portland cement or bituminous concrete, the granite setts themselves should be grouted with a bituminous mixture instead of cement or lime grouting. This renders the pavement more impervious to moisture, makes it less noisy, and adds considerably to its strength; the mode of applying it is nearly similar to that of ordinary grouting. The setts are placed on about an inch of sand and well rammed, the boiling mixture is then poured over the whole surface, which is then covered with a thin coating of small, sharp gravel.

The following table of the proportions necessary for the bituminous mixture may here be of use.

PROPORTIONS FOR BITUMINOUS MIXTURE.*

	Pitch.	Tar.	Pitch.	Creosote oil.
For grouting in pavements	1 to	1 or	3 to	1
For foundations or lower layer of asphalte macadam	3 to	1 or	3½ to	½
For upper layer of asphalte macadam and for foot paths	2½ to	1½ or	3¼ to	¾

The objections to this method of paving are only temporary: the nuisance arising from the fumes of the boiling mixture whilst it is being applied, and the necessity for dry

* As these ingredients often vary very much in their constitution, the surveyor must use his judgment to a great extent as to these proportions.

weather to make the operation successful. Healey's Patent Pitch Boilers * are said to moderate, if not entirely to do away with the former, and the latter can be arranged by only doing the work at favourable seasons, or if the worst come to the worst, to cover the work with tarpaulins raised on trestles.

Before closing this chapter I should like to draw attention to the question of provision for wheel tracks, or tramways paved with stone, asphalte, or other hard material, and a track for horses giving a firmer foot-hold, similar to those so highly spoken of in Milan and other Italian cities. An excellent description is given of them by Mr. P. le Neve Foster, Jun., in an appendix to a report on the Application of Science and Art to Street Paving and Street Cleansing of the Metropolis (1872).

The roadway where stone tramways are employed cannot be of convex section; on the contrary, it should be concave, with the channel, gutter, or water table in the centre. This is in itself an obvious advantage, and I trust that the question of these tramways may at some future date receive more attention from English engineers; the great objection to them in this country being that the smooth tram-track would be very slippery and apt to throw horses down when passing on and off, but they have many advantages which should not be passed over without consideration.†

* These boilers are now much used for such purposes, they hold from 60 to 500 gallons and are light and portable; the temper of the bituminous mixture also remains uniform whilst being drawn off, and there is very little evaporation or waste arising from them.

† Since writing the above, the Liverpool and Manchester tram-road was designed I believe on this principle.

CHAPTER IX.

WOOD PAVING.

IN the year 1843 Mr. Charles Cochrane, the President of the 'Association for the promotion of Improved Street Paving, etc.,' in a paper which he read before the Institution of Civil Engineers, on the State of the Streets of the Metropolis, said that there existed at that date 100,000 yards of wood pavement.* He further states that it is said to be slippery, but that he approves of it as the best material hitherto used, "both as regards its general economy and durability as well as its facility of traction, and more especially its extreme cleanliness."

Two years previous to this date, Mr. Edward Lomas condemned wood pavement as slippery, and recommended granite pavement for horses with wood tram-tracks for the wheels of vehicles.†

Since these dates the question of wood paving has made giant strides, many companies and private firms having started business as wood paviors, with many various methods, which they strongly advocate as being superior to the others; amongst them I will enumerate and describe the following:

The Improved Wood Pavement Company.—The ground being consolidated, a layer of sand is made the basis of the pavement, and assumes the shape the surface of the street is intended to take. Red-wood boards 1-inch in thickness are then laid across the roadway, from kerb to kerb, placed together so as to break joint; boards of the same material and

* The first wood pavement laid in London was in front of the Old Bailey, in 1839.

† *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. i. p. 131.

thickness are then laid longitudinally, and breaking joint in the same manner.* On this foundation red-wood blocks are placed in rows, taking the same direction as the under flooring.

Between each row of blocks, a strip of wood $\frac{3}{4} \times \frac{3}{4}$ inch is nailed to the block and flooring, the blocks in all cases breaking joint ; the spaces thus formed between the rows of blocks are then run with a thick composition which fills all vacant spaces there may be between the strip and the block, covering the strip about $\frac{1}{8}$ of an inch. Gravel, dried and sifted through $\frac{3}{4}$-inch mesh, is then put in, solidly rammed, and composition poured in ; the pavement is then covered to a depth of $\frac{1}{2}$ an inch with dried gravel and composition for the purpose of indurating the surface, and filling the spaces flush with the top of the block, a slight covering of sand is then spread, when the traffic may immediately pass over.

The Asphaltic Wood Pavement Company.—After the ground is properly prepared, 6 or 9 inches of concrete is laid, on this is laid a bed of asphalte not less than $\frac{1}{2}$-inch in thickness; then wood blocks 3 by 8 by 5 inches or 3 by 9 by 5 inches, of good, sound, yellow Baltic timber are laid with joints $\frac{1}{2}$-inch in width, these joints are filled from 2 inches up with heated asphalte, the remaining 3 inches being filled with a grouting of hydraulic lime, and clean, sharp, fine river grit or sand, the whole being covered with a top dressing of fine, sharp sand, which wears in with the traffic.

Croskey's Wood Pavement.—Upon a bed of concrete, cross grained planks were to be placed side by side and be forced together by pressure so as to form a compact homogeneous surface of wood.†

Lloyd's Patent Keyed Wood Pavement.—The special feature of this system is that *Pitch Pine* blocks are used laid

* This specification is the company's own, as advertised when they first began business ; for many reasons the boards have since been discontinued, and other alterations introduced into the system.

† I am unable to ascertain if this plan has ever been tried anywhere.

direct upon the concrete foundation, the blocks being grooved on each side so that the grouting (composed of Portland cement) shall run in and form a key.

Harrison's Wood Pavement.—This system consists of a concrete foundation, upon which strips of wood 2 inches wide by ½ an inch in thickness are laid. Upon these, wood blocks 3 inches in breadth are placed, and then hot asphalte is poured into the joints, which conglomerates the whole.

Henson's Wood Pavement.—The main feature of this patent consists in placing common felt on the concrete bed, and between the joints of the wood blocks; thus, it is contended, giving elasticity and allowing for the expansion and contraction of the blocks. The blocks are also bevelled on the top and grooved in a particular manner.

Carey's Wood Pavement.—In this case the blocks are cut 4 inches wide by 9 inches long, and 5 or 6 inches deep, according to the traffic; these blocks are shaped with alternate convex and concave ends, and are laid on a bed of sand about 2 inches thick, the joints between the blocks, which have been left about ⅜ inch wide, being filled with a grouting of lime and sand.

Messrs. Mowlem and Company's method of laying wood paving is to form a foundation of concrete, varying in thickness according to the nature of the subsoil and the traffic; then to pave with blocks of yellow deal, 3 inches wide and 6 or 7 inches deep; the joints, which vary from ⅜ to ½ inch, are filled in with sand and lias lime, and the surface is afterwards indurated by strewing it with shingle.

Patent Ligno-Mineral Paving Company.—This company lays claim to the speciality of using hard woods as well as pine, and that the pine blocks they employ are preserved or mineralised so as to be more durable than the wood in its natural state.*

* It is also affirmed by the Borough Surveyor of Sunderland that this process dispenses with watering. *Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. iii. p. 72.

Nicholson's Wood Pavement.—This is principally in use in the United States, and consists of rectangular blocks of pine laid upon a close flooring of pine boards, 1 inch thick, laid lengthwise with the line of street, their ends resting on similar boards laid transversely from kerb to kerb, the boards being thoroughly tarred and laid upon a bed of sand. The joints of the wood blocks are run with an asphaltic mixture, and the whole surface is finally covered with hot coal tar and sprinkled with fine sand and gravel.

Stowe's Wood Pavement.—This is also American, the blocks resting directly upon sand or gravel about 6 inches in thickness.* "The blocks are set in courses transversely across the street, so as to break joint lengthwise of the street, the courses being separated from each other 1 inch by a continuous course of wooden wedges placed close together edge to edge, and extending from kerb to kerb. These wedges are set in the first instance with their tops flush with the top surface of the blocks. After the whole pavement shall have been well rammed, so as to give each block a firm bed, the wedges are driven down about 3 inches, and the open joints thus formed above them between the courses are filled in with a concrete composed of hot coal tar and fine roofing sand and gravel. The surface of the pavement may then be coated with coal tar prepared by boiling with pitch, and finished off with a thin layer of sand."

Wood Paving in Norwich.—Mr. P. Marshall, the City Surveyor of Norwich, states† that the wood pavement in that city is "simply laid on the road formation levelled up with shingle. The blocks are grouted in with blue lias lime and well rammed down. This makes a splendid road, and is superior to any portion of the road that has been laid with

* *Vide* 'A Practical Treatise on Roads, Streets, and Pavements,' by Q. A. Gillmore, p. 166, which see also for a good account of wood pavements in the United States.

† *Vide* 'Wood Pavements,' by Henry Allnut, 1880, p. 22.

concrete. This wood paving, 5 inches deep, laid as described, costs *7s.* per yard super. We have had some down here now for 2 years, and have had no settlement whatever. It is a very important matter, for it makes wood paving possible for country towns."

Shiel's Composite Block Paving.—This pavement consists of composite blocks 12 inches by 15 inches, cast in iron moulds with two rows of wood placed at an equal distance from either side and each other, the vacant spaces being filled with granite broken as for macadam; over all is poured a boiling composition of pitch, chalk, and sand. The blocks are thus treated at the works, and are, when cool, taken to the street, laid on a concrete foundation, and grouted with cement grouting.

Prosser's Wood Pavement.—This is composed of blocks sawn at an angle of 60°, the grain of the wood running in the same direction. Each end of the block rests on the other, transversely to line of street. Between the rows of blocks a plank, the same depth as the blocks, but with the grain of the wood horizontal, is placed. The blocks, which on one side of the plank lean in an opposite direction to those on the other, are secured or dowelled together by wooden pins running through the plank and piercing the blocks about an inch.

In Chicago, U.S.A., cedar blocks 6 inches square, set on a composition of tar and gravel, are used, and are said to make a very durable pavement.

The following sanitary objections to wood as a material for pavements are made in the Report on the Application of Science and Art to Street Paving and Street Cleansing of the Metropolis (1872) page 17.

"The General Board of Health set aside wood as an ineligible material for this amongst other reasons, that street surfaces ought to be impermeable; and for roads of light traffic and cheap construction, they looked to modifications of

macadam, with bituminous binders of mineral tar. Since then wood has been reproduced for the purpose, and strongly pressed in improved forms for trial. It certainly offers the advantage of a great gain in noiselessness over granite, more especially from the horses' feet, though with some disadvantage from a dead rumble and vibration; and further it has the advantage of being more available than smooth pavements for inclines. But hygienists object to its use on grounds which, in the absence of sanitary science, are overlooked, but which it is important to particularise as showing the dangerous state of ignorance and incompetency of the authorities by whom they are not entertained or are disregarded."

The sum total of these charges against wood as a pavement consists in the following: "Wood is porous, it is composed of bundles of fibres, it absorbs and retains wet, foul wet especially." Why *foul* wet should be absorbed more than ordinary wet does not transpire.

There is no doubt that wood in its natural state does absorb a large quantity of water,* but this can be avoided in wood paving by preserving the wood of which it is composed by one of the following processes.

(1) Burnetising	Chloride of zinc is used in this process.
(2) Kyanising	Corrosive sublimate is used.
(3) Renwickising ..	Boiling in coal tar.
(4) Boucherising	Sulphate of copper is used.
(5) Bethelising	Creosote heated to 200° F. is used.
(6) Seelyising	Creosote is also used, the wood being first boiled.
(7) Hayfordising	Creosote is also used, wood being unseasoned.

The fibres of the wood are also compressed, and no open joints between the blocks are permitted, by paving the blocks

* The power of absorbing water by wood varies from 9·37 to 174·86 per cent. in dry wood. In its ordinary state the power varies from 4·36 to 150·64 per cent. The quantity of water contained in wood in its natural state varies from 4·61 to 13·56 per cent. *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lvi. p. 300.

transversely, with butt joints closely packed together, and by filling the cross joints with an asphaltic or other impervious grouting.

Wood paving should, however, be laid in streets with moderate traffic, and plenty of sun and air. In confined spaces such as courts, it soon rots and becomes a source of much unhealthiness.*

Many reports have been from time to time made on the advantages and disadvantages of wood paving, and much has been said and written upon the subject, so that I will only touch upon some of the principal questions at issue.

The first of importance is that of durability, and although the life of a hard wood constantly exposed to attrition is amazing, as may be seen on the stairs of the Metropolitan Railway Stations, and in many cog wheels of old machinery, still some diversity of opinion exists as to what may be fairly put down as the wear per annum of the surface of a street paved with wood blocks.

It must be remembered that to arrive at any fixed ratio of wear, a standard of traffic should be fixed; but this unfortunately has not hitherto been done, so that the results of observations are bound to differ considerably. It must also not be lost sight of that the reason of excessive wear in a wood pavement generally arises from wide joints being the means of causing the edges of the blocks to abrade and become worn.

Mr. D. T. Hope, in a paper he laid before the Scottish Society of Arts, upon some most careful investigations he had made on this subject, gives the wear as $\frac{1}{8}$ of an inch in 18 months on blocks laid with vertical fibre, which he proved was the best manner of laying them to ensure the longest life.

* *Vide* 'Roads and Roadways,' by George Waller Wilcocks, 1879, p. 34.

Mr. Deacon estimated the wear at from $1\frac{3}{8}$ inch to $2\frac{5}{16}$ inches per annum.*

Mr. Copland estimated the wear at $\frac{3}{16}$ of an inch per annum.†

Mr. Howorth estimates the life of wood paving at 25 years per inch of wood, if an absolutely uniform quality of wood fibre could be assumed.‡

Mr. Haywood says,§ "Wood pavements with repairs have in this City (London) had a life varying from 6 to 19 years, and that with repairs, an average life of about 10 years may be obtained."

The life of wood is no doubt extended by being preserved by one of the processes I have enumerated, but as its life may be taken as an average of 8 to 10 years, and as the blocks are bound to wear unevenly, they should be made as shallow as is consistent with stability; as it is an undisputed fact that the foundation of a roadway is the important carrier of the traffic, the surface material, of whatever it may be constructed, only acting as a skin to preserve it. If the blocks are too thick, unnecessary capital is locked up.

Wood pavement was laid in Sunderland‖ in 1859 with strips of creosoted red pine, creosoted beech wood, and unpreserved oak, the bulk of the paving being unpreserved red deal, and this was replaced in 1867.

In 1877, on renewing the pavement, it was found that the creosoted wood suffered less from wear and tear than the unpreserved, so the whole was done with creosoted red pine,

* *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lviii. p. 82.

† *Ibid*, vol. lx. p. 293.

‡ *Ibid*, vol. lviii. p. 45.

§ 'Report upon Asphalte and Wood Pavements,' by William Haywood, (1874) p. 44.

‖ See 'Paper on Wood Pavements,' by R. S. Rounthwaite, Boro' Surveyor, Sunderland, 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. vii. p. 48.

the original strip of creosoted red pine was left untouched, the strip of oak was turned, and the beech was merely raised; and there is no doubt that the best wood pavement is that which can be constructed in the simplest manner, as for instance deal blocks 4 or 5 inches deep, laid with a close joint upon a Portland cement concrete bed, the blocks being well grouted in with Portland cement grouting, their surface being afterwards sprinkled or strewn with sand or sharp gravel.

The woods employed for paving are beech and oak, both of which are said to be too slippery, elm, which is not durable, pitch pine and Baltic fir. Memel and Dantzic timber is better than Riga, the best wood for the purpose being said to be Wyborg or St. Petersburgh red deals.

All sappy wood must be at once rejected as unsuitable. This is a great objection to creosoting or other preserving, processes, as it hides defects in the wood.

The advantages of wood paving may be summed up as follows:—

(1.) It is the quietest of all known pavements, wheels make scarcely any noise upon it and there is no clatter of horses' hoofs.

(2.) It is much safer than either asphalte or granite pavements for horses travelling upon it and if a horse falls he can rise more easily.

(3.) The traction necessary upon it, though slightly greater than upon asphalte, is compensated for by the better foothold given to horses.

(4.) It is clean. If well constructed there should be no mud made upon it; all that appears upon its surface should arise either from its being imported upon it, or from the gravel with which it is sometimes necessary to dress the surface.

(5.) It presents a uniform and slight elasticity, which is of great benefit to vehicles passing over it.

(6.) It may be laid on a gradient of 1 in 20 with safety to the traffic.

The principal objections to wood as a paving are :—

(1.) It is said to absorb moisture and to smell offensively, but this has often been refuted.*

(2.) It is said to be difficult to cleanse without the aid of water, as dirt adheres to the wood, and lingers in the joints.

(3.) It is not easy to open it or repair it, for the purposes of gas and water pipes, etc., and rather a large surface has to be removed for this purpose, and it has to be left a little time after repairs before traffic is again allowed on it.

(4.) The wood swells if wet, and cases are on record of the side kerbs of streets being raised, and lamp posts thrown down, by the pressure of the wood thus swelling.†

With regard to the cost of wood paving. This must vary in different localities, according to the value of labour, of materials, and in the manner in which the work is done.

The practice of most of the companies engaged in this class of work is to make a fixed charge per square yard for the pavement, including the concrete but excluding the excavation, and they also guarantee to keep the pavement in

*. The surveyor of the parish of St. George's Hanover Square, London, says, "My experience of wood, and I have laid down 25,000 yards, is that it is perfectly free from smells, even on a cab rank." Report of a Committee of the Paddington Vestry on Wood and other Pavements (1878) p. 30.

† Mr. Allnutt says on this : "As to the swelling of the wood, it has been remarked that even brick walls have been forced out. We do not see what provision can be made for this ; but leaving the channel by the kerb stone for the last work may relieve the lateral pressure, and perhaps it would be as well for the blocks not to be so dry when being laid down." *Vide* 'Wood Pavement as carried out on Kensington High Road, Chelsea, etc.' by Henry Allnutt (1880) p. 15.

repair free of charge for one or two years, and then for so many years after, at so much per yard per annum.

About 14*s.* per square yard is generally the first charge for constructing, and 1*s.* per square yard is the annual charge for maintenance.

Upon the subject of cost the following tables* may be useful.

TABLE SHOWING THE ACTUAL DURATION AND COST OF CERTAIN WOOD PAVEMENTS IN THE CITY OF LONDON.

Situation.	Date when laid New.	Life.	First Cost per Square Yard.	Total Cost of Repairs per Square Yard during Life.	Average Cost per Square Yard per Annum.
		Yrs. Mths.	£ s. d.	£ s. d.	£ s. d.
Cornhill	May, 1855	10 2	0 12 2	0 17 4½	0 2 11
	July, 1865	6 8	0 11 6	0 8 9¾	0 3 0½
Gracechurch Street	Nov. 1853	11 7	0 12 8	0 17 1½	0 2 6¾
	June, 1865	6 0	0 11 6	0 6 11	0 3 0¾
Lombard Street ..	May, 1851	9 4	0 9 6	0 6 0	0 1 7¾
	Sept. 1860	10 7	0 9 2	1 0 2	0 2 9
Lothbury	May, 1854	12 3	0 12 6	1 8 4¾	0 3 4
	Aug 1866	6 1	0 12 6	0 3 5¾	0 2 7½
Mincing Lane ..	July, 1841	19 1	0 14 4	0 13 4	0 1 5¼
	Aug. 1860	13 0	0 9 2	1 2 6¾	0 2 5¼
Bartholomew Lane	May, 1854	12 3	0 12 6	0 17 5¾	0 2 5¼
	Aug. 1866	5 5	0 12 6	0 3 11¼	0 3 0¼

Foundations are included, but no excavation.

* *Vide* 'Report on Asphalte and Wood Pavements,' by William Haywood, 1874, pp. 38 and 41.

TABLE SHOWING FIRST COST, AND TENDERED COST PER ANNUM FOR MAINTAINING CERTAIN WOOD CARRIAGEWAY PAVEMENTS IN THE CITY OF LONDON.

Situation.	Date when Laid.	Name of Contractor.	Years to be maintained by Contractor.	First Cost per Square Yard.	Agreed Cost of maintenance per Square Yard for the Contract Term.	Total Cost of Pavements during Contract Term, per Square Yard.	Average Cost per Square Yard per Annum.
				£ s. d.		£ s. d.	£ s. d.
King William Street	Feb. 1873	Improved Wood Paving Co.	16	0 18 0	1 year free 15 years at 1s. 6d. = 1l. 2s. 6d.	2 0 6	0 2 6¾
Ludgate Hill ..	Nov. 1873	Ditto	16	0 18 0	1 year free 15 years at 1s. 6d. = 1l. 2s. 6d.	2 0 6	0 2 6¾
Portions of Great Tower Street and Seething Lane	Sept. 1873	Ditto	16	0 16 0	1 year free 15 years at 1s. 3d. = 18s. 9d.	1 14 9	0 2 2
Bartholomew Lane	Jan. 1872	Carey	No agreement	0 12 6	—	—	—
Ditto	Dec. 1871	Improved Wood Paving Co.	3	0 16 0	3 years free	0 16 0	—
Duke Street	May, 1873	Mowlem and Co.	*5	0 15 0	2 years free 3 years at 1s. = 3s.	These pavements will no doubt last some years longer than the contract term of maintenance.	
Houndsditch ..	Not yet laid	Ditto	*7	0 17 0	2 years free 5 years at 9d. = 3s. 9d.		
Ditto	Ditto	Carey	*7	0 13 6	2 years free 5 years at 1s. = 5s.		

In the wood pavements the cost of the foundation is included, but no excavation.
The pavements at the end of each financial year are to be in a good sound condition.
* The Ligno-Mineral Paving Company and the Improved Wood Paving Company offered to maintain their pavements, if laid, for terms of ten years and fourteen years respectively; their tenders were not accepted.

The following table* is also given as showing the comparative cost of wood paving with macadam and bituminous concrete paving in Liverpool.

Description of Pavement.	Original Cost per Square Yard at present prices.	Deductions from First Cost to determine Cost of Renewal.		Interest on Original Cost at 4½ per cent. per Square Yard per Annum.	Sinking Fund invested at 3 per cent. Compound Interest.	Maintenance per Square Yard per Annum.	Scavenging per Square Yard per Annum.	Gravelling per Square Yard per Annum.	Total Annual Cost per Square Yard.
		Cost of Foundation not requiring renewal.	Allowances for old Materials at date of renewal.						
	s. d.	*s. d.*	*s. d.*	*d.*	*d.*	*s. d.*	*d.*	*d.*	*s. d.*
No. 6. Bituminous Concrete Pavement	3 9	Nil	Nil	2·0	Nil	0 9	2·4	..	1 1·4
No. 7. Wood Pavement ..	15 1·5	2 0	Nil	7·5	4·3	0 1·0	2·7	5 0	1 8·5
No. 8. Macadam Pavement	6 9	Nil	Nil	3·4	Nil	1 0	8·0	Nil	1 11·4

* *Vide* 'Paper on Street Carriageway Pavements,' by G. F. Deacon, 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lviii. p. 23.

In concluding this chapter upon wood paving, I will give a specimen specification for work of this description.

Excavation.—Excavate the ground to a depth of — inches below the level of the proposed finished surface of the roadway.* The formation surface thus excavated must be well watered and rolled or punned if found necessary, and any soft or made earth removed to such a depth as may be found to be sufficient.†

Foundation.—Upon the excavated formation surface a bed — inches thick of concrete is to be laid, composed of one part of good approved Portland cement to two of fine, sharp river sand, and three of clean river ballast or broken stone. The concrete to be finished off with an even and smooth top surface conforming with the contour line of proposed finished roadway.

Wood Blocks.—Upon the concrete thus laid, and after it has sufficiently set, wood blocks are to be laid.‡ These blocks must be of the best description of Baltic red timber§ (or such other timber as shall be specified), sound and thoroughly well seasoned, free from all sap, shakes, large and loose knots or other defects, and any that may be rejected by the surveyor as unfitted for the work shall be at once removed from the works or broken up. The blocks must not be less than 6 inches or more than 12 inches in length by 3 inches in width and 6 inches in depth, they are to be carefully laid with the fibre of the wood placed vertically, their ends

* If the road material thus excavated is macadam, it may be screened and used as concrete in the foundation, if approved by the surveyor. The granite pitching of crossings, channel gutters, etc., must remain the property of the sanitary authority, as well as the surplus macadam.

† It is important to give sufficient notice to gas and water companies in order that they may attend to their mains and services before the foundations are put in.

‡ Sometimes about half an inch of fine sand is spread upon the surface of the concrete upon which the wood blocks are bedded.

§ If the blocks are to be creosoted, the number of pounds of creosote that should be absorbed in a cubic foot of the wood should be specified; this is generally about 10 lb. of creosote to 1 cubic foot of wood.

must butt with close joints to each other, and each course must be kept ⅜ of an inch apart by means of wooden laths, which are afterwards removed.

Joints.—The joints are then to be carefully run with a grouting composed of one part of best approved Portland cement to two parts of fine, sharp, clean river sand. (In some cases a hot bituminous mixture or asphalte is run between the joints as a grouting.)

Top Dressing.—The whole surface of the pavement is then to be spread with a coating, at least ½-inch in thickness, of fine sharp gravel or chippings.

The following heads of general conditions under such a contract may also be useful.

Alteration of gullies, sewer man-holes etc., will be done at the expense of the sanitary authority.

Contractor must make good at once any damage caused to gas or water mains or services—time penalty for delay.

Maintenance of work after completion for a specified time.

Power must be reserved to surveyor to suspend work during bad weather or from other causes.

Heavy time penalties for non-completion of contract by a certain date.

Payments to be made to contractor on surveyor's certificate, up to 80 per cent. of whole contract, remaining 20 per cent. to be paid at end of (say) 2 years after completion.

With the above specimen specification I conclude the chapter on Wood Paving.

CHAPTER X.

COMPRESSED ASPHALTE ROADWAYS.

THE word asphalte in its generally accepted sense implies a natural rock consisting of pure carbonate of lime, intimately combined and impregnated with mineral bitumen in very variable proportions; that used for roads or footpaths should not contain less than 7 or more than 12 per cent. of bitumen.

The rock when broken takes an irregular fracture without definite cleavage; it is principally derived from Val de Travers, Seyssel, Sicily, Chieti, Auvergne, Lobsann, and Limmer. Its grain should be regular and homogeneous, the finer the grain the better.*

When exposed to the atmosphere asphalte gradually assumes a grey tint, by reason of the bitumen evaporating from the surface leaving a thin film of limestone behind. The stone is usually taken from open quarries, but at Val de Travers shafts are sunk and the general treatment is similar to a coal mine.

Bitumen, it must be borne in mind, is itself a mineral product found in Trinidad and some other places; it is composed of carbon, hydrogen, and oxygen.

The weight of a cubic yard of natural asphalte is about 3874 lbs., its specific gravity is 2·114, but this of course varies with its percentage of bitumen.

The following is a test for asphalte given by Mr. Deland in a paper he read before the Institution of Civil Engineers in the year 1880.†

* In this respect the Seyssel is the best, being of a very fine grain.

† *Vide* 'Minutes of Proceedings of Institution of Civil Engineers,' vol. lx.

"A specimen of the rock freed from all extraneous matter, having been pulverised as finely as possible, should be dissolved in sulphurate of carbon, turpentine, ether or benzine, placed in a glass vessel and stirred with a glass rod. A dark solution will result, from which will be precipitated the pulverised limestone. The solution of bitumen should then be poured off. The dissolvent speedily evaporates, leaving the constituent parts of the asphalte, each of which should be weighed so as to determine the exact proportion. The bitumen should be heated in a lead bath and tested with a porcelain or Baumé thermometer to 428° Fahr. There will be little loss by evaporation if the bitumen is good, but if bituminous oil is present the loss will be considerable—gritted mastic should be heated to 450° Fahr. The limestone should next be examined. If the powder is white and soft to the touch it is a good component part of asphalte, but if rough and dirty on being tested with reagents it will be found to contain iron pyrites, silicates, clay, etc. Some asphaltes also are of a spongy or hygrometrical nature. Thus, as an analysis which merely gives so much bitumen and so much limestone may mislead, it is necessary to know the quality of the limestone and of the bitumen.

"For a good compressed roadway an asphalte composed of pure limestone and 9 to 10 per cent. of bitumen, non-evaporative at 428° Fahr., is the most suitable. Asphaltes containing much more than 10 per cent. of bitumen get soft in summer and wavy, those containing much less have not sufficient bind for heavy traffic, although asphalte containing 7 per cent. of bitumen properly heated does well for court yards, as it sets hard when cold."

For roadways "compressed" asphalte should be used and not "mastic," which is only fitted for footpaths, court-yards, etc. Compressed asphalte roadways are constructed as follows:

The asphalte rock is first crushed in a "Blake's" or other

suitable crusher, then pulverised in what is known as a "Carr's disintegrator," until it is reduced to a powder; this powder is then heated up to between 212° and 250° Fahr. in revolving cylinders and is laid about 2½ inches in thickness upon a concrete foundation previously prepared for its reception, the powder is carefully raked to the required contour and then either rolled or punned with iron punners previously heated to prevent the adhesion of the powder to them.

A roadway thus prepared presents many advantages over macadam, granite setts or wood, the following passage amply describing one of them :*

"An indispensable feature of a weight-carrying pavement must be the absolute exclusion of water at the surface as nearly as it can be insured, and in this one respect it cannot be questioned that a surface like asphalte has no equal, the absorption being so gradual as to be inappreciable during any possible continuance of moisture."

In addition to this indisputable fact the advantage of durability is claimed for asphalte, but this must vary considerably with the quality of the material and of the work. Mr. Hayward estimates the life of an asphaltic Val de Travers compressed roadway at 17 years, and it is claimed for it that it will wear until it becomes quite thin, very heavy traffic breaking it up when it is worn to about ¾ of an inch thick. Another advantage claimed for asphalte is cleanliness, and this is evidently indisputable, as, being impervious, none but imported mud or dust can be formed upon it.

In addition to the foregoing the following advantages are also claimed :

Pedestrians can walk on asphaltic roadways as well as on the footways.

It is comparatively noiseless under traffic, though in this

* *Vide* Mr. Howarth's paper on 'Wood as a Paving Material under Heavy Traffic,' 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lviii. p. 35.

case wood is better, as the clatter of the iron-shod horses' feet upon asphalte is very apparent.

It is expeditiously laid, and when repairs are necessary they can easily be effected; no pavement shows less signs of openings being made in it for gas and water-pipe repairs than asphalte.

The rapid laying causes less inconvenience to traffic in the streets.

Ease of traction; but here steps in the one great objection to asphalte as a roadway paving, viz. danger to horses by slipping and falling, of which I shall say more hereafter.

Cellars and vaults under the streets are kept dry, by reason of its impermeability to moisture.

Easily cleansed, especially by mechanical sweeping, and snow is easily removed.

It is very pleasing to the eye, being so uniformly regular and of good colour.

There is no vibration or concussion in travelling over it, and apart from the question of safety it is delightful to drive over it.

It is a cool pavement at night; it does not absorb heat during the day, and consequently none radiates from it after the sun has gone down.*

The great objection to asphalte as a material for roadways arises from the fact that it is extremely slippery when damp,† irrespective of temperature, and this in the climate of England is frequently the case. The result of this slipperiness is, that not only do horses frequently fall upon it, but it is also difficult

* In Paris and other cities liable to civil war or internal commotions, it is contended as an advantage of asphalte that it cannot be used for the construction of barricades, breastworks, or rifle pits.

† *Vide* Mr. Haywood's Report upon Asphalte and Wood Pavements, also 'Report on the Application of Science and Art to Street Paving and Cleansing of the Metropolis,' and numerous other pamphlets and reports by eminent authorities upon the subject.

to stop a horse when drawing a load, thus causing more risk to foot-passengers of being run over, and straining the horse considerably in its efforts. Again, in thoroughfares crowded with vehicular traffic, constant stoppages occur, and in starting again it is painful to witness the struggles of the horses to keep their footing and overcome the inertia of their load. When a horse falls he has very great difficulty in rising, but on the other hand, although he may be strained, a horse never breaks his knees upon this class of pavement. How far this might be altered if *all* the streets of a town were paved with asphalte, is a fair matter for argument, as it is asserted that horses are very nervous on going from one pavement to another, and accidents frequently happen in consequence.

The strewing of sand upon asphalte renders it less slippery, but in addition to the interference of the traffic whilst this is being done, there are the further objections, of the possible injury of the sand cutting into the asphalte, the expense of labour and materials, and the mud caused thereby which has afterwards to be removed. Another plan is to frequently wash the asphalte with water, but this is expensive and only of temporary benefit.

Another objection to asphaltic roadways is that they cannot with safety be constructed of greater gradient than 1 in 60, and it must also be borne in mind that fine weather is necessary both for the construction and repairs of a roadway of this description.

Very little smell, and that not of an unpleasant character, arises from the work when compressed asphalte is being used, the mastic is however temporarily unpleasant to those who dislike the odour.

With reference to the question of the cost of compressed asphalte for roadways: it is of course a matter depending upon local circumstances as to the first cost, but it must be remembered that the compressed asphalte hitherto laid has

been nearly all that of the Val de Travers Company, who charge a fixed price per square yard for laying according to thickness required, the distance of the locality from London, and other local circumstances. With reference to maintenance, this is a question dependent mainly upon traffic, but here again the company will undertake to keep in repair at so much per square yard per annum for a certain number of years.

It would, however, perhaps be a better plan not to enter into such an agreement, but to arrange for repairs under a schedule of prices, but this must greatly depend upon the character of the work in the first place, and other local considerations.

Mr. Ellice Clarke gives the following as the cost of Val de Travers compressed asphalte.*

The cost is reduced to 100,000 tons per annum per yard of width.

Original Cost per Square Yard.	Interest on original Cost.	Maintenance per Square Yard.	Scavenging per Square Yard.	Total.
s. *d.*	*d.*	*d.*	*d.*	*s.* *d.*
18 0	9·7	3·6	0·4	1 1·7

Nothing is charged for renewal, as the annual sum for maintenance provides the asphalte in perpetuity.†

The following table‡ may here be of use:

* *Vide* 'Asphalte and its Application to Street Paving,' by E. B. Ellice Clarke, 'Proceedings of the Association of Municipal and Sanitary Engineers,' vol. vi. p. 52.

† The asphaltic roadways of Paris, of which there were 290,000 square yards in the year 1878, cost from 10*s.* to 12*s.* per square yard to lay, and about 8·83 pence per square yard per annum to maintain, including the charge for renewing $\frac{1}{15}$th part of the surface every year, which is the method adopted there. *Vide* 'Annales Industrielles,' 1878.

‡ *Vide* Mr. Haywood's report on asphalte and wood pavements, 1874.

TABLE SHOWING THE AGREED COST PER ANNUM OF CERTAIN ASPHALTE CARRIAGEWAY PAVEMENTS IN THE CITY OF LONDON.

Situation.	Description of Asphalte.	Years to be maintained by Contractor.	First Cost per Square Yard.	Agreed Cost of maintenance per Square Yard for the Contract Term.	Total Cost of Pavements during Contract Term per Square Yard.	Average Cost per Square Yard per Annum.
			£ s. d.		£ s. d.	£ s. d.
Cheapside and Poultry ..	{Val de Travers (Compressed)}	17	0 18 0	{2 years free 15 years at 1s. 6d. = £1 2s. 6d.}	2 0 6	0 2 4½
Gracechurch Street ..	Ditto	17	0 17 0	{2 years free 15 years at 1s. = 15s. 0d.}	1 12 0	0 10 1½
Finsbury Pavement	Ditto	17	0 16 0	{2 years free 15 years at 9d. = 11s. 3d.}	1 7 3	0 1 7½
Moorgate Street	Ditto	17	0 16 0	{2 years free 15 years at 9d. = 11s. 3d.}	1 7 3	0 1 7½
Ditto	Limmer (Mastic)	17	0 16 0	{2 years free 15 years at 9d. = 11s. 3d.}	1 7 3	0 1 7½
Lombard Street	Ditto	17	0 16 0	{2 years free 15 years at 9d. = 11s. 3d.}	1 7 3	0 1 7½
Cornhill	Ditto	17	0 15 0	{2 years free 15 years at 9d. = 11s. 3d.}	1 6 3	0 1 6½
Mincing Lane	Ditto	17	0 12 0	{2 years free 15 years at 9d. = 11s. 3d.}	1 3 3	0 1 4½

The cost of foundations is included in this table, but their thickness is not mentioned; the excavation was done for the contractors.

With the one serious objection of slipperiness, compressed asphalte seems a most suitable material for the surface of a roadway, but that objection is of considerable weight when we reflect that the great object of roadways is that of "traffic," and it is for that purpose they are constructed; still, in cities where a heavy *business* traffic is going on, this class of roadway has so many advantages that where cheap horses are driven it might be used; where, however, valuable horses are used for pleasure driving, as in the west end of London and the corresponding better parts of cities, some other description of roadway should be maintained.

Mastic asphalte will be described in the chapter on footpaths.

Specimen Specification for a Compressed Asphalte Roadway.

Excavation and Concrete.—The excavation and concrete * foundation may be specified to be executed in a manner similar to that contained in the specimen specification for wood paving,† except of course that the excavation will be shallower in this case.

Asphalte.—The asphalte to be used shall be the pure unadulterated natural rock known as the Val de Travers, and be unmixed with any foreign or other matter whatever. The rock after being properly broken, shall be ground in a Carr's disintegrator to a powder of such fineness, that not more than per cent. shall be left on a sieve containing meshes to the square inch and decrepitation by heat will not be accepted. This powder shall be heated to 240° F. or such other

* "Lime concrete ruins compressed work." *Vide* 'Asphalte and its Application to Street Paving,' by B. Ellice Clarke. 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. vi. p. 46.

† See p. 94 *ante.*

temperature as shall be found desirable, so as to eliminate all moisture, and carefully transported to the street in covered iron carts, in order that not more than 20° F. of heat shall be lost in transit. The powder must be spread upon the concrete inches in thickness* and carefully raked so as to have regularity of depth and surface.

Ramming.—The powder must then be rammed with iron punners of not less weight than 10 lb. heated so as to prevent the adhesion of the asphalte. The ramming must be done lightly at first, so as to ensure equality of thickness, and afterwards augmented to heavy blows. Where the rammers are not available a T tool must be employed.

To meet some of the objections to compressed asphalte as a material for roadways the "Imperishable Stone Paving Blocks" have been introduced in America; they consist of asphalte formed into rectangular blocks under pressure of about one ton to the square inch, these are laid close together without any grouting, and a pavement of this description is said to combine all the advantages of wood and asphalte, though sufficient time has not yet elapsed to prove this.

In Salford, Manchester, etc., I believe "Woodward's Patent Molten Ironstone Blocks" are used with some success where there is not any very exceptionally heavy traffic.

One of the principal reasons of durability in asphalte pavement is its elasticity, and it should be remembered that compressed asphalte does not begin to "wear" until all compression has ceased; this is the case with no other system of pavement—stone and wood both begin "wearing" from the day the traffic commences. Under ordinarily heavy traffic it may be estimated that it will take two years to complete the compression of asphalte, and the weight of a square foot of this pavement will at the expiration of that time be nearly the same as on the day it was laid, though the thickness is

* It must be $\frac{2}{5}$ths more in thickness than that specified as finished.

reduced during the first two years as much as it will be in the following eight.

Much is said about the advisability of *good* and *dry* concrete, but it may be as well to explain the reasons that necessitate so much care in the foundation. First, it should be always borne in mind that asphalte pavement is nothing more than a tough "carpet," and has no power of itself of offering resistance to heavy traffic; consequently, if the substratum or concrete is not thoroughly solid and resisting, the weight of traffic will crush it, and the asphalte will at once give way in all directions. The concrete should be made strong enough to resist the traffic, and the asphalte is a simple covering to protect the concrete from direct contact with the wear and friction caused by the traffic. So much for the strength, but the dryness is of even still greater importance; for the best asphalte, laid by skilled workmen, on thoroughly first-rate but damp concrete, will rapidly go to pieces—a phenomenon takes place, which, although quite natural, is little realised by most engineers. When the hot asphalte is laid, the water is immediately sucked up and turned into steam, which tries to escape through the heated powder, and the result is that although the surface of the asphalte is smooth, the mass is really disintegrated from underneath by its bitter enemy "water," and as soon as the surface begins to wear, the fissures formed by the passing of the steam appear on the surface and the whole pavement falls to pieces: thus accounting for some of the failures this description of roadway has met with under unskilled treatment.

This completes the subject of roadways; I will turn to that of footpaths in the next chapter.

CHAPTER XI.

FOOTPATHS.

As in the case of roadways, so with footpaths : the foundation is of primary importance, whatever material may be used for the surface. Where this material may be classed under the head of "Paving," concrete* makes the best foundation. For gravel, tar paving, or other similar surface, a hard core bottom well drained is sufficient. The materials of which a footpath can be formed are almost innumerable, but the following may be given as embodying most of them :

(1.) Natural asphalte, compressed and mastic.
(2.) Yorkshire flagging—Caithness flagging.
(3.) Blue lias, and Devonian limestone flagging.
(4.) Concrete.
(5.) Bricks.
(6.) Granite slabs.
(7.) Artificial asphaltes, including tar pavement.
(8.) Gravel.

First on the list stands natural asphalte, compressed and mastic.

The compressed has been thoroughly described in the preceding chapter ; it is sometimes used for footpaths where there is a very heavy traffic, and answers admirably.

I will, however, now deal solely with mastic asphalte, which means the rock ground to powder, mixed with a certain proportion of bitumen to act as a flux, and then subjected to

* Concrete is especially necessary as a foundation for asphalte, as it has little or no power of resistance to vertical pressure in itself, and indentations in its surface would be very unsightly as well as hold water. The concrete should be perfectly dry and thoroughly set before the asphalte is laid on it.

heat; this is sometimes used in conjunction with fine sharp clean river sand, but more often with finely crushed stone about the size of peppercorns, and is styled "gritted asphalte."

As long ago as the year 1838, Mr. F. W. Simms speaks of asphalte mastic from Pyrimont, near Seyssel, and says "it may be considered a species of mineral leather"*—a very good description of its surprisingly tough, hard, durable and pliant properties.

The usual method of the preparation of the mastic is as follows:—

According to the amount of bitumen contained in the natural stone, from 5 to 8 per cent. of refined Trinidad bitumen† is placed in a large caldron which is usually provided with agitators driven by steam power; when this is thoroughly melted, the powdered asphalte is added little by little, the heat being raised to between 390° and 480° F., the mixture kept well stirred and "cooked" for about five hours. It is then turned out into iron moulds, most companies having a special pattern with a trade mark for this purpose.

The caldrons generally used contain from 1½ to 2 tons of mastic.

Some companies in large towns are provided with caldrons on wheels, commonly called "Locomobiles," in which case the grit is mixed with the mastic in the fixed caldrons, and the whole mass run out into the locomobiles (which are also provided with agitators worked by an endless chain attached to the axle of the wheels), and transported direct to where the work has to be done. This system, though undoubtedly the best, is not practicable except in large towns; the more usual

* *Vide* 'Proceedings of the Institution of Civil Engineers,' vol. i. p. 6.

† Trinidad bitumen is best, but it has to be refined before it can be used. This is done by cooking it with shale oil, then straining it and decanting it, which is a troublesome and tedious process, and there is great danger of fraud being practised. Good bitumen can be detected by its elasticity and softness when rolled between the finger and thumb, and also by its smell.

method of laying mastic footpaths is to send the asphalte cakes to the works, where they are remelted in small round street caldrons, containing from 8 to 12 cakes each, weighing from 40 to 50 lbs., the grit being sometimes added in the fixed caldrons, sometimes in the street caldrons, this amount of grit varying from 20 to 60 per cent. according to the nature of the work.

The grit makes the asphalte more difficult to spread, but it lessens the cost and makes a very durable path. The affinity between the asphalte and grit is so great that, in breaking a sample, the actual pieces of grit will be found broken in half.

The asphalte should be spread from ½ to ⅞ of an inch in thickness (if compressed 1 inch is the minimum), and should be brought hot on to the works in covered caldrons on wheels, the test of its being ready and fit to lay being made by plunging a wooden spatula into it, which should come out without any of the asphalte adhering to it, and also by jets of light smoke darting out of the mixture.

The mastic should be taken from the caldron with a warmed ladle, and put into buckets previously heated, then thrown out on the concrete (which should be perfectly dry) near the spreader, who spreads it skilfully with a wooden stave, spreader, or spatula. The surface should then be floated and dusted over with fine sand, portland cement, or stone dust.

Dishonest contractors sometimes substitute inferior materials for natural asphalte, such imitations being made of ground chalk, fire-clay, and pitch or gas tar, or ground limestone mixed with bitumen.

A sample of the footpath after it is laid should be cut out (this is easily effected by heating the surface with a piece of hot mastic), in order to see that the proper thickness is given, and by applying a light to the sample, the smell will readily tell if real asphalte or any inferior material has been used.

Stockholm tar or common pitch should not be allowed to be substituted for Trinidad bitumen, or it will spoil the mastic.

Asphalte mastic footpaths are excellent in every way, the only objections to them being the necessity for the grit, and the temporary unpleasant smoke and smell whilst being laid. It is also necessary to put stone sills round the cellar openings and coal shutes, etc., for it to butt against, but it makes an invaluable pavement, especially for courts, alleys, back yards, etc., for sanitary and other reasons.

The proportions of asphalte, bitumen and grit are given as follows by Mr. Delano in his translation of a paper by M. Ernest Chabrier, on the applications of asphalte.*

"One ton of sanded mastic requires 13 cwt. of pure block mastic, 2 qrs. 12 lb. of bitumen, 7 cwt. of grit or sand washed and dried," and it takes 2 cwt. of coal to heat it. He further says that one workman can easily prepare 3 tons of material in 12 hours.

The following table gives the number of square yards that a ton of prepared Sicilian rock asphalte will spread.

Without grit.	With about 25 per cent. of grit.	Thickness.
square yards.	square yards.	inches.
63	80	$\frac{3}{8}$
51	65	$\frac{1}{2}$
32	40	$\frac{3}{4}$
26	33	1
16	20	$1\frac{1}{2}$
$12\frac{1}{2}$	16	2

A skilled workman properly assisted can lay 140 to 180 square yards in a day.†

With regard to the price of asphalte mastic footpaths, this

* *Vide* 'Proceedings of the Institution of Civil Engineers,' vol. xliii. p. 293.

† *Ibid*, vol. xliii. p. 293.

is quite a local question, and is not worth while discussing. The life of a footpath thus treated may be reckoned at about 15 years under ordinary traffic; the concrete will remain untouched and what is left of the asphalte may be remelted, so that a renewal is not so costly as the first expense.

Yorkshire Flagging.—This pavement is too well known to need any description from me; it is an excellent pavement in many ways, and is most pleasant to walk upon, there being a cling or foothold not experienced in any other material.

The objections to this description of pavement are:—

(1.) Its first cost, which is undoubtedly high as compared to its durability.

(2.) The fact of uneven wearing: one stone will be found soft next to a hard one; the former wears, leaving a pit which forms a pool for water in due course, and has to be removed.

(3.) Unless very carefully bedded, a stone will see-saw; this is very unpleasant in wet weather, water accumulates beneath, and as the pedestrian treads on one end of the stone a squirt of dirty water up to his knees, and a stumble, remind him that the stone is loose.

(4.) Liability to crack when any heavy goods are thrown upon it.

The following specimen specification for Yorkshire flagging pavement may be of use.

Specimen Specification for Yorkshire Flagging Foot Pavements.

The old flagging (where and when directed) to be taken up, refaced, squared, and relaid.

The new flagging is to be chisel-dressed to a fair face, true, out of winding, and not less than 3 inches thick,* to be pro-

* A rule is sometimes made that York flags should be ½-inch thick for every square foot of surface, but they should never be less than 2 inches thick.

perly squared and not pitched off only, or undercut, but to hold good to the square; to have not more than fourteen pieces to the hundred superficial feet; the joints must be set flush, and bedded and pointed with the best blue lias mortar.

The bed for the flagging both old and new, if any is required, to be made with proper earth, gravel, or dry rubbish, and all surplus earth and rubbish to be carted from the streets as it arises from the works.

The flagging to be properly cut and rebated to receive all area gratings, coal shoots, rain water troughs, &c.

Any damage done to gas or water service pipes in digging for the flagging, or in any way connected with the work, to be made good by the contractor, as also all and every other damage to windows, wood, or glass work; and the contractor will be held responsible for, and will make compensation for any injury that the public may sustain through the negligence of his workmen, or otherwise.

The whole of the flags to be of the very best quality, from Halifax, the quarries in the neighbourhood of Bradford or in Yorkshire, and subject to the approval of the surveyor.

The contractor to provide all lights and proper guards at night, and when old paving is to be taken up the work is to be done under the direction of the surveyor, and if considered necessary, the stones are to be removed from the streets to be re-faced and squared. No stone to be stacked in the streets.

The flagging to be measured after the work is completed.

The contractor to provide all stone, materials, tools, implements, horse and cart hire, and pay all railway dues, freightages, etc., and also to provide all labour of every kind for properly completing the work to the full and entire satisfaction of the surveyor. Payment will be made as the work proceeds, on the certificate of the surveyor.

Should the contractor fail to perform the work to the satisfaction of the surveyor, he then shall have power to execute the work and charge the same to the contractor, and deduct the cost from any amount that may be due to him; and in the event of the cost being more than the amount due, or if there shall then be no sum due to the contractor, such cost shall be paid by the contractor to the mayor, aldermen, and citizens, and the same shall be recoverable from him as liquidated and ascertained damages.

Caithness Flagging is now used very largely instead of Yorkshire; it comes from Thurso in Scotland, and it is contended for it that it possesses many excellent qualities, amongst others may be enumerated the following:

(1). It is impervious to wet.

(2.) It is not slippery nor does it wear so.

(3.) It does not scale or flake.

(4.) It dries rapidly after rain.

(5.) Its appearance is cheerful.

(6.) Great durability, as it does not abrade.

(7.) Frost has no effect upon it.

(8.) Can be re-used when half worn.

(9.) Cleanliness; for, not being porous, no dirt or dust can adhere to it.

(10.) Vehicular traffic may be turned over it without injury to the path.

(11.) Economy; as natural forces can be used, thus saving labour, and it can be laid from 1½ to 2 inches thick only.

(12.) Having sawn edges, the joints are expeditiously and well made.

(13.) Its whole surface wears evenly.

The following table was compiled by the well-known firm of Kirkaldy, by direction of Mr. Tarbotton the Borough Engineer of Nottingham, in order to ascertain the resistance to a gradually increased bending stress upon Yorkshire flagging as compared with Caithness.

YORKSHIRE.

Test No.	Weight.	Dimensions.			Ultimate Stress.
		Length.	Breadth.	Thickness.	
K	lbs.	inches.	inches.	inches.	lb.
1918	184	36	24·07	2·46	4·744
1919	163	36	24·03	2·22	3·398
1920	107	36	23·90	1·50	1·459
Mean	151	36	24·00	2·06	3·200

CAITHNESS.

Test No.	Weight.	Dimensions.			Ultimate Stress.
		Length.	Breadth.	Thickness.	
K	lb.	inches.	inches.	inches.	lb.
1921	215	36	24·06	2·59	17·274
1922	178	36	24·05	2·15	12·711
1923	114	36	23·90	1·38	6·211
Mean	169	36	24·00	2·04	12·065

By which it appears that the balance in favour of Caithness flagging is 8·865 lbs.

The objection to this style of flagging is, that however varied the sizes of the stones selected may be, as they have sawn edges and are very hard to cut with a chisel, a difficulty sometimes arises in finishing rounded corners of footpaths, and against uneven frontages of shops or buildings abutting on the footpath; this is especially the case in old towns.

Blue Lias Flagging.—A blue lias flagging does not make a first-rate pavement, as although it is very cheap, durable, clean, and has many other good qualities, it sometimes wears slippery and is then dangerous to pedestrians; but the Devonian limestone, which is much used in the west of England, has not apparently this defect.

Concrete Footpaths.—These have been tried in this country, but generally without success; the concrete or cement cracks,

and in addition to this the paths wear slippery and greasy, and as some time is necessary in order to allow the concrete to thoroughly set before the traffic can be allowed on them, they have not found much favour.

In the United States, however, concrete footpaths seem to be made successfully; the following detail particulars of such a foot-pavement will, I think, be of great interest and use.*

"Concrete footpaths should be laid upon a form of well-compacted sand, or fine gravel, or a mixture of sand, gravel and loam. The natural soil, if sufficiently porous to provide thorough sub-drainage, will answer.†

"It is not usual to attempt to guard entirely against the lifting effects of frost, but to provide for it by laying the concrete in squares or rectangles, each containing from 12 to 16 superficial feet, which will yield to upheaval individually, like flagging stones, without breaking and without producing extensive disturbance in the general surface.

"When a case arises, however, where it is deemed necessary to prevent any movement whatever, it can be done by underlying the pavement with a bed of broken stone, or a mixture of broken stone and gravel, or with ordinary pit gravel containing just enough of detritus and loam to bind it together. In high latitudes this bed should be 1 foot and upwards in thickness, and should be so thoroughly subdrained that it will always be free from standing water. It is formed in the usual manner of making broken stone or gravel roads already described, and finished off on top with a layer of sand or fine gravel, about 1 inch in depth, for the concrete to rest upon.

"The concrete should not be less than $3\frac{1}{2}$, and need rarely exceed 4 to $4\frac{1}{2}$ inches in thickness, the upper surface to the depth of $\frac{1}{2}$ an inch should be composed of hydraulic cement and sand only. Portland cement is best for this top layer. For

* *Vide* 'Roads, Streets, and Pavements,' by Q. A. Gillmore, p. 208.

† Sawdust 2 feet in thickness has sometimes been used, well rammed and rolled.

the rest, any natural American cement of standard quality will answer. The following proportions are recommended for this bottom layer.

Rosendale or other American cement	..	1 measure
Clean sharp sand	..	2½ ,,
Stone and gravel	..	5 ,,

"It is mixed from time to time as required for use, and is compacted with an iron-shod rammer in a single layer to a thickness less by ½ an inch than that of the required pavement. As soon as this is done and before the cement has had time to set, the surface is roughened by scratching, and the top layer, composed of,

1 volume of Portland cement, and
2 to 2½ volumes of clean fine sand,

is spread over it to a uniform thickness of about 1½ inch, and then compacted by rather light blows, with an iron-shod rammer. By this means its thickness is diminished to ½ an inch. It is then smoothed off and polished with a mason's trowel and covered up with hay, grass, sand, or other suitable material to protect it from the rays of the sun, and prevent its drying too rapidly.

"It should be kept damp and thus protected for at least 10 days, and longer if circumstances will permit; and even after it is opened to travel, a layer of damp sand should be kept upon it for two or three weeks, to prevent wear while tender.

"At the end of one month from the date of laying, the Portland cement mixture forming the top surface will have attained nearly one-half its ultimate strength and hardness, and may then be subjected to use by foot-passengers without injury.

"The rammers for compacting the concrete should weigh from 15 to 20 lb., those used on the surface layer from 10 to 12 lb. They are made by attaching rectangular blocks of hard wood shod with iron to wood handles about 3 feet long, and are plied in an upright position. Certain precautions are

necessary in mixing and ramming the materials in order to secure the best results. Especial care should be taken to avoid the use of too much water in the manipulation. The mass of concrete, when ready for use, should appear quite incoherent, and not wet and plastic, containing water however in such quantities that a thorough ramming with repeated though not hard blows will produce a thin film of moisture upon the surface under the rammer, without causing in the mass a gelatinous or quicksand motion."

Under the head of Concrete may be included many artificial stone pavements, such as "Bucknell's Granite Breccia" "Ransome's Artificial Stone," "Eureka Concrete," "Granolithic," and the "Silicated Victoria Stone," this last being worth a description. The stone is really a concrete, formed by mixing very superior Portland cement with *crushed* Thames gravel, furnace or iron slag, Kentish rag-stone, granite chippings, or other suitable material carefully washed. This fine concrete, after being mixed in the moulds forming the slabs, is thoroughly incorporated by being rocked or jiggled in a trembling machine; this motion, as can be easily understood, making the whole mass even and homogeneous when it sets. The cost of the slabs is about 9*d.* per square foot, 3 inches in thickness, and they make an excellent footpath.

Brick Footpaths.—These are sometimes constructed of ordinary bricks laid on their sides, but soon wear, and are unsuitable for the purpose.* Staffordshire blue paving bricks make an excellent footpath. These are bricks made of stoneware highly vitrified; they should be about 12 inches in length by 6 inches wide, by about $2\frac{7}{8}$ inches in thickness, their surface being chequered with a diamond pattern so as to prevent their being slippery. They are exceedingly hard

* The town of Brighton is an instance of this. Ordinary red bricks used to be laid as a footpath, no doubt to give a rural appearance for the eye of the jaded Londoner, but these are giving place to more modern materials.

and durable if well burnt, and to ascertain this a brick should be broken across and the colour, etc., noted.

They should be laid in cement mortar upon a bed of concrete or sand. The objections to this class of pavement are as follows:

(1.) The colour is objectionable; being very dark, the footpaths give a street the appearance of mourning.

(2.) The difficulty of breaking up the path for gas or water services, or for other purposes.

(3.) The hardness of the bricks makes them awkward to cut to rounded corners, or for water trunks, coal-holes, etc.

(4.) A loaded hand-barrow driven over them will sometimes break off the chequered pattern.

(5.) They are slippery in a frost after snow.

But notwithstanding these disadvantages, they make a most wonderfully durable and useful pavement for back streets.

Granite Slab Pavement.—This is sometimes adopted, large granite slabs, 6 inches in thickness being laid; they are very useful when there are cellars underneath, or where heavy vehicular traffic is intended to cross the foot pavement. Granite is of course excessively durable, but it wears very slippery with traffic and must then be tooled or axed; in process of time this wears it out, and its first cost is heavy.

This description of pavement can be laid with advantage in front of markets or similar buildings.

Artificial Asphalte Pavements.—The cost of obtaining natural rock asphalte from the mines, and the knowledge that it is composed of two very simple ingredients, limestone and bitumen, has led to a great number of artificial asphaltes being introduced, especially for foot pavements. "British Rock Asphalte" is a name by which many of the compositions are known; "Beauchamp's Mendip Mountain Machine-made Granite Asphalte" is a high-sounding title; "Prentice's Mineral Foreign Rock Asphalte" is another.

All these, and many more of the same description, are really what may be better and more correctly described as "tar concrete" or "tar paving," and consist of different modifications of the homely coal-tar and limestone.

So long ago as the year 1840, "Lord Stanhope's Composition" was well known; it was made as follows:

Three gallons of Stockholm tar, 2 bushels of well-dried chalk, 1 bushel of fine, sharp, clean sifted sand, the whole being boiled in an iron caldron.

Tar paving is now made in many and various ways by different surveyors of towns, some making it with hot compositions, some with cold. A description will be found in the chapter on Macadamised Roadways, page 46, of one method of making it, a modification of this being all that is necessary for foot pavements.

The best paths of this description that I have seen are to be found at Torquay, and by the kind permission of Mr. John Little, County Surveyor of Devon, and late Surveyor of Torquay, I give his useful specification in detail, as follows:

Tar Concrete for Footpaths.

PROPORTIONS OF MATERIALS.

12 barrow loads of engine ashes.
4 ,, ,, screened slaked blue lias lime.
4 ,, ,, small spar or sharp grit.
34 gallons of best gas tar.
20 bucketsful, say 70 to 80 gallons of water.

Method of Mixing.—On a clean flagged or wooden floor spread three barrow-loads of ashes, then about one barrow-load of lime, and so on until the whole of the dry materials (or one mixing) has been spread; then throw over them about three bucketfuls of tar, and before mixing it with them add (say) six bucketfuls of water; then mix as for concrete, and when the liquids are pretty well absorbed add a similar quantity, mix again, and so on until all the liquids have been absorbed; the mass will then be something of the consistency

of ordinary mortar. Next pass the whole three times *at least* through a pug mill: if this be not done the concrete will be a failure. An ordinary hand pug-mill will not be sufficient; the knives are not strong enough, nor will it incorporate the materials thoroughly, but an upright pug-mill, worked by steam power where practicable, or by at least one horse, should be used.

It will be found that as the mass emerges from the pug-mill a large proportion of the water will run from it; means should therefore be provided for allowing the water to escape freely from the floor.

Method of Laying.—Prepare the path for a layer of concrete 3 inches in thickness, on a hard dry bottom, inclining from the inside to the kerb, at the rate of $\frac{1}{2}$ an inch to a foot for pathways not more than 6 or 7 feet wide, but for wider pathways an inclination of $\frac{3}{8}$ of an inch to a foot will be sufficient.

A template the full width of the path having been provided, lay concrete with a shovel on the inner side of the path for a length of (say) 15 feet and a width of 1 foot, at such a height that when it has been well rammed and patted with shovels it shall be the exact height intended for the path; this is to form a resting-place for one end of the template, the kerb forming that for the other end; then fill the intervening space with concrete up to the template, treading and ramming it solidly for about twenty minutes, and as it gets into shape, patting it with shovels and smoothing with a trowel; then, with an iron (not stone) roller weighing about 5 cwts., roll for two hours, trimming and filling up hollows where necessary; then go on with another length, and occasionally roll the first for half-an-hour, and so on. Experience alone will decide the quantity of rolling necessary after the first day or two, as weather and other causes tend to a more rapid solidification of the concrete at some times than at others.

On the third day, sprinkle a small quantity of sea or other very fine sand on the concrete, and allow it to remain for two or three days after the path has been in use—it should then be removed.

General Remarks.—The ashes should not be those from a saw-mill or other place where wood ashes would be mixed with them. All ashes, spar or grit, and lime, should be passed through a screen of $\frac{3}{8}$-inch mesh. The lime should be the best blue lias, slaked under cover; it should be allowed to lie for at least four days, but not more than six days, before it is used. The spar or grit should be sharp and angular.

Great care should be taken to keep the concrete free from mud or dust; it should be tipped from the carts or barrows, either directly into place, or, if this cannot be done, a few slabs or boards should be laid down, on which it may be tipped.

The path should not be used until the concrete is sufficiently solid to bear a man's weight without taking the impression of his boots.

It has been found by experience that the laying of this concrete should not be commenced before May, and that it should not be continued beyond the end of September (or middle of October, if the weather is very fine). Frost is fatal to it before it has become hard, and continuous cold wet weather retards considerably the hardening.

There can be no doubt that a pavement of this description for traffic that is not too heavy answers every requirement; for streets of greater traffic, genuine mastic asphalte should be used.

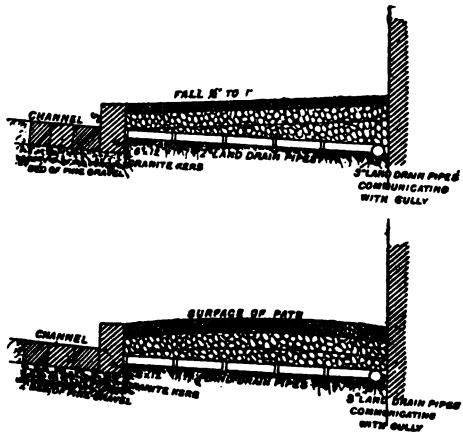
Before closing my remarks on artificial asphalte pavements, the following description of an American method may be interesting:

On a dry foundation is placed a coat of rough clinkers from anthracite coal or iron clinkers from a foundry, mixed

with sand and tar in the proportions of 15 cubic feet of fine sifted ashes, 14½ cubic feet of pit sand, and 1½ cubic feet or 9 gallons of tar. This is laid about 3 to 4 inches thick and well rolled. Over this is placed a coating from 1 inch to 1½ inch thick, composed of 15 cubic feet of coarse sifted ashes, 15 cubic feet of clinkers, and 1¼ cubic feet or 8 gallons of tar. It must be then well rolled and sanded, care having been taken that the materials are thoroughly mixed.

Gravel Footpaths.—For the suburbs of a town and in the country, nothing looks so pretty as a gravel footpath.

The same rules that apply to a macadamised roadway apply to a gravel footpath. They must be well "bottomed," and well drained and well rolled. Limestone or other stone chippings may with advantage be used with a pit gravel for constructing paths of this description, and a barrelled surface looks better and is more enduring than a hanging path. The following cross sections of footpaths will explain themselves better than any long description:



Gravel footpaths are sometimes tarred over when thoroughly consolidated. This must be done only when the weather is quite settled and fine: the least rain will spoil the whole operation; it consists in simply tarring over the

surface of the footpath in the same manner that a gate or wall or any other substance would be tarred. The surface of the path must previously have been swept perfectly clean, and immediately as the tarring is completed, fine stone dust must be sprinkled on its surface; the traffic should be diverted from it for a few hours, and it is then ready.

Care must be taken that the tar is not too thin in consistency, and that the coat is not put on too thick. Treating a path in this manner saves gravel, which is washed or kicked off it if left with an ordinary surface; but a cold night, a slight shower, or inferior tar will make the whole process abortive, and the path will be in a fearful mess in the winter.

CHAPTER XII.

KERBING AND CHANNELLING, ETC.

FOR all footpaths both urban and sub-urban a kerb of some description is necessary to be fixed on the outside of the footpath, for the following reasons:

(1.) It acts as a sill against which the material of which the footpath is paved may butt.

(2.) It retains both the foundation and surface of the footpath.

(3.) Whether there is a paved channel gutter or not, a kerb is necessary in order to finish the haunches of the roadway.

(4.) The appearance of a footpath without kerbing is very unsightly.

(5.) Unless a footpath is raised above the roadway it is liable to be flooded.

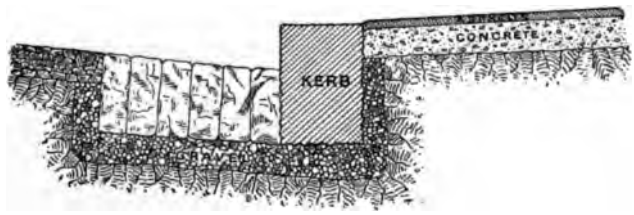
Many materials are used for kerb, of which granite being the best is generally used in streets where there is much traffic, as the kerb is often subjected to severe blows from the passing vehicular traffic as well as a grinding action from the wheels of waggons and other heavy vehicles, especially on gradients where "hugging" the kerb acts as a drag or break. In such cases granite, although the most expensive in the first case, is certainly the most economical, and no other material should ever be used.

Granite kerb varies in dimensions considerably in different localities and according to the width of the footpaths, the wider the path the wider should be the kerb. It should however never be of less depth than 9 inches, nor narrower than 4 inches; depth is necessary to prevent the kerb turning over towards the channel gutter, or water table as it is sometimes

termed, and the filling in on the gutter side must also be well rammed with a bar to prevent this. Kerb should never be in less lengths than 3 feet, and when 8 inches and broader it is better that the top surface should be bevelled off to conform with the slope of the footpath, but in narrower kerbing such a practice is unnecessary, and if carried to an extreme may even be dangerous.

The kerb should be drafted about 1 inch along both top edges and hammer dressed about 5 inches on the face, in addition to the whole surface of the top and for 3 inches at the back, in order that there may be a smooth surface visible against the channel gutter, and also for the flagging or other paving to butt fair against, besides giving a clean appearance to the aris of kerb both inside and out.

The following section of an 8-inch granite kerb will explain this:



The top surface should always be tooled or axed whenever it has worn smooth and slippery, as a slip from a kerbstone often causes a very bad fall to a pedestrian.

Setting kerb requires a very experienced hand, for as it is set dry great care must be shown, or it will sink, turn slightly over, or move even months after it has been set. In addition to this it is heavy stuff to handle, but unless the line is accurate both as regards level and contour, the appearance will be exceedingly bad. Of course the skillet line and boning rods are freely used in setting kerb, but even with these helps one mason will set kerb in a pleasing manner, whilst

another, with even more care, does not seem able to make it appear graceful.

Deep and narrow kerb should be bedded on good clean river gravel, and beaten into its place with hard blows from a heavy wooden setting maul or beetle weighing not less than 50 lbs.

Broader and shallower kerb should be bedded on concrete.

In addition to granite, kerbing is also made of Endon or Yorkshire stone, limestone, and for brick pavements a kerb specially made of the same material is generally used; it is also, though not often in this country, constructed of wood, old railway sleepers being used for the purpose. In the more rural districts grass sods are used with good effect for gravel paths.

It is difficult to estimate the cost of kerbing, as local questions must interfere, carriage of the material and value of labour entering so largely into the question.

Mr. Codrington* states that "A limestone kerb about 1 foot deep and 4 inches wide costs from 2*s.* 6*d.* to 3*s.* 6*d.* per lineal yard, and a channel 10 inches wide by 6 inches thick rather more.

"Granite kerbs 12 inches wide by 9 inches deep, 6*s.* 6*d.* to 7*s.* per yard run.

"Granite channel 12 inches wide by 6 inches deep, 4*s.* 6*d.* per lineal yard.

"A channel 12 inches wide, formed of granite cubes 4 inches by 7 inches, costs about the same."

I have found that granite kerb 6 by 12 inches could be fixed "*in situ*" at 3*s.* 3*d.* per yard run, and 8 by 12 inches at 4*s.* 6*d.* per lineal yard.

Granite channelling composed of 3 courses of granite pitchers 6 by 8 inches, costing 5*s.* 6*d.* per lineal yard.

* 'The Maintenance of Macadamised Roads,' by Thomas Codrington, p. 18.

Limestone channelling 15 inches in width by 3 inches in depth, costing 3*s.* per lineal yard.

A paved channel, gutter, or water table is of the greatest use to a roadway, besides adding greatly to its appearance. Without such a channel the haunches of a road become sadly damaged by the wash of the surface water, which is sometimes so extreme as to undermine the kerb and cause it to fall out.

These channel gutters are made of different materials for macadamised roads, granite setts laid in the direction of the gutter being the best. A channel gutter should not be less than 18 inches wide, so that if made with ordinary 3-inch setts, 6 courses will be necessary; they should be bedded on gravel and well grouted in with lime or cement grouting. Sometimes granite slabs 18 inches wide by 3 or 4 inches thick are used and make an excellent gutter, they are however liable to tip under heavy loads. Limestone slabs can also be used in roads of light traffic with advantage.

In streets paved with granite setts, wood blocks or asphalte, the same material is used for the channelling, the setts or blocks being however bedded in line with the channel instead of transversely as in the street itself.

The channel gutter should take the slope of the roadway and the granite kerb should show from 3 to 5 inches above it. At paved crossings it is well to keep them level with the kerb so that pedestrians may step off the path on to the crossing without any drop, or if there is any water in them at such points, it is a good plan to let the edge of the crossing drop rather suddenly towards the kerb, so that the ordinary stride of the pedestrian carries him on to the level.

Gulley gratings or buddle holes should be placed along the line of channel at such intervals as may be found necessary. A great number of different forms have been from time to time introduced for this purpose, the objects to be considered being :

(1.) Sufficient area to carry off all the water.

(2.) Not easily choked on surface by leaves or other debris.

(3.) Sufficiency of pit to retain all sand or road detritus and prevent it being washed into the sewer.

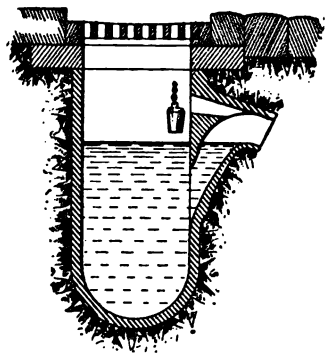
(4.) The least possible obstruction to the traffic.

(5.) Constructed so that the pit may easily be cleaned out.

(6.) Trapped so as to prevent the escape of sewer gas.*

(7.) The drain from it should be easily freed of any obstruction.

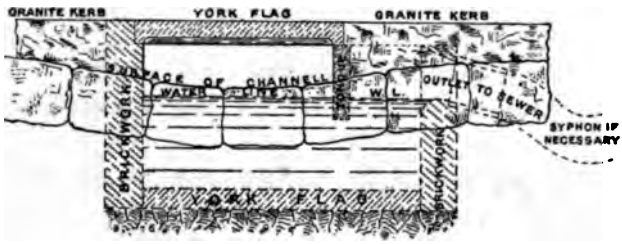
One of the best forms of gully pit is that manufactured by Messrs. Oates and Green of Halifax, as it meets nearly all the requirements which I have summarised as being necessary for this description of work. The following drawing will explain itself:



What is called a "buddle hole," which is an opening under the kerb, has much to recommend it as giving a free unobstructed waterway and at the same time avoiding the

* In many towns the gully gratings are purposely in direct communication with the sewers, so as to act as ventilators.

necessity of a grating in the street itself. The following drawing will explain the general features of this "buddle-hole:"



A great number of different descriptions and forms of gully pits are shown in Mr. Baldwin Latham's excellent book on sanitary engineering, to which I refer my readers for any further information upon this subject.

CHAPTER XIII.

LIGHTING STREETS.

AT the present moment the question of lighting streets by electricity is gaining so much attention, that it must necessarily be first considered in connection with the subject of lighting streets: but to enter fully into all the details and comparative merits of electricity and gas as applied to street lighting would entail more space than can be afforded in this work. It may however be of some use, even under the present state of uncertainty, if I attempt to condense as much information upon this necessary part of a surveyor's duty into as small a compass as possible. Nor must it be forgotten that electric lighting will not easily be adapted in old cities and towns, where, in addition to the main streets being narrow and crooked, there are few large open spaces suitable for intense lights, and there are numerous small courts and alleys which require lighting, and this for a long time to come will probably be effected with gas.*

* Since writing these lines the following letter has appeared in the *Standard* and has never been refuted, which shows that electric lighting for streets is not yet all that can be desired :

ELECTRIC LIGHTING.

To the Editor of the STANDARD.

SIR,—At this time, when the question of lighting by means of electricity is receiving so much attention, and as Chesterfield is the only town in England whose lighting is done throughout by electricjty, it may be interesting to your readers to know what our experience has been.

I need not detail the stages which led to our abandoning gas, and taking up the electric light after being in darkness some months. I may briefly state that, after going carefully into the question, we decided to adopt the system whose praise was in everyone's mouth a year ago, namely, "The Brush," and, though we were applied to by other companies, we placed the execution of the work in the

Section 161 of the Public Health Act 1875 enacts as follows:

"Any urban authority may contract with any person for the supply of gas or other means of lighting the streets, markets, and public buildings in their district, and may provide such lamps, lamp-posts and other materials and apparatus as they may think necessary for lighting the same. . . ." (38 and 39 Vic. c. 55, s. 161.)

I do not propose to entertain the question of lighting where the gas works are the property of the corporation, but only to give information that may be of use where a contract has to be entered into between the corporation and a company. These contracts are based nearly always upon the length of time at which the public lamps are to be kept lighted, and may be summarised as follows:

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hands of the one that we considered the most suitable—the Hammond Company. During the negotiations of the contract, Mr. Hammond particularly pressed us not to stipulate for incandescent lamps, as he acknowledged that their Company were not in a position to cope with incandescent lighting for public purposes. We, however, decided upon the town being lighted with the Lane-Fox Incandescent Lamps, as well as the Brush Arc Lights.

After waiting many weary months for the completion of the incandescent lighting, it is now, when declared by the contractors complete, in my opinion a decided failure. The Lane-Fox lamps, which have been supplied by the Brush Company, are most variable in their lighting power; whilst some are good, others only give a feeble light instead of a light equal to that of fifteen candles, as expected. The arc lights are doing good service in some of the large streets, but as a whole I think it has been fully demonstrated in a year's trial in Chesterfield, that the field for arc lighting is very limited indeed.

Though the tradesmen have been canvassed by the Hammond Company with a view to introducing the arc lights into their shops and hotels, in not one single case has the light been adopted. Indeed, it is evident to us who have them under our eyes every night, that they are only fit for lighting works and large, open spaces. The experience that has been thus gained at Chesterfield at the present juncture must be of value to all towns intending to adopt the electric light, and is my reason for troubling you with this letter, although I believe the time will shortly come when lighting by electricity may be advantageously adopted, both for public and private purposes.

I am, Sir, your obedient servant,

GEO. EDWD. GEE,

Alderman of the Borough of Chesterfield.

HIGH STREET, CHESTERFIELD, *October* 10, 1882.

(1.) The public lamps are lighted from sunset to sunrise every night throughout the year; this averages 12 hours per diem, or about 4000 hours per annum.

(2.) The public lamps are not lighted on the nights of full moon, nor for two or three nights before and after this period; the rest of the year they are lighted at sunset.

(3.) Similar to the preceding, except that the public lamps are not lighted during the five nights of full moon, the night after they are lighted for one hour and extinguished on the rising of the moon; this lighting increases from night to night about three quarters of an hour until the moon has entirely disappeared, when the lamps are lighted during the whole of the night for five consecutive nights. Then again on the appearance of the new moon the lamps are extinguished the first night for about an hour that the moon is visible, and this extension increases nightly about three quarters of an hour according as the moon appears until the period of full moon, the intention being to profit by every hour of the moon's light.

By this arrangement the lighting is about 2000 hours per annum, instead of 4000 hours, when it is continued throughout the night during the whole of the year.

(4.) Sometimes, in addition to the foregoing, the lamps are not lighted at all during the summer months.

(5.) Occasionally the public lamps are extinguished at midnight all the year round, if not for the whole, for some portions of the district, it being assumed that all respectable citizens being in bed, no light is required.

(6.) In some cases every other lamp only is lighted in the summer months, and many other similar variations for the sake of economy may be practised.

(7.) The public lamps are sometimes supplied by gas through meters, which is then paid for at so much per 1000 cubic feet consumed.

Of all the above methods the first is undoubtedly the

most satisfactory to the inhabitants, the urban authority, their officers, and the gas company; it is the least likely to introduce disputes, and although something may be saved by adopting the more parsimonious methods enumerated, it is found in practice that the first is the best.

In drawing up an agreement with the gas company to light the public street lamps for any length of time, the following points must be considered.

Hints for a Contract with a Gas Company.

The company to provide a sufficient supply of gas of the full illuminating power and quality as provided by their Act.

Payment to be at so much per lamp, or per 1000 cubic feet consumed, or at per hour, or whatever may be determined on.

Payment to be made by urban authority for lighting, extinguishing, cleaning, repairing, etc., as may be agreed, such payments to be made quarterly, or at such times as may be agreed upon.

The hours or times throughout the year during which the lamps shall be lighted to be determined by a table, every lamp to be fully lighted within one hour of the time named, and not extinguished before that named for extinguishing. The consumption of the gas to be regulated and determined by Sugg's or Borradaile's street lamp governors, or such other mode as is agreed upon.

The company to keep the governors and burners in repair, and also the lanterns, at a fixed sum per lamp per annum.

The company to light and extinguish, and keep all lanterns clean, and all pipes, valves, etc., in repair.

The company to keep the lamp posts etc., properly painted after they are fixed by the urban authority. Lamps may be shifted or fresh lamps erected by the urban authority, on their paying the cost.

The company not to be compelled to supply gas to lamps

which are beyond a certain distance of their existing mains, without compensation.

A certain pressure of gas must be maintained, to be ascertained by water gauges fixed at certain public places, or at such points as may be determined.

Any lamps burning under size or out, shall be immediately attended to by the company. A deduction in payment for gas by the urban authority to be made if neglect can be proved. An arbitration clause is necessary for this or other matters that may be disputed, and also a clause for determining the agreement upon notice being given.

In supplying gas to the public lamps by meter, either wet or dry meters may be employed, and these are fixed either in the lamp posts themselves or under the footpath. Sometimes each lamp has a separate meter, but in the generality of cases one meter fixed to a lamp gives the average of gas consumed by ten or a dozen of its fellows at the same level, and in the same neighbourhood. The difficulties arising from this system are:

(1.) The liability of the meters to get out of repair, especially in times of severe frost, or by vibration of traffic.

(2.) The first cost of providing and fixing the meters, and subsequent cost of repairs.

(3.) The trouble and cost of inspection and keeping the accounts.

And it is found that by employing either "Borradaile's," "Sugg's," or other regulators the consumption of the gas can be readily adjusted to consume from 3 to 6 cubic feet per hour, according to the requirements of the situation of the lamp.*

* The Surveyor of Folkestone says: "Sugg's self-acting regulator is used, adjusted as nearly as may be practicable to consume 4 feet per hour, and so very satisfactory is this apparatus that for the last two years, after burning 7294 hours, it is found by the average meter to have consumed 29,227 feet, as against 29,176 feet as per regulator, being only 51 feet in excess of that which the apparatus is adjusted to consume." *Vide* Ellice Clark on gas in Public Streets, 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. ii. p. 193.

Lamp posts and lanterns are of innumerable sizes, shapes, and patterns, but the following hints in connection with them may be of some service.

The lamp must not only be ornamental by day, but useful by night.

The light must not be placed either too high or too low.

The post must not be too clumsy so as to interfere with the pedestrian traffic, nor too fragile so as to be easily broken if driven against. Bracket lamps have advantages in these respects, and also in the very important one of throwing no downward shadow,* as well as being cheaper.

The lantern should be made with the lightest possible amount of metal frame compatible with sufficient strength, the angle bars should be very narrow to avoid shadow, trap doors of perforated zinc or glass should be provided at the bottom for the admission of the torch, and a good outlet at the top is essential for the escape of the heated air. Flat glass is much cheaper and easier of repair than curved. The top of the lantern should be furnished with a reflector cover, otherwise a large percentage of the light is lost: this is very observable on approaching a large city, by the glare which is thrown upwards. Some hundreds of different patterns of lanterns for street lamps have been designed from time to time, and it is not necessary, nor have I space, to describe them.

The burners should have steatite tips and be of varying size to suit the requirements of the locality, the regulators which I have previously mentioned must be kept in good repair. A lever tap is indispensable with the torch for lighting, as well as the trap door or opening in the bottom of the lantern through which the torch is inserted.

Each public lamp post should be legibly numbered, and

* Bracket lamps may not be fixed by an urban authority to houses within their district without the previous consent of the owners of such houses. *Vide* 'Fitzgerald's Public Health Act,' third edition, p. 182.

the surveyor should keep a register in his office of all the public lamps in his town.

In order to determine the distance apart of the public lamps in a street, it must be remembered that the intensity of light is directly proportional to the illuminating power of the light, and inversely proportional to the square of the distance of the light, if unreflected. For instance, the illumination of any point between lamps may be arrived at by adding all the quotients obtained by dividing the illuminating power in standard sperm candles of each lamp, by the square of its distance in yards from the point.

Thus a point midway between two lamps of 15 candles each, 20 yards apart, would be reckoned thus :

$$X = \frac{15}{100} + \frac{15}{100} = \cdot 30$$

In this country, the rule has generally been adopted that public street lamps burning 5 cube feet per hour of 15 candle gas should not be placed at a greater distance than 60 yards apart, the average distance in most English towns being about 40 yards.

On this question, the following interesting particulars by Monsieur Servier will be of special interest.*

It appears to M. Servier that up to the present there has been too much straining after intensity, with insufficient care for the object of obtaining a proper quantity of light uniformly spread over the surface of the ground. The paper in question is therefore intended in the first place to elucidate this latter subject, so as to determine beforehand the necessary intensity for luminous centres, gas or electric, and also their height from the ground and distance from each other required to produce a certain effect. With this purpose M. Servier proposes to determine for any point of the road-surface, by

* Meeting of the 'Société Technique de l'Industrie du Gaz en France' in 1882.

the law of the squares of the distances, the intensity of light, in terms of the Carcel standard, which is spread at that point by one or more lights of given power. Representing these intensities by proportional ordinates, the extremities of these ordinates form an irregular surface, and the volume contained between this surface and that of the roadway represents a specific value equivalent to the total luminous intensity distributed over the soil. In default of a better term, M. Servier calls this a volume of *cubic Carcels*, a cubic Carcel being the intensity of a Carcel (9·5 standard candles) multiplied by a square mètre of surface. The different cases capable of being valued in this manner are as follows :

1. A burner consuming 140 litres (5 cubic feet nearly), and of 1·1 Carcels (10·45 candles) illuminating power, placed at the height of 3 mètres (9 feet 6 inches). This burner gives at the foot of the lamp-pillar a maximum intensity of 0·122 Carcel (1·159 candles), and at 10 mètres (32·8 feet) away the illuminating power is reduced to 0·01 Carcel (0·095 candle). The distance of 20 to 30 mètres kept between the street lamps, even in the best-lighted towns, is therefore excessive, for these should not be more than 13 mètres (14 yards) apart in order to obtain between them the minimum illuminating power of 0·05 Carcel (0·475 candle), sufficient for enabling passengers to read.

2. The second case is that of a burner consuming 1400 litres (50 cubic feet nearly) of gas, with an illuminating intensity of 14 Carcels (133 candles), placed at the height of 3·20 mètres; this being the class of burner fixed in the Rue du Quatre Septembre. The intensity of light at the foot of the lamp-pillar is 1·367 Carcels (13 candles nearly), and to obtain the light of 0·05 Carcel (0·475 candle) already mentioned as the least intensity enabling one to read, a point must be fixed in a circle of 16 mètres radius from the lamp as a centre. Taking now a group of six lamp-columns, three on each side of the street, and overlapping, as in the Rue du

Quatre Septembre, it will be found that the distribution of light is defective. The most brilliantly lighted point at the foot of the column has an intensity of 1·367 Carcels (13 candles), or more than triple that of the darkest point, which has an intensity of 0·5 Carcel (4·75 candles) at 4·58 mètres distance.

3. A lamp of 50-Carcel (475-candle) power, gas or electric, fixed at the height of 8 mètres (26·24 feet). The illuminating intensity at the point vertically under the light is reduced to 0·7 Carcel (6·65 candles); but the light of 0·5 Carcel (4·75 candles) is to be found in a circle of 6 mètres radius from this point. It will therefore be observed that *the distribution of light over the ground is better in proportion as the luminous centre is higher;* but conversely also, *the amount of light thrown on the ground is greater as the luminous centre is lower.* It consequently results that the power of the light and its height should be determined in every case with reference to the effect desired. The method shortly described shows that, in the case of the lighting of the Rue du Quatre Septembre, the mean amount of light per square mètre of the roadway is 855 *décicarcel-tubes*, the best lighted parts having an intensity of 1·62 cubic Carcels, and the darkest portions an intensity of 0·50 cubic Carcel.

M. Servier has examined the question of lighting a street 20 mètres wide and one or more kilomètres long, with the condition that the illumination of the ground shall present a mean determinate quantity of light per square mètre, or a given intensity at the darkest points. Some interesting results are thus obtained. Thus, by substituting for the 14-Carcel (133-candle) lamps in the Rue du Quatre Septembre, burners of 50-Carcel (475-candle) power, with the condition of giving the same intensity of 0·5 Carcel (4·75 candles) to the darkest points, a quantity of light more considerable than before will be required. That is, a greater number of Carcels (3000 as against 1848 per kilomètre in length) will be neces-

sary in the larger burners than were required in the original smaller lamps. It is therefore imperative, in order that the lighting shall be equally economical, that the unit of intensity —the Carcel or candle power—shall be less costly in a lamp of 50 Carcel (or 475-candle power) than in the smaller lamps. By fixing lamps of 50-Carcel (475-candle) power in the centre of the street, instead of along the side walks, maintaining the condition of giving the light of 0·5 Carcel (4·75 candles) in the darkest parts of the thoroughfares, it is found that the pillars must be 8 mètres high and 20 mètres apart. The best-lighted part of the road would then have the intensity of 1 Carcel (9·5 candles), and would therefore be only twice as brilliantly lighted as the darkest corner; the mean quantity light per square mètre would be 755 *décicarcel-cubes.*

Lastly, the same method of lighting has been applied to the "ordinary," as distinguished from the "luxurious" lighting of the public thoroughfares, assumed to be 20 mètres wide, giving a light of 0·05 Carcel (0·475 candle) at the darkest points. With ordinary street burners consuming 200 litres (7 cubic feet) of gas per hour, and giving 1·72-Carcel (16·34-candle) power, it is found that the lamps should be 18 mètres (20 yards nearly) apart, the burners being 3 mètres (9 feet 10 inches) high. With burners of 14-Carcel (133-candle) power placed at the height of 3·20 mètres (10 feet 6 inches), the lamp-pillars would be 106 mètres (115 yards) apart. Or with lamps of 50-Carcel (475-candle) power placed at a height of 8 mètres (26·24 feet), the distance between the pillars may be increased to 270 mètres (494 yards).

In the case of electric lighting M. Servier has studied two examples—the Jablochkoff candle, and an arc light (system not stated). The former is credited with the illuminating power of 16 Carcels (152 candles), and is fixed at the height of 5 mètres (16 feet 3 inches), on pillars 110 mètres (120 yards)

apart. This would give a light of 0·65 Carcel (6·27 candles) at the foot of the pillar, and a minimum intensity of 0·05 Carcel (0·475 candle) midway between the lights. The arc light is purposely made exactly equal in computed efficiency to the larger Siemens burner of 50 Carcels (475 candles). In the matter of expense, however, using the data applicable to Paris, with 12-candle gas at 6*s.* 6*d.* per 1000 cubic feet, M. Servier makes a striking comparison. The cost of lighting a kilomètre of road in the "ordinary" manner last described varies very little for the three classes of gas lamps—small, large, and very powerful—included in the calculation, and ranges from 3·33 frs. to 3·96 frs. per hour. The cost of the same work done by the Jablochkoff candle is estimated at about double, or 6·91 frs. per hour; and with the arc light the cost would be 4 frs., or still higher than with the most costly system of gas lighting, although less than the expense of the Jablochkoff electric light.

The following table will show the particulars of different lights so placed that persons may see to read ordinary print in any part of the street, which may be taken as then being a well-lighted street.

Description of Light.	Illuminating Power.	Height of Lamps.	Distance of Lamps apart.	Number of Lamps per Mile.	Total Illuminating Power.	Consumption of Gas per Mile.	Greatest Intensity of Light on Ground.	Least Intensity of Light on Ground.
Gas.	candles.	ft. in.	yards.		candles.	cub. ft.	candles.	candles.
Batswing, 7 cubic feet	16·34	9 10	20	176	2876	1232	2·15	0·47
Cluster, 50 ,, ,,	133·00	10 6	115	29	3857	1450	13·10	0·47
Siemens, 100 ,, ,,	475·00	26 3	294	10	4750	1000	7·46	0·47
Electricity								
Jablochkoff candle ..	152·00	16 3	120	29	4408	..	6·18	0·47
Arc light	475·00	26 3	294	10	4750	..	7·46	0·47

It must not be lost sight of, that the illuminating power of the gas in Paris is very low, and is thus fixed. Under a

pressure of 12 hundredths of an inch, gas burning at the rate of 4·05 cubic feet per hour (or 115 litres) shall give a light of 9·5 standard sperm candles (or a "Carcel" lamp burning 42 grammes of pure colza oil) per hour.

The competition which has been started by the electric lighting companies has given a great impetus to gas lighting. A large number of improved street gas lamp burners and lanterns having been invented and brought into general use, the following particulars with reference to some of those which were tried in the City of Exeter may be of use as a comparison.

Description of Lamp.	Candle Power of Light.	Consumption of Gas in cubic feet per hour.	Cost per Hour, gas being supplied at 3s. per 1000 cubic feet.
			pence.
Ordinary street lamp with batswing burner	15	5	$\frac{3}{16}$
Siemens'	330	50	$1\frac{2}{4}$
Ditto	130	·25	$\frac{1}{8}$
Ditto	45	10	$\frac{3}{8}$
Sugg's	50	16	$\frac{5}{8}$
Ditto	30	10	$\frac{3}{8}$
Bray's	80	20	$\frac{3}{4}$

Having thus far given a few facts upon lighting streets with coal gas, I will now turn to the question of lighting them by means of electricity, and in doing this the following points will be considered:

(1.) The motive-power to be employed in producing electricity and its applicability for the purpose.

(2.) The description of machinery to be employed.

(3.) The value of the light produced, and its adaptability to the requirements of any town.

(4.) The comparative cost of the electric light as compared with gas.

(1.) Whatever motive power is employed, whether water-

power, steam or gas, it is essential that it should be steady and unfailing; steady, because the regularity and uniformity of the light depends upon the evenness of the speed with which the power works, and unfailing, because a stoppage means the immediate extinguishment of the lights: electricity, unlike gas, is not stored after manufacture, but is used as fast as it emanates from the producing power.*

Sensitive governors and careful bedding of the machinery greatly tend to lessen unsteadiness, and are points of considerable importance.

(2.) The machinery consists of the dynamo machines, the conducting wires and the lamps.

I will not here enter into the question of which is the best dynamo machine to employ, as to discuss the merits of them all would involve a large amount of space; but for this and other valuable information upon the subject of electric lighting I will refer my readers to Mr. Hedges' excellent little book entitled 'Useful Information on Electric Lighting,'† but the following points should be attended to. The dynamo machine should be fixed in a dry place, and not be exposed to dust or flyings, it should be kept perfectly clean, and its bearings well oiled, its coils and conductors should be perfectly insulated, and it should, where practicable, be fixed on an insulated bed. With regard to the wires, the following 'Regulations for the prevention of Fire Risks arising from Electric Lighting,' published by the Society of Telegraph Engineers and of Electricians, are given in full, as they leave nothing to be desired in the way of their careful selection and fixing:

"(7.) Every switch or commutator used for turning the current on or off should be constructed so that when it is

* "Faure's" batteries can store electricity, but at present this cannot be manipulated on a very large scale.

† Published by Messrs. Spon, 16 Charing Cross, London.

moved and left to itself it cannot permit of a permanent arc or of heating, and its stand should be made of slate, stoneware, or some other incombustible substance.

"(8.) There should be in connection with the main circuit a safety fuse constructed of easily fusible metal which would be melted if the current attain any undue magnitude, and would thus cause the circuit to be broken.

"(9.) Every part of the circuit should be so determined that the gauge of wire to be used is properly proportioned to the currents it will have to carry, and changes of circuit, from a larger to a smaller conductor, should be sufficiently protected with suitable safety fuses, so that no portion of the conductor should ever be allowed to attain a temperature exceeding 150° F.

"N.B.—These fuses are of the very essence of safety. They should always be enclosed in incombustible cases. Even if wires become perceptibly warmed by the ordinary current, it is a proof that they are too small for the work they have to do and that they ought to be replaced by larger wires.

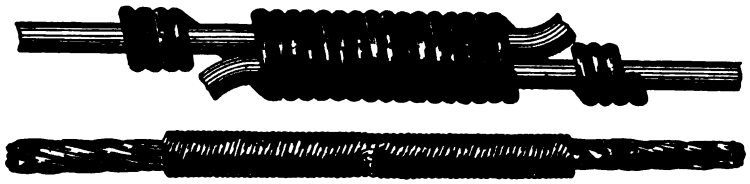
"(10.) Under ordinary circumstances complete metallic circuits should be used, and the employment of gas or water pipes should in no case be allowed.

"(11.) Where bare wire out of doors rests on insulating supports, it should be coated with insulating material, such as india-rubber tape or tube, for at least two feet on each side of the support.

"(12.) Bare wires passing over the tops of houses should never be less than seven feet clear of any part of the roof, and they should invariably be high enough, when crossing thoroughfares, to allow fire-escapes to pass under them.

"(13.) It is most essential that the joints should be electrically and mechanically perfect. One of the best joints

is that shown in the annexed sketches. The joint is whipped around with small wire, and the whole mechanically united by solder.



"(14.) The position of wires when underground should be efficiently indicated, and they should be laid down so as to be easily inspected and repaired.

"(15.) All wires used for indoor purposes should be efficiently insulated.

"(16.) When these wires pass through roofs, floors, walls, or partitions, or where they cross or are liable to touch metallic masses, like iron girders or pipes, they should be thoroughly protected from abrasion with each other, or with the metallic masses, by suitable additional covering; and where they are liable to abrasion from any cause or to the depredations of rats or mice, they should be efficiently encased in some hard material.

"(17.) Where wires are put out of sight, as beneath flooring, they should be thoroughly protected from mechanical injury, and their position should be indicated.

"N.B.—The value of frequently testing the wires cannot be too strongly urged. It is an operation skill in which is easily acquired and applied. The escape of electricity cannot be detected by the sense of smell as can gas, but it can be detected by apparatus far more certain and delicate. Leakage not only means waste, but in the presence of moisture it means destruction of the conductor and its insulating covering by electric action."

The lamps may take either the "arc" form, or the "incandescent." The former is produced by the electric current passing between carbon points, and requires considerable electrical pressure; they give a light of from 1500 to 4000 candle power; the mechanism of arc lamps has to be of the most delicate kind to ensure the proper distance of the carbon points being maintained. The lamps should be guarded by globes of frosted glass, not only to prevent incandescent pieces of carbon from falling, but to lessen the glare of the light. "Incandescent" lamps are of small size, giving a light of from 8 to 50-candle power, which is produced by the heating of a filament of carbon in a vacuum owing to the resistance caused to the electric current by this contraction of the conductor.

(3.) With regard to the value of the light produced, and its adaptability to the requirements of any town, it will be seen on reference to the opening of this chapter that at present considerable doubt exists as to its adaptability for general public lighting, and as each town varies in the length, straightness, and width of its streets, the number of its large squares or confined courts and alleys, the surveyor must use his own judgment as to the suitability of the light before recommending his corporation to adopt it.

As to the value of the electric light, there can be no doubt that a most brilliant and powerful light is produced by the voltaic arc: so brilliant indeed, as to render it necessary to screen it nearly always behind frosted or opalescent glass globes, the former being found to be much the best for many reasons.

As to the photometrical value of the light, some considerable difficulty has hitherto been experienced in obtaining accurate observations, principally owing to the peculiar colour of the electric light, and also from its fluctuating character; but these difficulties are being steadily overcome, and with a photometer mounted on a light frame with wheels,

some excellent experiments have been made in the public streets upon the comparative values of different lights.

(4.) The last and really one of the most important questions remaining to be discussed is that of the cost of the electric light as compared with gas.

With reference to the cost of the electric light, the following table may be of use; it is compiled from an excellent paper on electric lighting, by Mr. James N. Shoolbred:*

TABLE OF COMPARATIVE ESTIMATES OF FIRST OUTLAY AND OF WORKING EXPENSES OF SOME SYSTEMS OF ELECTRIC LIGHTING.

Name of Machine.	First Cost, including Engine to drive it.				Working Expenses per hour.			
	One light.	Two lights.	Three lights.	Five lights.	One light.	Two lights.	Three lights.	Five lights.
	£	£	£	£	s. d.	s. d.	s. d.	s. d.
Gramme single light "A" with Siemens lamp	330	535	725	935	1 6	2 1	2 7	3 0
Cost per light per hour	—	—	—	—	1 11·4	1 4·8	1 2·2	0 10·2
Siemens single light "medium" with Siemens small-sized lamp	365	611	835	1185	1 7½†	2 4	2 10	3 9
Cost per light per hour	—	—	—	—	2 1·4	1 6·8	1 3·84	1 0·8

	Six lights.	Twenty lights.	Six lights.	Twenty lights.
	£	£	s. d.	s. d.
Gramme "many light" machine with candles	576	1155	2 8	6 3
Cost per light per hour	—	—	0 6·4	0 4·2

Mr. Shoolbred has also given another table‡ of street

* *Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. vi. p. 9 *et seq.*

† Siemens' light at Blackburn cost 2*s.* per hour per lamp of 6000 candle power.

‡ *Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. viii. p. 171, &c.

lighting which partly deals with the question of cost, it is as follows:

Date of Lighting.	Cost to Municipal Authority.	Length of Street Lit.	Annual Cost per mile of street.	No. of Lamps.	Illuminating Power of each (on horizontal).	Remarks.
			CITY OF LONDON.			
			District No. 1. (Ludgate Hill, &c.).—"Brush" Electric Light Co.			
Mar. 31, 1881 to Mar. 30, 1882	£ 660*	yards lineal. 1750	£ 660	32 arc	candles. 950	1 40-light Brush machine. * Add £750 to cost, for fixing and final removal of apparatus.
			District No. 2. (King William Street, &c.).—Siemens Bros. & Co., Ld.			
Mar. 31, 1881 to Mar. 30, 1882	2270†	1960	2026	6 arc 23 arc	4000 330	6 continuous current machines. 2 alternating ditto. † Add £1450 to cost, for fixing and removal of apparatus.
			Metropolitan Board of Works (Thames Embankment).—"Jablochkoff" Co.			
Dec. 13, 1878 to June 30, 1881	2½*d.* per light per hour.	2540	1131	60 candles	380	3 Gramme double-machine ("A" and divider). 1 Ransome's steam engine. 20 HP nominal.
July 1, 1881 to June 30, 1884	1½*d.* per light per hour.	..	753			
			CITY OF NORWICH (Prince of Wales' Road, &c.).—R. E. Crompton & Co.			
Aug. 15, 1881 to Jan. 31, 1883	710	1700	531	5 arc 9 arc	2000 500	4 Bürgin machines. 1 Ransome's steam engine, 20 HP nominal.
			Chesterfield (Market Place, &c.).—Brush (Hammond) Electric Light Co.			
Nov. 1, 1881 to Oct. 31, 1882	855	3500	..	22 arc 100 Incandescent.	950 16	2 40-Light "Brush" machines. 2 Fowler's semi-portable compound engines, 20 HP nominal.

As to the comparison of cost between the electric light and gas, this has only, I believe, been properly estimated on the Thames Embankment, London, by Sir Joseph Bazalgette, the results of whose investigations upon this important point I shall give presently; it has, however, been stated generally, and without contradiction, that arc lights can be produced of about 2000 candle power, with 1 HP at a cost of from 3*d.* to 6*d.* per candle per annum of 4000 hours, gas costing from 1*s.* 9*d.* to 3*s.* 6*d.* per candle according to the price of the gas.

Incandescent lamps cost 3*s.* to 4*s.* per candle per annum, as their life is short, and only 200 candle power can be got from 1 HP.*

The latest investigations into the comparative cost of lighting by gas and electricity upon the Victoria Embankment and Waterloo Bridge in London, show that the lighting as effected by 96 gas burners for an average of 12 hours burning all night, and 121 gas burners for 6 hours lighted after the electric lights are put out, together with the electric lighting 40 lights on the parapet of Embankment, and 10 on the bridge, costs 834*l.* for the gas and 663*l.* for the electric light per annum. Gas costing 3*s.* 2*d.* per 1000 cubic feet showed a cost of nearly 1*s.* per hour for every 1000 candle power of light. The electric lights cost 1½*d.* per light per hour, which is stated to represent 5·66 pence per 1000 candle power of light; each electric light as now used, it is said, gives a photometric light of 265 candles, frosted glass globes being found to pass much more light than the opalescent globes.

These are by far the most important and reliable compari-

* On this point Mr. W. G. Laws, Borough Engineer, Newcastle-upon-Tyne, says: "Taking as an example a street a mile long, lighted by the arc system, the arrangement would probably be lamps 60 yards apart, placed alternately on either side, giving 30 lamps or 60,000 candles at a cost of about 800*l.* per annum. If lighted by 'incandescent lamps' we should have them placed about 30 yards apart on both sides: that is, 120 lamps giving 2400 candles at a cost of about 420*l.* per annum. The number of gas lamps for the same distance might be 150, giving about 2250 candles at a cost of 300*l.* per annum." ('Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. viii. p. 65.)

sons that have hitherto been made, and it will be seen that the cost is in favour of the electric light.

There is no doubt that the acme of all artificial lighting is the prolongation of the light of day, and whether this is proposed to be effected by electricity or gas, it should be the goal aimed at by all who make this question their study.

CHAPTER XIV.

STREET NAMING AND NUMBERING.

IT was not until the commencement of the present century that inconvenience was apparently felt from the want of any distinguishing names of streets, or numbers to houses, either in London or provincial towns; the first Act of Parliament on the subject being one passed in the year 1819, which gave powers to vestries and district boards to put up the names of streets, and even then for some considerable period afterwards houses or premises were not marked with numbers, but with distinguishing trade signs or names.

The Towns Improvement Clauses Act 1847, however, contains the following clauses which are incorporated with the Public Health Act 1875, by the 160th section of that act:

"The commissioners shall from time to time cause the houses and buildings in all or any of the streets* to be marked with numbers as they think fit, and shall cause to be put up or painted on a conspicuous part of some house, building or place at or near each end, corner, or entrance of every such street the name by which such street is to be known; and every person who destroys, pulls down, or defaces any such number or name, or puts up any number or name different from the number or name put up by the commissioners, shall be liable to a penalty not exceeding 40*s.* for every such offence" (10 & 11 Vic. c. 34, sec. 64).

"The occupiers of houses and other buildings in the streets shall mark their houses with such numbers as the com-

* "Street" includes any highway (not being a turnpike road), and any public bridge (not being a county bridge), and any road, lane, footway, square, court, alley, or passage, whether a thoroughfare or not. (38 & 39 Vic. c. 55, s. 4.)

missioners approve of, and shall renew such numbers as often as they become obliterated, or defaced; and every such occupier who fails within one week after notice for that purpose from the commissioners to mark his house with a number approved of by the commissioners, or to renew such number when obliterated, shall be liable to a penalty not exceeding 40*s.*; and the commissioners shall cause such numbers to be marked or to be renewed as the case may require, and the expense thereof shall be repaid to them by such occupier, and shall be recoverable as damages" (10 & 11 Vic. c. 34, s. 65).

Some difference even now exists as to the manner in which streets are named, there being considerable diversity in the sizes, colours, and materials of the name plates, as well as in the spaces allowed for the letters. The following list is given to show how this diversity existed in the metropolis even so late as the year 1870.

Table taken from a "Memorandum by the Superintending Architect of the Metropolitan Board of Works, relative to the enforcement of the Law regulating the naming of Streets and numbering of Houses in the Metropolis" (1871):

	Parish A.	Parish B.
Names on houses at corners of streets ..	237	281
,, on piers of railings	24	36
,, on iron plates	6	44
,, on wooden boards	18	36
,, on enamelled plates	1	2
,, impressed in terra cotta	2	3
,, in cement letters	14	9
,, in Minton's china letters	2	1
,, engraved on stone	5	13
,, on porcelain plates	1	1
,, with raised letters on iron girder ..	1	
,, on board on posts		11
,, on zinc		2

And to this table are added the words "Some names are completely hidden by vines, names given for 'streets' are put up as 'roads.'" Since this table was prepared however, the con-

fusion has been rectified by the energetic action of the Metropolitan Board of Works.

It is no doubt essential that for postal, telegraphic, and social reasons there should be uniformity in the manner in which the naming and numbering of streets is carried out, and the following particulars and suggestions may be of use.

Names of streets should be marked up in such a manner as to be legible both by day and lamp light, and the materials of which the name-plates are composed should be of sufficient strength to prevent any damage accruing to them from stone-throwing or other wilful or accidental injury, or from the action of changes of temperature or climatic influences of any kind, and the following list is given descriptive of some of the modern methods of effecting this:

Minton's China Tiles.—These are white glazed china tiles 6 inches square, on which either blue or black letters are burnt in, one letter on each tile (except in the case of St. which is on one tile); they are fixed by chasing them into walls of buildings, and setting them in cement. They are the best description of name-plate with which I am acquainted, their cost being only *6d.* each, with the additional advantages of being not easily broken, they can be removed and re-used with facility, weather has no effect upon them, and they require no attention whatever after they are once fixed.

Cast-iron Plates with Embossed Letters.—These are generally painted with a white ground, and black letters; they are liable to become broken, and as they are fixed with screws these rust through in course of time, when the plate may suddenly fall in a dangerous manner into the street; another disadvantage is that they require to be painted about once every three years.

Painted Names on Walls of Buildings.—This method requires no special mention; it is an economical plan and is more adopted than any other, but the letters must be painted

every three years at least, and they are apt to be defaced if the premises are painted by the owner or occupier.

Enamelled Iron Plates.—These look very well, but they are apt to get loose, and a blow from a stone will shiver them.

Wooden or Metal Figures cut out and fastened on to Boards or against Walls.—The same objection holds good with this method as with others of the same description, the fastenings fail in time, and the name disappears.

Enamelled Glass Tablets in Street Lamps.—This is an excellent method of recent introduction, and has many advantages. The name can be seen very plainly either by day or night, no private premises have to be interfered with in fixing them,* a uniformity of position or "where to look" for the name of the street is secured, and there is no limit to the number of times the name may be repeated.

Where the names of streets are placed against buildings the letters which compose the name should not be less than 4 inches in height by 2 inches in breadth, with a space between each letter of not less than 1 inch; a light colour should always where practicable be used for the back ground, and black or blue for the letters. One great objection to painted letters is that they must be frequently repainted, and in order to do this, ladders have to be raised against the building, which the occupiers naturally object to without previous notice: it is always very annoying to any citizen to have the head of a painter appearing outside his bed-room window at any time, and more especially at an inconvenient hour in the morning.

In selecting names for streets it is very important that they should not be duplicated in a town, and also that there should be some sense in their nomenclature; generally some local

* The law apparently gives the Sanitary Authority power to fix names of streets against any premises they may choose, without first applying for or obtaining any consent from either the occupier or owner of such premises. (*Vide* 10 & 11 Vic. c. 34, s. 64.)

association can be found with a family or historical name which is suitable for the street. Nothing is more ridiculous than to see such names as Bath Street or York Road given to streets which have as much association with such places as with Jericho.

The street having been properly and conspicuously named, the next point to consider is that of the manner in which it shall be numbered, there being three methods in vogue by which this can be effected.

(1.) By allotting even numbers on one side of the street and odd numbers on the other side.

(2.) By allotting consecutive numbers up one side of the street, and down the other side.

(3.) By allotting corresponding numbers to both sides of the street, which are distinguished by a prefix of north and south, or east and west, as the case may require.

The first is by far the best method to pursue, for the following reasons:

If the street is ever extended after being numbered, the sequence is in no way disturbed. By this method any house can be more easily found, as on reference to a directory it will at once be seen at which end of the street it is situated. If the second method had been adopted this would be impossible, except for the first few numbers, and where a street is of considerable length with branch streets running into it this is of the greatest importance. It is the best method also for the Post-Office officials, as it facilitates the district sorting of the letters.

Giving each side of the street distinctive prefixes to its name, such as north and south, &c., is evidently a bad plan, and leads to much confusion.

In allotting numbers to premises in a street, if it has been already numbered care should be taken to disturb existing numbers as little as possible, for an altered number involves considerable expense as well as inconvenience to the occupier

of business or trade premises, owing to the necessity of altering bill heads, letter paper, &c., and sometimes even considerable trouble and expense in order to secure the validity of the title.

Avoid numbering from right to left, and take care to allot sufficient numbers to vacant spaces which may eventually be built upon, and to do this the length of frontage may be divided into such lengths as (in the surveyor's judgment) will represent the new frontages. In any case it is better to have too many numbers in a street than too few, and large premises, and any public or other buildings which may be removed, and other buildings substituted should have numbers allotted to them, although it will not be necessary to serve the notices to have them affixed. Most large shops prefer to have more than one number, although I have heard the rather far-fetched contention urged, that more than one number means extra rating.

Considerable care must be exercised to ensure that no separate premises are passed over in allotting the numbers, often only a door or side passage denoting the existence of another claimant for a number. Nothing looks worse in a freshly numbered street than to see such numbers as 37A or 96½ placed upon premises that should have had a distinct numeral, and thus showing that they must have been left out.

The manner in which streets are numbered is generally as follows:

The town surveyor or one of his assistants walks through the street, and with a piece of chalk legibly marks each house with its correct number, taking care to observe the precautions I have enumerated; having done this throughout its entire length, these numbers must be entered in a book with the name of the occupier written opposite to the number. Upon returning to the office the surveyor must then fill up and serve the necessary notice upon each of these occupiers, the following being given as a specimen of such notice:

Urban Sanitary Authority for the .

TOWN SURVEYOR'S OFFICE, 188 .

I beg leave to give you notice, that the Town Council of , as the Urban Sanitary Authority, have approved of the number for the house in your occupation, in .

You are therefore required, within one week from the date of this notice [to obliterate the present number, and]* to mark the said house with the number so approved of, and to renew the same from time to time in the case of its becoming obliterated.

A penalty of 40*s.* will be incurred in the event of default in compliance with this notice.

I am,

Your obedient Servant,

Town Surveyor.

*To*_____

*No.*_____

* If the premises have no existing number, these words can be left out.

In the event of the old number with which any premises were marked not being obliterated by the occupier, the following notice may be served :

Urban Sanitary Authority for the .

TOWN SURVEYOR'S OFFICE, 188 .

It has been reported to the Town Council that you have neglected to obliterate the old number of your premises, No. Street, after receiving notice of a new number being allotted to such premises by the Town Council, whereby you have incurred a penalty of 40*s.*

The duplication of numbers in the same street was found to be the occasion of so much inconvenience, that the Council

were obliged to re-number the street in question, and it is manifest that if a number allotted to another house is retained by you, the inconvenience sought to be removed will still remain.

I am therefore instructed to inform you that unless the old number of your premises is obliterated within seven days from the date of this notice, proceedings will be taken against you for the recovery of the penalty incurred.

Yours faithfully,

Town Surveyor.

Of course, if nothing is done after service of this second notice, it only remains to summon the offender as provided by the sections of the Act, which I have given in the early part of this chapter.

CHAPTER XV.

BREAKING UP STREETS.

IN nearly every city and town of the United Kingdom, except those where the gas and water undertakings are the property of the urban authority, the town surveyor is constantly annoyed by having some portions of his streets broken up and greatly damaged by the action of the gas or water companies of the district.

With regard to the lasting character of the damage caused to the street by this disturbance of its surface, I shall have something to say in this chapter, but it is first necessary to see what legal powers the companies have to break up the streets, and what powers the surveyor has to enforce the work being properly carried out.

It will be found that the sections bearing upon this point are almost precisely similar in their wording in the following Acts:

"The Gas Works Clauses Act 1847" (10 & 11 Vic. c. 15).

"The Water Works Clauses Act 1847" (10 & 11 Vic. c. 17).

"The Electric Lighting Act 1882" (45 & 46 Vic. c. 56).

but with regard to the powers of the Government to lay telegraph and telephone wires, &c., the clauses are different, and are contained in,

"The Telegraphs Act 1863" (26 & 27 Vic. c. 112).

As the clauses on this subject of "the Water Works Clauses Act" are those which are incorporated with the Public Health Act 1875, I shall select the sections from that Act, the first of importance being as follows:

"The undertakers, under such superintendence as is hereinafter specified, may open and break up the soil and pavement of the several streets and bridges within the limits of the special Act, and may open and break up any sewers, drains, or tunnels, within or under such streets or bridges, and lay down and place within the same limits pipes, conduits, service pipes, and other works, and engines, and from time to time repair, alter, or remove the same, and for the purposes aforesaid remove and use all earth and materials in and under such streets and bridges, and do all other acts which the undertakers shall from time to time deem necessary for supplying *water* * to the inhabitants of the district included within the said limits; doing as little damage as can be † in the execution of the powers hereby or by the special Act granted, and making compensation for any damage which may be done in the execution of such powers" (10 & 11 Vic. c. 17 s. 28).

The next clause deals only with the powers of laying pipes, &c., in private property, and here it will be well to remark that if the water undertaking is in the hands of the urban authority they have much more power of entry for these purposes than companies possess (*Vide* ss. 16, 18, 32, and 54, 38 & 39 Vic. c. 55), but this is a matter which does not affect the questions dealt with in this chapter.

The next clause is upon the subject of giving the necessary notices, and is as follows:

"Before the undertakers ‡ open or break up any street, bridge, sewer, drain, or tunnel, they shall give to the persons under whose control or management the same may be, or to their clerk, surveyor, or other officer, notice in writing of their

* Or gas or electricity, as the case may be.

† These words apply only to the manner of doing the work, not to alternative ways of doing it. (*Vide* 'Fitzgerald's Public Health and Local Government Act, 1875,' 3rd edition, p. 45.)

‡ In the "Electric Lighting Act 1882," the words "proceed to" have been inserted before the word open, which is an obvious improvement.

intention to open or break up the same, not less than three clear days before beginning such work, except in cases of emergency arising from defects in any of the pipes or other works, and then so soon as is possible after the beginning of the work or the necessity for the same shall have arisen" (10 & 11 Vic. c. 17, s. 30).

The next clause is of great importance, as it gives the surveyor the necessary powers to dictate the manner in which the interference with his streets is to be conducted.

"No such street, bridge, sewer, drain, or tunnel shall, except in the cases of emergency aforesaid, be opened or broken up except under the superintendence of the persons having the control or management thereof, or of their officer, and according to such plan * as shall be approved of by such persons or their officer, or in case of any difference respecting such plan, as shall be determined by two justices; and such justices may, on the application of the persons having the control or management of any such sewer or drain, or their officer, require the undertakers to make such temporary or other works as they may think necessary for guarding against any interruption of the drainage during the execution of any works which interfere with any such sewer or drain. Provided always, that if the persons having such control or management as aforesaid, and their officer fail to attend at the time fixed for the opening of any such street, bridge, sewer, drain, or tunnel, after having such notice of the intention of the undertakers as aforesaid, or shall not propose any plan for breaking up or opening the same, or shall refuse or neglect to superintend the operation, the undertakers may perform the work specified in such notice

* It is incumbent upon the undertakers intending to break up a road to communicate beforehand their proposed plan or method of executing the work to the road authority, and this in a sufficient manner to enable the road authority to judge whether what is proposed ought to be done without modification. The plan should, therefore, show the position on the road of the proposed excavation, and its depth. (Edgware Highway Board *v.* Colne Valley Water Company, 46 L. J. ch. 889.)

without the superintendence of such persons or their officer" (10 & 11 Vic. c. 17, s. 31).

There are several points to which it is necessary to draw attention whilst considering the above clause. I am afraid that the "attendance" of the surveyor "at the time fixed for the opening" or even of one of his assistants could not always be managed, nor would it be practicable to prepare a "plan" for every opening that might be made by a gas or water company for new services, leaks in mains, &c.; but where it is proposed to carry out any extensive works, such as laying a considerable length of new main or removing an old one, it is certainly necessary that there should be some "plan" of the manner in which such work is proposed to be carried out by the company.

On referring to the clause it is evident that the first "plan" mentioned must be prepared by and on behalf of the company proposing to carry out the work, and this plan must show the exact position on each street of the proposed excavations, and their depth, &c., which "shall be approved of by such persons (having the control of the streets) or their officer," their officer really being the surveyor.

Lower down in the clause another "plan" is referred to in the following words: "or shall not propose any plan for breaking up or opening the same." This plan, or more correctly speaking, a specification of the manner in which the company shall proceed with the work, must be prepared by the surveyor, and if it meets with the approval of his corporation it can be enforced.

In order to assist town surveyors who may be required to act under this clause, I now give a verbatim copy of a "plan" or specification under which I compelled a gas company to work after they had given me the usual statutory notice of their intention to break up certain macadamised streets for the purpose of removing some disused mains.

Plan of the manner in which the Gas Light and Coke Company shall take up and remove the old mains in street, commencing at or near street.

A trench to be excavated of not greater width than inches and of no greater length than feet at a time.

Great care must be taken to keep the top facing metal separate from the lower formation of the roadway, so that they may not become mixed together; no metal is on any account to be removed from the street.

The mains must be taken up with all possible speed and instantly conveyed away, without being allowed to remain at the sides of the streets.*

The trench to be then at once filled in, care being taken to replace all the materials of which the roadway is formed in their proper positions. All extra filling in that may be required owing to the removal of the mains shall be done on the surface with the best stone, broken so as to pass all ways through a ring of 2½ inches internal diameter, the top of the trench being always kept flush with the surface contour of the roadway. No earth, rubbish, or other material shall be allowed to be brought on to the ground by the gas company for the purpose of filling in, nor shall any material of any kind be allowed to be brought from any other excavations that may be being made by the gas company in other parts of the town for the purpose of laying or removing mains.

The filling in to be done in the proportion of one man filling to two men ramming with punners of not less weight than lbs. each. During dry weather a plentiful supply of water must be allowed to run into the trench whilst the filling in is in progress, for the purpose of consolidating the ground.

The traffic must not in any case be impeded, and planks

* This precaution was necessary, as the smell of the old mains was naturally very offensive and a nuisance.

must be placed across the excavations, where necessary, for the convenience of foot passengers.

The work shall if necessary be suspended on market days, or any other days that the surveyor may deem proper for the convenience of the public.

* * * * * * * * *

The next clause of the Act deals with the manner in which the companies shall reinstate and make good the road or pavement, and is as follows:

"When the undertakers open or break up the road or pavement of any such street, or bridge, or any sewer, drain, or tunnel, they shall with all convenient speed complete the work for which the same shall be broken up, and fill in the ground and reinstate and make good the road or pavement, or the sewer, drain, or tunnel so opened or broken up, and carry away the rubbish occasioned thereby; and shall at all times whilst any road or pavement shall be so opened or broken up cause the same to be fenced and guarded, and shall cause a light sufficient for the warning of passengers to be set up, and kept there against every night during which such road or pavement shall be continued open or broken up, and shall after replacing and making good the road or pavement which shall have been so broken up, keep the same in good repair for three months thereafter, and such further time, if any, not being more than twelve months in the whole, as the soil so broken up shall continue to subside" (10 & 11 Vic. c. 17, s. 32).

The conditions embodied in the above clause are easier written than carried out.

It is well known that a trench cut longitudinally through a street takes a very long time to heal. Asphalte shows it the least if there is a good backing of concrete, but all other pavements suffer considerably in the process, as it is almost impossible to maintain their strict contour, and with macadamised roadways the result is simply disastrous.

Opening a macadamised roadway does it more harm than the heaviest and most persistent traffic, and it is surprising for what a length of time the surface will show the treatment it has received.

It is unfortunately the practice generally for the men in the employ of a gas or water company, after laying a pipe, to try and ram into the trench all the material they have removed, without allowing for the cubical contents taken up by the pipe, or if they do condescend to cart anything away it is generally the metal, which they think will come in nicely for the repairs of the trench during their liability for such repairs. What ought to be done is that no filling of ordinary earth, &c., should be allowed to come within at least six inches of the top of the trench, which should then be filled in with good road metal, and as this wears down it should be brought up to the proper level with more metal. In the former plan a hump is seen over the trench, and this hump is a mass of mixed dirt and road-metal for which there is no cure but its entire removal to a depth of at least six inches, and the substitution of good clean road-metal, which would have been the best and most economical plan in the first place.

The clauses following those I have quoted are "penalty clauses" for non-compliance with the provisions of the Act, and need not be here given, but there is one more clause of the Water Works Clauses Act 1847, dealing with the powers of private individuals to break up streets for the purpose of laying service pipes, which it is necessary to give *in extenso.*

On the question of similar powers to private individuals to break up streets for drains, &c., I shall speak later on in this chapter:

"Any such owner or occupier may open or break up so much of the pavement of any street as shall be between the pipe of the undertakers and his house, building or premises, and any sewer or drain therein, for any such purpose as aforesaid, doing as little damage as may be and making compensa-

tion for any damage done in the execution of any such work; provided always, that every such owner or occupier desiring to break up the pavement of any street or any sewer or drain therein, shall be subject to the same necessity of giving previous notice, and shall be subject to the same control, restrictions, and obligations in and during the time of breaking up the same, and also reinstating the same, and to the same penalties for any delay in regard thereto, as the undertakers are subject to by virtue of this or the special Act" (10 & 11 Vic. c. 17, s. 52).

It would also seem that the *consent* of the urban authority must be obtained (as well as notice given to them) before a street is broken up" (38 & 39 Vic. c. 55, s. 149).

Very often, however, the companies prefer to execute all this work themselves, as they do not like anyone else to interfere with their mains or put in services which may be unfitted for the purpose; consequently they give the necessary notices, execute the work themselves, and charge the owner or occupier with the expense.

The powers under which streets are broken up for telegraphic or telephonic purposes are, as I have previously stated, contained in the "Telegraphs Act 1863," the following being the clauses which refer to this subject:

"The company shall not place a telegraph under any street within the limits of the district over which the authority of the Metropolitan Board of Works extends, or of any city or municipal borough or town corporate, or of any town having a population of thirty thousand inhabitants or upwards (according to the latest census), except with the consent of the bodies having the control of the streets within such respective limits" (26 & 27 Vic. c. 112, s. 9).

"Where the company has obtained consent to the placing, or by virtue of the powers of the company under this Act intends to proceed with the placing of a telegraph under a street or public road, the depth, course and position at and in

which the same is to be placed shall be settled between the company and the following bodies:

"The body having the control of the street or public road.

"The body having the control of the sewerage or drainage thereunder.

"But if such settlement is not come to with any such body, the following provisions shall take effect:

"(1.) The company may give to such body a notice specifying the depth, course and position which the company desires.

"(2.) If the body to whom such notice is given does not, within 28 days after the giving of such notice, give to the company a counter-notice objecting to the proposal of the company, and specifying the depth, course and position which such body desires, they shall be deemed to have agreed to the proposal of the company.

"(3.) In the event of ultimate difference between the company and such body, the depth, course and position shall be determined in England or Ireland by two Justices, and in Scotland by two Justices or the Sheriff" (26 & 27 Vic. c. 112, s. 10).

"Subject to any special stipulations made with a company by the body having the control of a street or public road, and to any determinations, orders, or directions of the Justices, or Sheriff, as aforesaid, where the company proceeds to open or break up a street or public road, the following provisions shall take effect.

"(1.) The company shall give to the bodies between whom respectively and the company the depth, course and position of a telegraph under such street or public road are hereinbefore required to be settled or determined, notice of their intention to open or break up such street or public road, specifying the time at which they will begin to do so, such notice to be given in the case of an underground work ten days at least, and in the case of an above-ground work five

days at least before the commencement of the work, except in case of emergency, in which case notice of the work proposed shall be given as soon as may be after the commencement thereof.

"(2.) The company shall not (save in case of emergency) open or break up any street or public road except under the superintendence of the bodies to whom respectively notice is by the present section required to be given, unless such bodies respectively refuse or neglect to give such superintendence at the time specified in the notice for the commencement of the work or discontinue the same during the work.

"(3.) The company shall pay all reasonable expenses to which such bodies respectively may be put on account of such superintendence" (26 & 27 Vic. c. 112, s. 17).

It will be seen by the above section that the time required before the work is commenced after service of the notice is considerably longer than that for gas or water mains or for electric lighting wires, and subsection 3 authorises a payment for the services of the surveyor or other officer attending to superintend the work, which is not the case in the other Acts.

The next clauses are as follows:

"Subject to any such special stipulations as aforesaid, after the company has opened or broken up a street or public road they shall be under the following further obligations:

"(1.) They shall with all convenient speed complete the work on account of which they opened or broke up the same, and fill in the ground and make good the surface, and generally restore the street or public road to as good a condition as that in which it was before being opened or broken up, and carry away all rubbish occasioned thereby:

"(2.) They shall in the meantime cause the place where the street or public road is opened or broken up to be fenced and watched, and to be properly lighted at night:

"(3.) They shall pay all reasonable expenses of keeping the street or public road in good repair for six months after the

same is restored, so far as such expenses may be increased by such opening or breaking up" . . . (26 & 27 Vic. c. 112, s. 18).

"Whenever the permanent surface or soil of any street or public road is broken up or opened by the company it shall be lawful for the body having the control of the street or road, in case they think it expedient so to do, to fill in the ground, and to make good the pavement or surface or soil so broken up or opened, and to carry away the rubbish occasioned thereby, instead of permitting such work to be done by the company; and the cost and expenses of filling in such ground and making good the pavement or soil so broken up or opened, shall be repaid on demand to the body having the control of the street or road by the company, and in default thereof may be recovered by the body having the control of the street or road from the company, as a penalty is or may be recoverable from the company" (26 & 27 Vic. c. 112, s. 19).

"The company shall not stop or impede traffic in any street or public road, or into or out of any street or public road, futher than is necessary for the proper execution of their works. They shall not close against traffic more than one third in width of any street or public road or of any way opening into any street or public road at one time; and in case two-thirds of such street or road are not wide enough to allow two carriages to pass each other, they shall not occupy with their works at one time more than fifty yards in length of the one-third thereof except with the special consent of the body having the control thereof" (26 & 27 Vic. c. 112, s. 20).

It will be seen that these are much more elaborate clauses, restricting the rights of the telegraph companies than those of the gas and water companies, &c., and as the Telegraphs Act containing these strict clauses was passed in the year 1863 and the Water Works Clauses Act in 1847, it is fair to assume

that the clauses of the Telegraphs Act 1863 were framed to meet certain objections to these clauses and upon experience of their working, and are consequently better and more adapted for the case in point.

To obviate all the difficulties and complications arising out of this constant breaking up of streets, with the attendant inconvenience to the public and damage to the surfaces of the roadways, it was suggested many years ago that subways should be constructed under the surface of the principal streets, in which should be placed all the gas and water mains then existing.

There is no doubt that there are many advantages in this plan as well as some disadvantages. It must be recollected that probably the subways would have been constructed of sufficient capability to carry all the mains and wires then existing, with a margin for future extensions of size, but when we see the enormous growth of many towns, notably that of the metropolis, and the consequent increase necessary in the number and diameters of the mains, it is to be feared that sufficient space would not have been left, and competition between rival gas and water companies might consequently have been crippled.

Still there would be great convenience in many respects if all water and gas mains, telegraph and telephone wires could be carried in subways, as they would be easily accessible for repairs, and hidden leaks would be unknown. With regard to the one great objection so constantly urged, that in the case of a leaky gas main or service a most terrible and damaging explosion might take place, it is true that this is a very grave and serious objection, but it must also be recollected that although this danger may be enhanced by the necessarily solid masonry of which the subway is constructed, still there would be every precaution taken to prevent leakage of gas, and in the present system liability to explosion is not altogether remote. In Percy Street, Tottenham Court Road,

only a year or two ago, there was a terrible explosion in trenches and mains which had become full of gas and atmospheric air in the proportions of one volume of gas to fifteen volumes of air, and if gas mains were laid in subways greater precautions would no doubt be taken.

There would be also great danger in conveying the wires used for electric lighting purposes in these subways, as they might fuse and thus cause danger, and at all events they would have some considerably disturbing influence upon the wires of the telegraph and telephone systems, if laid too near.

I will now pass on to consider the powers of individuals to break the surface of public streets for the purpose of putting new drains to their premises or of repairing existing drains.

With regard to the former question I have given full particulars with regard to new drains or connections with sewers in the chapter upon "house drainage," but with regard to the latter question it will be necessary to make a few remarks.

There is no doubt that the public streets vest in the urban authority, and it is contended that the following clause of the Public Health Act 1875 prevents any person from breaking up any street without their permission, although it is sometimes questioned whether the words "wilfully displaces" do not mean the doing of an illegal act, such as taking up a stone in a street to annoy or injure a neighbour or from sheer mischief, rather than that of a legal act for a proper purpose; the clause in question is as follows:

"All streets being or which at any time become highways repairable by the inhabitants at large within any urban district, and the pavement stones and other materials thereof and all building implements and other things provided for the purposes thereof, shall vest in and be under the control of the urban authority. . . . Any person who without the consent of the urban authority wilfully displaces or takes up, or who injures the pavement, stones, materials, fences or posts of or the trees in any such street, shall be liable to a penalty not

exceeding five shillings for every square foot of pavement, stones or other materials so displaced taken up or injured; he shall also be liable in the case of any injury to trees to pay to the local authority such amount of compensation as the court may award" (38 & 39 Vic. c. 55, s. 149).

Even, however, granting that application must be made before any individual can break up a street, the urban authority would not be likely to withhold their consent if it was for a legitimate purpose, and having disturbed the street, a person must light and guard the opening, and the "hole," as it is called in the clauses following must be "filled up or otherwise made secure;" but it is very doubtful if he can be called upon to keep the surface of the road in repair for any length of time, as can be done in the case of water and gas companies, &c.; the following are the clauses in question:

"When any building materials, rubbish or other things are laid or any hole made in any of the streets, whether the same be done by order of the commissioners or not, the person causing such materials or other things to be so laid or such hole to be made, shall at his own expense cause a sufficient light to be fixed in a proper place upon or near the same, and continue such light every night from sun-setting to sun-rising while such materials or hole remain. And such person shall at his own expense cause such materials or other things and such hole to be sufficiently fenced and enclosed until such materials or other things are removed or the hole filled up or otherwise made secure" . . . (10 & 11 Vic. c. 34, s. 81).

"In no case shall any such building materials or other things or such hole be allowed to remain for any unnecessary time." . . . (10 & 11 Vic. c. 34, s. 82).

"If any building, or hole, or any other place near any street be for want of sufficient repair, protection or inclosure, dangerous to the passengers along such street, the commissioners shall cause the same to be repaired, protected, or inclosed, so as to prevent danger therefrom, and the expenses of

such repair, protection, or inclosure shall be repaid to the commissioners by the owner of the premises so repaired, protected or inclosed, and shall be recoverable from him as damages" (10 & 11 Vic. c. 34, s. 83).

These three sections are incorporated in the Public Health Act 1875, by 38 & 39 Vic. c. 55, s. 160, and the last clause undoubtedly gives power to the urban authority to repair a "hole" which for want of "sufficient repair" is "dangerous to passengers" but not otherwise, in however unsightly a manner the trench may have been repaired.

The result of this uncertainty has been that a great many towns have inserted in their private improvement Acts, clauses making it compulsory upon all persons to give them from 3 to 7 days' notice of their intention to break up the streets, specifying the manner in which the work shall be done, and also compelling them to deposit a sum of money in order to secure that the repairs of the street are properly executed.* A better method than this is to insert in any private improvement Act a clause giving powers to the urban authority to execute all drain-work themselves and charge it upon the owners of the property, thus ensuring that any interference with the surface of the street shall be done in a proper manner by men accustomed to the work, and also that the drain itself shall be of perfect workmanship.

Where the town surveyor has no private improvement Act dealing with this question, it is well to frame some regulations as to the manner in which the notice of intention to break up the surface of the street shall be given to him by the person intending to do the work, and if possible to obtain a deposit of a few shillings as a guarantee that the surface of the street shall be kept in something like decent repair.

* In some towns it is the practice to give the builder a junction pipe or block for nothing, thus ensuring his calling to give notice, but this is only successful in the case of new attachments to sewers, in which case the law is much more strict.

Although this may not be strictly legal, it is a very universal practice amongst town surveyors.

The following forms of notices are given as specimens of the description of notice now in use, and are copied verbatim from those which are now enforced in a very large borough in this country:

Borough of .

TO THE BOROUGH SURVEYOR,

I hereby apply for permission to break up the footway or roadway, and make excavations in for the purpose of , and I hereby undertake to light, watch and fence the place during the progress of the works, to temporarily make good the surface of the footway or roadway, to remove all rubbish, and to execute and complete the work to the satisfaction of the borough surveyor. I also deposit the sum of five shillings for the repair of the surface, and agree to pay the balance if it should cost more than that sum.

(Signature)
(Address)

Witness and receiver .
Received by accountant 188 .
Surface repaired 188 .
At a cost of .

Borough of .

188 .

To Mr.

This is to certify that you have paid a deposit of five shillings, and that you are hereby permitted to take up the footway or roadway and make excavations in for the purpose of on the undertaking you have given to light, watch and fence the place during the progress of the works, to temporarily make good the surface of the footway or roadway, to remove all rubbish, and to execute and complete the work

to the satisfaction of the borough surveyor ; also that you will pay the balance if the surface repairs should cost more than the aforesaid sum of five shillings.

Borough Surveyor.

NOTE.—If the surface repairs should cost less than the deposited sum, the balance will be returned to you by the accountant, who will notify you of the fact.

Notice must be given to the Building Inspector when the work is ready for inspection, and no drainage work must be covered up until it has been examined by the Inspector.

It may be well to add to this authority to break up the streets, the following words—

"This authority may be revoked at any time if found necessary, and it does not in any way relieve the person to whom it is granted from any liabilities he may incur in respect of accidents from anything done in pursuance thereof."

In some towns the following custom prevails in regard to this question.

The person desirous of opening the street for the execution of any work has to apply to the surveyor for a licence, and at the same time deposit a sum sufficient to cover the expense of the work, such sum being estimated and fixed by the surveyor. The corporation then supply one labourer whilst the job is in hand, who, whilst working, takes care that the soil is properly rammed and the surface made good ; a mason is also supplied to make any drainage or sewer connections. The deposit is kept for about 3 months, and the cost of the labourer and mason, and of any subsequent making good the surface of the street, is then deducted, and the balance returned to the person who made the deposit.

This arrangement seems an excellent plan, and is said to work remarkably well where it is in vogue, but whether it is strictly legal is open to considerable question.

CHAPTER XVI.

OBSTRUCTIONS IN STREETS.

FOR convenience, I propose to treat in this chapter some subjects which, strictly speaking, do not come under the head of "obstructions," but they are all questions which have to be considered by the town surveyor; temporary obstructions and other offences with which it is the province of the police to deal are omitted.

The following subjects will therefore be discussed:

(1.) Improving the line of frontages of streets.

(2.) Removing projections.

(3.) Doors and gates opening outwards.

(4.) Vault or cellar coverings.

(5.) Rain-water shutes and down-pipes.

(6.) Blinds or awnings over footpaths.

(7.) Trees over-hanging roadways.

(8.) Surface water from private premises running over footpaths.

(9.) Hoardings and scaffolds.

(10.) Dangerous buildings.

(1.) *Improving the Line of Frontages of Streets.*—By the Towns Improvement Clauses Act 1847, certain powers were granted which enabled the commissioners to agree with owners of property to set back for the purpose of widening any street,* but this was often found to be difficult and wearisome of accomplishment, consequently in the Public Health Act 1875, the following important clause bearing upon this point was inserted.

* *Vide* 10 & 11 Vic. c. 34, s. 67.

"Where any house or building situated in any street in an urban district, or the front thereof, has been taken down in order to be rebuilt or altered, the urban authority may prescribe the line in which any house or building, or the front thereof, to be built or rebuilt in the same situation shall be erected, and such house or building or the front thereof shall be erected in accordance therewith. The urban authority shall pay or tender compensation to the owner or other person immediately interested in such house or building for any loss or damage he may sustain in consequence of his house or building being set back or forward, the amount of such compensation in case of dispute to be settled by arbitration in manner provided by this Act"(38 & 39 Vic. c. 55, s. 155).

This clause gives an excellent power to the sanitary authority, especially in older towns, to lay down improved building lines upon the plan of their town, and thus set back the line of buildings as opportunity offers.

In assessing the value of compensation to be paid to the owner for setting back his property, the following points should be considered:

(1.) The value of the area of the land given up to the public.

(2.) The loss of available and useful space to the premises.

(3.) If any use is made by the owner of the land given up to the public by constructing cellars underneath, the amount of compensation should be less.

(4.) The amount the owner will have to expend to make good the sides of the neighbouring premises thus exposed by his setting back must be considered.

A surveyor should be very careful to recollect if any building line has been laid down in any street when the plans of new buildings are deposited with him for approval. If these plans are approved without any notice being given to

the owner to set back, it is questionable whether he can afterwards be called upon to do so.*

(2.) *Removing Projections of Buildings.*—The Towns Improvement Clauses Act 1847 made provision for setting back any house or building, or any part which projected beyond the regular line of street when taken down, on payment of compensation,† and this and the following sections were incorporated in the general Public Health Act 1875.‡

"The commissioners may give notice to the occupier§ of any house or building to remove or alter any porch, shed, projecting window, step, cellar, cellar-door, or window, sign, sign-post, sign-iron, show-board, window shutter, wall, gate, or fence, or any other obstruction or projection erected or placed after the passing of the special Act, against or in front of any house or building within the limits of the special Act, and which is an obstruction to the safe and convenient passage along any street, and such occupier shall within fourteen days after the service of such notice upon him, remove such obstruction or alter the same in such manner as shall have been directed by the commissioners, and in default thereof shall be liable to a penalty not exceeding forty shillings; and the commissioners in such case may remove such obstruction or projection, and the expense of such removal shall be paid by the occupier so making default, and shall be recoverable as damages; provided always, that except in the case in which such obstructions or projections were made or put up by the occupier, such occupier shall be entitled to deduct the expense of removing the same from the rent payable by him to the owner of the house or building."

The wall of a garden in front of a house, and shrubs in the

* *Vide* Fitzgerald's 'Public Health and Local Government Act 1875,' 3rd edition, p. 166.

† *Vide* 10 & 11 Vic. c. 34, s. 68.

‡ *Ibid.* ss. 69 and 70.

§ Or *Owners*, see s. 160, 38 & 39 Vic. c. 55.

garden, which encroach on the street, come within the words "any other obstruction" in this section.*

It is doubtful, however, if trade signs projecting at such a height as not to be "an obstruction to the safe and convenient passage along any street" can be removed under this section, however unsightly they may be, nor does it appear that flag poles or flags can be ordered to be removed when at such a height as to cause no obstruction.

The following clause, however, of the Public Health Act 1875 affects the question of new projections much more closely.

"It shall not be lawful in any urban district, without the written consent of the urban authority, to bring forward any house or building forming part of any street or any part thereof, beyond the front wall of the house or building on either side thereof, nor to build any addition thereto beyond the front of the house or building on either side of the same. Any person offending against this enactment shall be liable to a penalty not exceeding 40*s.* for every day during which the offence is continued after written notice in this behalf from the urban authority" (38 & 39 Vic. c. 55, s. 156).

Here some difficulty is frequently experienced as to the question if the building has really been brought beyond the common line of neighbouring buildings, especially where the houses are detached; but it is apparently left to the tribunal before whom the case is heard to decide this point, and the surveyor can only give his evidence, as in many other cases, to the best of his ability and knowledge, and trust to obtaining a verdict in his favour.

With regard to obstructions erected before the passing of the special Act, the commissioners may cause the same to be removed or altered as they think fit—

"Provided that they give notice of such intended removal or alteration to the occupier† of the house or building against

* *Vide* Fitzgerald's 'Public Health and Local Government Act 1875,' 3rd edition, p. 174.

† Or owner, see 38 & 39 Vic. c. 55, s. 160.

or in front of which such alteration or removal is begun ; and if such obstructions or projections shall have been lawfully made, they shall make reasonable compensation to every person who suffers damage by such removal or alteration."*

Here the words "*reasonable* compensation" are difficult of construction and lead frequently to long litigation.

(3.) *Doors or Gates opening outwards.*—

Section 71 of the Towns Improvement Clauses Act 1847 enacts that "All doors, gates and bars put up after the passing of the special Act within the limits thereof, and which open upon any street, shall be hung or placed so as not to open outwards, except when in the case of public buildings the commissioners allow such doors, gates or bars to be otherwise hung or placed; and if (except as aforesaid) any such door, gate or bar be hung or placed so as to open outwards on any street, the occupier of such house, building, yard or land shall, within eight days after notice from the commissioners to that effect, cause the same to be altered so as not to open outwards; and in case he neglect so to do the commissioners may make such alteration, and the expenses of such alteration shall be paid to the commissioners by such occupier, and shall be recoverable from him as damages, and he shall in addition be liable to a penalty not exceeding 40*s*."

Section 72 of the same Act further enacts, "If any such door, gate or bar was before the passing of the special Act hung so as to open outwards upon any street, the commissioners may alter the same so that no part thereof when open shall project over any public way."

It is naturally necessary that doors or gates of all public buildings should hang so as to open outwards, so as to give a free and easy exit in case of panic, many serious accidents having arisen from a want of this precaution; but with regard to private premises the case is altogether different, and if doors and gates were allowed to open out-

* Towns Improvement Clauses Act 1847, s. 70.

wards, they would soon become a dangerous and intolerable nuisance.

It will be seen that there are two courses to be pursued in connection with this offence.

The first is where the door, gate or bar has been placed before the passing of the Towns Improvement Clauses Act in 1847, in which case the "commissioners may alter the same, so that no part thereof when open shall project over any public way." This duty of course rests with the town surveyor, and in many cases it is not easy of execution, as structural difficulties may have to be encountered and overcome.

In the second case, where the door, gate or bar has been placed since the passing of the Act in 1847, certain penalties are incurred by the occupier or owner, and the commissioners may also alter the door, gate or bar at his expense.

The following specimen form of notice to be served in connection with a case of this description may be of use:

TOWN SURVEYOR'S OFFICE.

SIR,

I beg leave to give you notice that of the premises in your occupation opens outwards, and when open, projects into the street called or known as

I have therefore to require that you will be good enough to have such altered so that it shall not open outwards into the said street, within eight days next after your receipt of this notice.

I beg leave also to give you notice that if you neglect to make the alteration required within the period specified by this notice, you render yourself liable to a penalty of 40*s*., and I shall proceed to make the necessary alterations, and recover the costs and penalties from you as the law directs.

I am, Sir, your obedient Servant,

_____

Town Surveyor.

To _____

(4.) *Vault or Cellar Coverings.*—

Section 73 of the Towns Improvement Clauses Act 1847 enacts, "When any opening is made in any pavement or footpath within the limits of the special Act, as an entrance into any vault or cellar, a door or covering shall be made by the occupier* of such vault or cellar, of iron, or such other materials, and in such manner as the commissioners direct, and such door or covering shall from time to time be kept in good repair by the occupier of such vault or cellar: and if such occupier do not within a reasonable time make such door or covering, or if he make any such door or covering contrary to the directions of the commissioners, or if he do not keep the same when properly made in good repair, he shall for every such offence be liable to a penalty not exceeding five pounds."

Besides the penalty, the person negligently leaving the covering in a dangerous condition would be liable to an action for damages at the suit of anyone who had sustained an injury in consequence of the covering being so kept.†

There is another clause incorporated in the Public Health Act 1875 from the Towns Police Clauses Act 1847 upon this subject, which is as follows:

"Every person who leaves open any vault or cellar, or the entrance from any street to any cellar or room underground, without a sufficient fence or hand rail, or leaves defective the door, window or other covering of any vault or cellar . . . . shall be liable to a penalty not exceeding 40*s.* for each offence, or in the discretion of the justice before whom he is convicted may be committed to prison, there to remain for a period not exceeding 14 days" (10 & 11 Vic. c. 89, s. 28).

But the former section I have quoted is that upon which the town surveyor generally acts.

* Or owner.

† *Vide* 'Fitzgerald's Public Health and Local Government Act 1875,' 3rd edition, p. 175.

In connection with this duty the following is given as a specimen notice :

SIR,

I beg to call your attention to the fact that the door or covering to the vault or cellar in your occupation, No. Street, is not in good repair (and is slippery and dangerous to foot-passengers),* you are in consequence liable to a penalty of 5*l.*

I must request you will be good enough to have such door or covering properly repaired and made good in accordance with the construction required by law, within days from the date hereof, and in the event of your failing to do so, proceedings will be taken to enforce the penalty to which you are liable without further notice.

I am, your obedient Servant,

Town Surveyor.

To _____

In accordance with the provisions contained in the section of the Towns Improvement Clauses Act 1847 which I have quoted, that the "door or covering shall be made by the occupier of such vault or cellar of iron or such other materials, and in such manner as the commissioners direct," most towns in this country have prescribed the size and materials of which they shall be made, the size being often limited to 6 feet in length, by 20 inches projection, from the line of plynth of the building, for cellar coverings or pavement lights as they are sometimes called, and 12 inches in diameter for coal plates.

Hayward's patent hexagonal and semiprismatic pavement lights, however, have obviated the danger of slipping upon this description of covering, and consequently little or no incon-

* Care must be taken that the mode of construction "directed by the commissioners" authorises this part of the notice.

venience is experienced, even if the greater portion of the foot pavement is covered by them.*

Coalhole plates should be so firmly fixed as to prevent the possibility of their shifting, even when the rebate of the flag stone into which they are dropped is worn, and also to prevent mischievous persons from raising them.

Here let me state that no person can without the written consent of the urban authority cause "any vault, arch or cellar to be newly built or constructed under the carriageway of any street" (38 & 39 Vic. c. 55, s. 26); but from this section it does not appear illegal to construct a vault, arch or cellar under the footpath, which would generally be the extent to which such constructions would be extended. However, the more general powers contained in section 149 of the same Act, by which all "streets and the pavement stones and other materials thereof" vest in and are under the control of the urban authority, give the necessary powers to prevent the construction of cellars under any portion of the foot-pavement without the consent of the urban authority.

The usual practice adopted is for any person who requires to construct a cellar under the foot-pavement or carriageway of any street, to apply to the urban authority for the necessary permission to do so. In granting the permission, the urban authority call upon the owner of the premises to which the proposed vault or cellar is attached, to enter into an agreement acknowledging that the cellar or vault is only an easement, and agreeing to remove the encroachment whenever called upon by the urban authority to do so.

These agreements and any other similar easements should be kept together in a book, which may be called the "Easement Book," and indexed in such a manner that a reference

* In the City of London these patent lights have been fixed in the pavement round the whole of the frontage of Mansion House Buildings, at the corner of Queen Victoria Street, and also over the whole of the pavements in Draper's Gardens, besides many other equally crowded thoroughfares, without the least inconvenience being experienced.

can be easily made at any time to any easement that has been granted.

(5.) *Rain-water from Shutes or Down Pipes.*—

Water may not be allowed to drip on to the pavements of the streets from the adjoining houses, and the following clause from the Towns Improvement Clauses Act 1847 has been incorporated with the Public Health Act 1875:

"The occupier of every house or building in, adjoining, or near to any street shall, within seven days next after service of an order of the commissioners for that purpose, fit up and keep in good condition a shoot or trough of the whole length of such house or building, and shall connect the same either with a similar shoot on the adjoining house, or with the pipe or trunk to be fixed to the front or side of such building from the roof to the ground, to carry the water from the roof thereof in such a manner that the water from such house or any portico or projection therefrom shall not fall upon the persons passing along the street or flow over the footpath; and in default of compliance with any such order within the period aforesaid, such occupier shall be liable to a penalty not exceeding 40*s.* for every day that he shall so make default" (10 & 11 Vic. c. 34, s. 74).

In many private Town Improvement Acts, the cost of the repair necessary under an order to do so from the urban authority may be deducted by the occupier from the rent payable to the owner of the premises, thus ensuring the work being done more quickly.

The following is a specimen notice to be served upon the occupier to repair or put new shuting to his house:

I beg to give you notice that the eaves, shuting, or projecting cornice * to the house or building No. in your occupation, is out of repair. A penalty of 40*s.* will be incurred

* In the Act the words used are "shoot" and "trough."

if this shuting be not repaired within seven days from the date of this notice (and under the Special Improvement Act the cost of such repair may be deducted from the rent payable to the owner).*

I am, your obedient Servant,

_____

Town Surveyor.

To _____

It is a common practice in most towns for the urban authority to provide and fix trunks or troughs across their footpaths into which the down pipes from the rain-water shutes can empty their contents.

(6) *Blinds or Awnings over Footpaths.*—

These may be dealt with as obstructions under sec. 69 of the Towns Improvement Clauses Act 1847, which I have already quoted,† but they are more particularly alluded to in the Police Clauses Act 1847 in the following section:

"Every person who . . . places any blind, shade, covering, awning, or other projection over or along any such footway, unless such blind, shade, covering, awning or other projection is 8 feet in height at least in every part thereof from the ground, shall be liable to a penalty nor exceeding 40*s.* for each offence, &c." . . . (10 & 11 Vic. c. 89, s. 28).

Thus legalising the fixing of shop-blinds, &c., provided they are at least 8 feet in height and consequently no obstruction to the traffic.

In order to make the blinds or awnings sufficiently secure where they are of large dimensions, it is very usual for the owner or occupier of the premises to which the blind or awning is to be attached, to seek and obtain the consent of the local authority to fix iron sockets in the kerb of the footpath into which iron or wood standards are inserted for the purpose of supporting the outer part of the blind or awning, and there

* These words must be omitted if there is no special Improvement Act.

† *Vide* p. 176.

can be no objection to this practice provided that the work is efficiently performed and to the satisfaction of the town surveyor.

(7) *Trees overhanging Roadways—*

It used formerly to be considered by road surveyors and others * that great injury was caused to roadways by overhanging branches of trees or bushes, which were supposed to exclude the light and air from the roadway and thus damage it, hence powers were given to local authorities, as surveyors of highways, to compel occupiers of premises adjoining the roadways to cut back and prune their trees or hedges in order to prevent this damage. The following being the form of notice usually adopted for this purpose :

To _____

You are hereby required to cut, prune, and trim your hedges adjoining the highway leading from to and also to cut down, prune, or lop the branches of trees, bushes and shrubs growing in or near such hedges and other fences adjoining thereto, in such manner that the said high-

* Sir Fred. Parnell in his celebrated work upon roads has the following paragraph upon this subject :—

The great advantage of having a road perfectly exposed to the action of the sun and wind will be more accurately conceived by referring to writers of science on evaporation. Dr. Halley states that one-tenth of an inch of the surface of the sea is raised per diem in vapour. He also says that the winds lick up the water somewhat faster than it exhales by the heat of the sun. Other writers say the dissipation of moisture is much accelerated by the agency of sweeping winds, the effects being sometimes augmented five to ten times.

Trees are particularly injurious by not allowing the sun and wind to have free action on the surface of roads producing evaporation. Besides the benefit which a road receives from its drying rapidly by an open exposure to the atmosphere, there is another of great importance, namely, that of affording to horses the advantage of free respiration ; for it is well known that the powers of a horse to perform work with ease, particularly when moving rapidly, depends upon the quantity of cool and fresh air that he can pass through his lungs. If the cause of horses tiring or becoming ill under their work be carefully examined into, it will often be found that it is not their muscles or limbs that fail them, but their wind ; and therefore, it is particularly important to have a road so circumstanced that a horse may on all parts of it have the benefit of a free current of air.

way shall not be prejudiced by the shade thereof, and that the sun and wind may not be excluded therefrom. And you will further take notice, that if you shall neglect so to do within five days of the delivery hereof, I shall proceed to have the said hedges, trees, and bushes cut and pruned, according to the power and provisions of the various Acts of Parliament relating thereto. And further, that I shall also proceed to recover from you the penalties in this respect imposed by the said Acts of Parliament.

Dated this day of

Surveyor.

It is however now very seldom that overhanging branches of trees or hedges cause any damage to the roadways within an urban district, and unless they are an actual obstruction to the traffic, the growth of trees near urban roads and streets should be encouraged; indeed it is now a common practice to plant trees close alongside the roadway, the branches of which must of necessity hang over it, and cause no damage if the roadway is properly formed and attended to.

(8.) *Surface Water from Private Premises running over Footpaths.*—

It frequently happens that the rain-water which falls upon a front garden or courtyard finds its way, for want of a sufficient drain, out of the gate and across or along the public footpath, thus causing annoyance to pedestrians even if it does no injury to the path. There does not seem to be any clause in the Public Health Act 1875 to meet this objection, for the section which I have given with reference to rain-water shutes and down pipes (10 & 11 Vic. c. 34, s. 74), does not apply to such cases, as it only refers to water from the "roof or any portico or projection" and not to water falling upon the surface of a garden or courtyard, nor is there anything in the Highways Acts which can be brought to bear upon the subject.

If, however, any injury is caused to the footpath, no doubt the cause of offence may be stopped or the perpetrator prosecuted or indicted in default.

(9.) *Hoardings and Scaffolds.*—

When buildings are in course of erection, or repairs are being carried out to them, it is generally necessary that the person engaged in the work should construct either a hoarding or inclosure, or at all events a scaffold, so as to execute the work properly. Upon this point the following clause of the Towns Improvement Clauses Act has been incorporated with the Public Health Act 1875:

"Every person intending to build or take down any building within the limits of the special Act, or to cause the same to be so done, or to alter or repair the outward part of any such building, or to cause the same to be so done, where any street or footway will be obstructed or rendered inconvenient by means of such work, shall, before beginning the same, cause sufficient hoards or fences to be put up in order to separate the building where such works are being carried on from the street, with a convenient platform and handrail if there be room enough, to serve as a footway for passengers, outside of such hoard or fence, and shall continue such hoard or fence with such platform and handrail as aforesaid standing and in good condition, to the satisfaction of the commissioners, during such times as the public safety or convenience requires, and shall, in all cases in which it is necessary in order to prevent accidents, cause the same to be sufficiently lighted during the night.* And every such person who fails to put up such fence or hoard or platform with such handrail as aforesaid, or to continue the same respectively standing and in good condition as aforesaid, or who does not, while the said

* No person can put up hoards or scaffolds in the streets without first obtaining the consent of the urban authority, *vide* sections 144 and 149 of the Public Health Act 1875. Many towns also have private improvement Acts with very binding clauses on this subject, empowering the surveyor to demand a fee for a licence to erect a hoarding, and empowering him to remove these after notice, &c.

hoard or fence is standing, keep the same sufficiently lighted in the night, or who does not remove the same when directed by the commissioners within a reasonable time afterwards, shall for every such offence be liable to a penalty not exceeding 5*l.*, and a further penalty not exceeding 40*s.* for every day while such default is continued" (10 & 11 Vic. c. 34, s. 80).

Hoardings and scaffoldings are now so scientifically erected as to be little or no inconvenience to foot-passengers. Care must, however, be taken to see that in the erection of a hoarding the doors or gates in it shall not open outwards, and the police should be instructed to prevent carts being backed in and left standing across the footpath.

The surveyor must exercise great discretion in the length of time he allows a hoarding to remain; without undue hardship on the builder, he must study at the same time the more important question of the public convenience.

(10.) *Dangerous Buildings.*—

This is the last, although by no means the least, of the series of "obstructions" I have enumerated. Here, again, very grave responsibility rests with the surveyor to determine what is a dangerous building, and in what manner it shall be rendered safe and secure, for his opinion is apparently legally conclusive on this matter.

The following is the clause of the Towns Improvement Clauses Act which deals with ruinous or dangerous buildings:

"If any building or wall, or anything affixed thereon, within the limits of the special Act, be deemed by the surveyor of the commissioners to be in a ruinous state and dangerous to passengers or to the occupiers of the neighbouring buildings, such surveyor shall immediately cause a proper hoard or fence to be put up for the protection of passengers, * and shall cause notice in writing to be given to the owner of such building or wall, if he be known and resident

* This is scarcely ever feasible, or of the slightest use if done.

within the said limits, and shall also cause such notice to be put on the door or other conspicuous part of the said premises, or otherwise to be given to the occupier thereof, if any, requiring such owner or occupier forthwith to take down, secure or repair such building, wall or other thing, as the case shall require. And if such owner or occupier do not begin to repair, take down or secure such building, wall or other thing, within the space of three days after any such notice has been so given or put up as aforesaid, and complete such repairs or taking down or securing as speedily as the nature of the case will admit, the said surveyor may make complaint thereof before two justices to order the owner, or in his default the occupier (if any) of such building, wall, or other thing, to take down, rebuild, repair or otherwise secure, to the satisfaction of such surveyor, the same, or such part thereof as appears to them to be in a dangerous state, within a time to be fixed by such justices. And in case the same be not taken down, repaired, rebuilt or otherwise secured within the time so limited, or if no owner or occupier can be found on whom to serve such order, the commissioners shall with all convenient speed cause all or so much of such building, wall, or other thing as shall be in a ruinous condition and dangerous as aforesaid, to be taken down, repaired, rebuilt or otherwise secured in such manner as shall be requisite, and all the expenses of putting up every such fence, and of taking down, repairing, rebuilding or securing such building, wall or other thing shall be paid by the owner thereof" (10 & 11 Vic. c. 34, s. 75).

Great care must be observed in seeing that the notices are properly prepared and served in accordance with sections 266 and 267 of the Public Health Act 1875, and the town clerk, as the legal adviser of the sanitary authority, should be consulted (in this as in all cases requiring notices) by the surveyor.

It sometimes happens that a tall chimney shaft, wall, or

other erection may apparently be perfectly safe, whereas in a high gale of wind it may be blown down.

Many tall chimney shafts rock in an alarming manner in a high wind,* but he would be a bold surveyor who would order some of these expensive structures to be pulled down in the face of the opposition he would receive.†

A curious case of some difficulty in connection with dangerous buildings has come under my notice, where a house was built with the approval of the urban authority, and after completion and occupation the attention of the surveyor was called to the fact that a large piece of rock at the back of the house, from which the site had been excavated for the purpose of its erection, was in a dangerous condition and likely to fall at any moment and cause great damage to property, or even loss of life. The clerk to the urban authority, when consulted, was of opinion that the surveyor could do nothing in the matter, as the case was not met in any way by the Act.

The following is given as a specimen notice to serve with reference to a dangerous structure:

NOTICE.

To (A) *the Owner of*
the ruinous and dangerous (B) *under-mentioned*
and the occupier thereof.

Whereas a certain (B) situated at within the borough of , in the county of , is deemed by me, the undersigned, the surveyor of the mayor, aldermen and burgesses of the said borough of , acting by the council as the urban sanitary authority for the same, to be in a ruinous

* Mr. Cooper states that "a tall chimney will rock 1 inch in a moderate wind, and even to an extent of $\frac{1}{8}$th of an inch at a distance of only 16 feet up from its base, and yet be safe." (*Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. xxvii. p. 100.)

† Whilst this work was in the press the terrible disaster arising from the falling of an immense chimney shaft at Bradford took place, the result of which was the death of upwards of forty persons and great destruction of property.

state and dangerous to passengers or to the occupiers of neighbouring buildings:

Therefore take notice, that you are hereby required, in pursuance of the provisions in that behalf of the Public Health Act 1875, and the Towns Improvement Clauses Act 1847, to take down, repair or secure the said (B).

And that if you do not or if neither of you does begin to take down, repair, or secure the said (B) within the space of three days after this notice has been served upon you or put upon the said premises, and complete such taking down, repairing or securing as speedily as the nature of the case will admit, I shall cause complaint thereof to be made before two justices in accordance with the provisions of the statutes aforesaid.

Dated this day of 18

Surveyor of the said Urban Sanitary Authority.

A. The name and description of the owner or occupier, or the names, &c., of both should be here inserted.

B. Building, wall, or anything affixed thereon.

Before closing this chapter upon "Obstructions in Streets" I give the following clause from the "Towns Improvement Clauses Act," which comes after two other sections of the same Act principally dealing with building materials, rubbish, or holes in streets, and although in this clause the word "building" is used, the section cannot be taken as referring to dangerous buildings, although it may undoubtedly be used where it is required on account of waste land, &c., being left in an unprotected and dangerous state:—

"If any building or hole or any other place near any street be, for want of sufficient repair, protection or inclosure, dangerous to the passengers along such street, the commissioners shall cause the same to be repaired, protected or inclosed so as to prevent danger therefrom; and the expense of such repair, protection or inclosure shall be repaid to the com-

missioners by the owner of the premises so repaired, protected or inclosed, and shall be recoverable from him as damages" (10 & 11 Vic. c. 34, s. 83).

I have purposely omitted any reference to temporary obstructions in the streets, which are naturally subjects for the interference of the police, but I think I have enumerated all those which require the attention of the town surveyor.

CHAPTER XVII.

IMPROVEMENT OF PRIVATE STREETS.

PRIOR to the passing of the Public Health Act 1875 the improvement of private roads and streets was dealt with under section 69 of the Public Health Act 1848, but the clause under which the town surveyor now works is that which is so well known as the 150th section of the Public Health Act 1875, and is as follows:

"Where any street within any urban district (not being a highway repairable by the inhabitants at large) or the carriageway, footway, or any other part of such street is not sewered, levelled, paved, metalled, flagged, channelled and made good, or is not lighted to the satisfaction of the urban authority, such authority may, by notice addressed to the respective owners or occupiers of the premises fronting, adjoining or abutting on such parts thereof as may require to be sewered, levelled, paved, metalled, flagged or channelled, or to be lighted, require them to sewer, level, pave, metal, flag, channel or make good, or to provide proper means for lighting the same within a time to be specified in such notice.

"Before giving such notice the urban authority shall cause plans and sections of any structural works intended to be executed under this section, and an estimate of the probable cost thereof, to be made under the direction of their surveyor, such plans and sections to be on a scale of not less than one inch for eighty-eight feet for a horizontal plan, and on a scale of not less than one inch for ten feet for a vertical section, and, in the case of a sewer, showing the depth of such sewer below the surface of the ground: such plans, sections and

estimate shall be deposited in the office of the urban authority, and shall be open at all reasonable hours for the inspection of all persons interested therein during the time specified in such notice; and a reference to such plans and sections in such notice shall be sufficient without requiring any copy of such plans and sections to be annexed to such notice.

If such notice is not complied with, the urban authority may, if they think fit, execute the works mentioned or referred to therein; and may recover in a summary manner the expenses incurred by them in so doing from the owners in default, according to the frontage of their respective premises, and in such proportion as is settled by the surveyor of the urban authority, or (in case of dispute) by arbitration in manner provided by this Act; or the urban authority may by order declare the expenses so incurred to be private improvement expenses.

"The same proceedings may be taken and the same powers may be exercised in respect of any street or road of which a part is or may be a public footpath or repairable by the inhabitants at large, as fully as if the whole of such street or road was a highway not repairable by the inhabitants at large" (38 & 39 Vic. c. 55, s. 150).

One has only to look at the number of footnotes that follow this clause both in "Glenn" and "Fitzgerald" to see that it requires some considerable interpretation. I propose in this chapter to call attention to some of its engineering discrepancies and to point out the duties of the town surveyor in connection with its enforcement.

First then, I conclude that it is the duty of the surveyor to call the attention of the urban authority to the fact that any street within his district (not being a highway repairable by the inhabitants at large) is not "sewered, levelled, paved, &c." but there is no express order for him to do so, but with whoever this duty rests, it is no doubt the surveyor's duty to be certain that the street in question has never been dedicated

to the public or repaired at the cost of the rates, but is really a private street within the meaning of the Act.

Before proceeding to give the manner of putting the 150th section into force, it is necessary to draw attention to some of its wording.

The word "sewered" no doubt is also meant to include all drains both for house sewage and surface water falling on the street, &c., and may be used in the same comprehensive manner that the word "sewerage" is generally employed.

"Levelled" is also rather a vague term, but it has been held to refer only to the level or cross section of the street itself, there being no power to charge the adjacent owners with the expense of altering the level of the street so as to make it conform to a street with which it connects. The word "formed" would in this case have therefore been a more appropriate phrase.

"Paved, metalled, flagged, channelled and made good" are very precise directions, but why both the words "paved" and "metalled" are used is not clear. Is the paving to be placed on the top of the metalling or vice versâ? It seems ludicrous to have used both words. The word "kerbed" also ought no doubt to have been inserted, as no street either urban or suburban can be formed without this necessary adjunct.

These very precise directions, if carried out in their entirety, would cause great injustice to the adjacent owners of the property who had to bear the expense, for although "paving" and "flagging" may be necessary for streets situated in a town itself, they would be perfectly unnecessary for a suburban road, and it is to this latter class of work that the section is more frequently applied. There are generally very few badly maintained private streets in the heart and busiest parts of a town, much difference of opinion consequently exists in different localities as to what the requirements shall be.

Some urban authorities insist that the roadways shall be

paved with granite setts or wood blocks, the footpaths being flagged or paved with asphalte, while others are content with ordinary macadamised roadways and gravelled paths.

There can be no doubt that the town surveyor must use considerable discretion in deciding what class of work should be demanded, and he must be greatly guided by the situation and requirements of the street in question and the description and value of the adjoining property.

With reference to the words "or is not lighted," my opinion is that nearly all private streets are at once lighted by the urban authority out of the rates, so soon as buildings are erected at its sides or it is found necessary for the public convenience to do so. A reference to section 161 of the Public Health Act 1875 will show that there is no exclusion of private streets for that purpose, and for many obvious reasons it is better that the urban authority should themselves undertake this duty rather than throw it upon private individuals.

Having thus far drawn attention to some of the wording of the clause, it is now necessary to discuss the duties of the town surveyor in connection with it.

It will be seen that notice has to be addressed to the owners or occupiers of "premises fronting, adjoining or abutting *on such parts thereof* as may require to be sewered, levelled, paved, &c." It is often found that although the greater portion of a certain private street may be in a shocking state of repair, perhaps just a small length here and there opposite portions of different frontages may not be so bad: for instance, the path may be well gravelled and kerbed and a narrow channel gutter inserted against a wretchedly constructed roadway. It is often open to question if the owners of these properties against which these partial improvements have been effected can expect to escape their liability. If they can, it complicates still more the working of an already greatly complicated clause.

"Before giving such notice the urban authority shall

cause plans and sections . . . to be made under the direction of their surveyor."

This order involves some considerable amount of work. Very accurate surveys must be made and plotted to a large scale, levels must be taken, and where sewers have to be included in the notice it is often necessary to extend the survey considerably, in order to make provision for future extensions of streets or buildings or for the existing sewerage system. The clause is very particular in stating that the "depth of such sewer below the surface of the ground" must be shown, but no mention is made about the size. The latter point being of quite as great importance it would be thought as the depth, the question also at once arises, whether the new sewer must be specified of such a size as only to meet the requirements of the street alone, or may it be made of such an area as will carry the sewage of a considerable district? It would be most unjust to expect the owners of property to pay for a sewer larger than was required for the street in respect of which they were responsible, and if legal, the better plan would be for them to be charged with the cost of such a sewer as would be sufficient for their purpose and let any extra size that the surveyor found was requisite be paid for out of the public rates.

It should be noted that in addition to the plans and sections "an estimate of the probable cost" must also be prepared by the surveyor, and this must be very carefully prepared, for it has been held to be a "condition precedent to the recovery of the expenses, that such estimate should have been properly made" (*Vide* 'Fitzgerald' p. 160, 3rd edition).

No mention is however made in the Act of a specification, which is of course absolutely essential.

It may here be of use if I give a specimen form of notice to be served in connection with carrying out the duties involved by this clause; of course each town surveyor must alter the work specified to meet the requirements of the case;

To the Owner or Owners of certain premises fronting, adjoining, or abutting upon a certain street, called in the parish of in the borough of in the county of

Whereas the said street is not levelled, paved, metalled, channelled and made good to the satisfaction of the mayor, aldermen and burgesses of , the urban sanitary authority of the above-named borough :

And whereas your said premises front, adjoin, or abut on certain parts of the said street which requires to be levelled, paved, metalled, channelled and made good as aforesaid :

Now therefore, the mayor, aldermen and burgesses of , the urban sanitary authority of the said borough as aforesaid, hereby give you notice (in pursuance of the statute in that case made and provided) to level, pave, metal, channel and make good the portion of the said street in which your said premises front, adjoin, or abut as aforesaid, within the space of one month from the date hereof, in manner following, that is to say :

(*If a sewer is to be formed, fill in this first.*)

The carriage-way and water tables thereof to be formed in the mode, according to the sections, and on the levels and at the rates of inclination shown upon the plan, sections, and in accordance with the specification of the work prepared by the surveyor to the said urban sanitary authority, and now open for public inspection at his office, during the usual office hours.

The carriage-way to be bottomed, formed, and carefully levelled up to the form shown by the said sections ; and in the following manner :

(*Here fill in specification of method.*)

Construct gullies, fitted with five-bar cast-iron gratings and frames of the form and pattern to be seen

at , these gullies to be placed in such positions as are shown on the aforesaid plan and sections; each gully to have a six-inch glazed stoneware socket-pipe drain connecting it with the sewer, to be laid on a solid bed, and at an uniform inclination from gully to sewer,. with joints made of neat Portland cement.

The existing kerb to be taken up and replaced by inches by inches granite kerb in lengths of not less than inches, to the lines shown on plan, and to the levels marked on sections.

The water-tables or gutter to be channelled with properly laid, and bedded on fine gravel to the levels and inclinations marked on sections.

The footpaths shall be properly formed, bottomed, and drained where required; the formation level made to the inclination shown on section, and afterwards coated with .

The whole of the above-mentioned works to be executed by you in accordance with the plan and sections hereinbefore referred to and now open for inspection at the surveyor's office as aforesaid, and of the dimensions, widths and levels shown thereon, and to be done in a good, workmanlike and substantial manner, to the satisfaction of the said urban sanitary authority and of their surveyor.

An estimate of the probable cost of the said work, prepared under the direction of the surveyor to the said urban sanitary authority, is also lying for inspection at the office of the said surveyor, in manner required by section 150 of the Public Health Act 1875.

Dated this day of 18 .

Town Clerk.

The clause then goes on to say "If such notice is not complied with."

It would be a most difficult and costly proceeding for any individual owner of property to execute the work for half

the width of the street opposite his length of frontage, and the result would be anything but satisfactory if the owners of the properties were to comply with the notices in this manner.

If the owners do intend to comply with the notice, and carry out the work themselves, the best method for them to adopt is to hold a meeting and decide upon having it done, then to appoint one of their number, or some other person to superintend or carry out the work, and afterwards collect the money, but this is very seldom done, and the wisest course (which is generally adopted) is not to comply with the notice, but let the urban authority execute the work themselves. This again entails considerable labour upon the town surveyor, who has to superintend the work and see that all the details contained in the statutory notices are properly carried out, but his labour does not end here. Upon the completion of the work the amount expended has to be recovered "from the owners in default according to the frontage of their respective premises, and in such proportion as is settled by the surveyor of the urban authority, or (in case of dispute) by arbitration."

It is scarcely necessary to point out what an immense amount of responsible work this involves. First, a separate account of all the labour and materials employed on the street must be most carefully kept and totalled at the end of the work, with such additional sum for supervision, &c., as the urban authority may think necessary.* The exact length of each property "fronting, adjoining or abutting" on the street, must be most carefully measured. A proportionate sum has then to be calculated for each of these, and this sum is often complicated by cross roads, cul-de-sacs, narrow passages, strips of land intervening between the street and the properties, and many other perplexing intricacies, in addition to those persons

* In some districts the urban authority make an additional charge of 5 per cent. upon the total outlay to cover the cost of preliminary surveys and supervision of the work by their surveyor; this 5 per cent., however, is not paid to him, but is paid to the city treasurer, and thus becomes a set off against his salary.

who are legally exempted from any payment under the following clause of the Public Health Act 1875 :

"The incumbent or minister of any church, chapel, or place appropriated to public religious worship, which is now by law exempt from rates for the relief of the poor, shall not be liable to any expenses under the last preceding section as the owner or occupier of such church, chapel, or place, or of any churchyard or burial ground attached thereto, nor shall any such expenses be deemed to be a charge on such church, chapel or other place, or on such churchyard or burial ground . . ." (38 & 39 Vic. c. 55, s. 151.).

The town surveyor, having ascertained what is the amount of the sum due from each owner, shall proceed to fill in the amount upon a form a specimen of which is now given :

To the Owner of certain premises fronting, adjoining or abutting upon a certain street called in the parish of in the borough of in the county of

Whereas the mayor, aldermen and burgesses of the urban sanitary authority for the said , by a notice in writing pursuant to the statute in that behalf made and provided, dated the day of , 18 , required you being the owner of certain premises fronting, adjoining or abutting upon a street or highway called , within the said (and not being a street or highway repairable by the inhabitants at large) to level, pave, metal, channel and make good the said street or highway within the time and in the manner specified in the said notice, and according to the plans and sections deposited at the office of the surveyor to the said urban sanitary authority at :

And whereas the said notice not having been complied with by you within the time limited by the said notice, the said urban sanitary authority have executed the works mentioned or referred to therein :

And whereas the expenses incurred by the said urban sanitary authority in levelling, paving, metalling, channelling and making good the said street, amount to pounds shillings and pence :

Wherefore take notice that I the undersigned, being the surveyor of the said urban sanitary authority, in pursuance of the statutes in that case made and provided, do hereby apportion the sum of pounds, shillings and pence as the proportion of the said sum of pounds, shillings and pence, to be paid by you as such owner aforesaid, such apportionment being according to the frontage of your said premises, fronting, adjoining or abutting upon the said street or highway.

Further take notice that the aforesaid apportionment will be binding and conclusive upon you unless within the period of three months from the day of the date of this notice you shall by written notice to the said urban sanitary authority dispute the same.

Dated this day of , 18 .

Surveyor to the said Urban Sanitary Authority.

Clerk of the said Urban Sanitary Authority.

There seems to be no power on the part of any owner to dispute the question as to whether the works carried out have been necessary or not, or whether the cost of the works have been excessive ; the only point upon which they can go to arbitration is that as to whether the proportion settled by the surveyor is accurate or not, and this point the arbitrator is left to decide.

It must not be lost sight of that there is a clause in the Public Health Act 1875, which makes the expenses so settled by the surveyor very binding upon the owner of the property in question, unless he appeals within three months from the

service of the notice, as the following extract from the clause will show:

. . . "Where such expenses have been settled and apportioned by the surveyor of the local authority as payable by such owner, such apportionment shall be binding and conclusive on such owner, unless within three months from service of notice on him by the local authority or their surveyor of the amount settled by the surveyor to be due from such owner, he shall by written notice dispute the same" . . . (38 & 39 Vic. c. 55, s. 257)* and it must also be borne in mind that the person from whom these expenses may be recovered "is the owner of the premises at the time when the work was done, not the owner to whom notice requiring the work to be done may be given" (*vide* Fitzgerald's Public Health Act, p. 301, 3rd edition); so that the town surveyor must be very careful to make sure that any of the property abutting on the street has not changed hands before he commences the work.

After the 150th section of the Public Health Act has been carried out and a private street has been thus put into thorough repair, the urban authority may take possession of it and declare it to be a highway repairable by the inhabitants at large; the following section of the Act gives the modus operandi necessary to effect this:

"When any street within any urban district, not being a highway repairable by the inhabitants at large, has been sewered, levelled, paved, flagged, metalled, channelled and made good and provided with proper means of lighting to the satisfaction of the urban authority, such authority may if they think fit, by notice in writing put up in any part of the street, declare the same to be a highway, and thereupon the same shall become a highway repairable by the inhabitants at large, and every such notice shall be entered among the proceedings of the urban authority.

* See also 38 & 39 Vict. c. 55, s. 268, where a person who deems himself aggrieved may memorialise the Local Government Board, &c.

"Provided that no such street shall become a highway so repairable if within one month after such notice has been put up, the proprietor or the majority in number of proprietors of such street, by notice in writing to the urban authority, object thereto, and in ascertaining such majority, joint proprietors shall be reckoned as one proprietor" (38 & 39 Vic. c. 55, s. 152).

The necessary notices in conformity with this section are usually prepared by the town clerk, so that the town surveyor has nothing to do with this proceeding except to maintain the street after it has been declared a highway repairable by the inhabitants at large, in the same manner as he does the rest of the public streets within his district.

There is still one other clause of the Public Health Act 1875, which deals with the question of private roads, and it is as follows:

"Any urban authority may agree with any person for the making of roads within their district for the public use through the lands and at the expense of such person, and may agree that such roads shall become and the same shall accordingly become on completion, highways maintainable and repairable by the inhabitants at large within their district; they may also with the consent of two-thirds of their number agree with such person to pay and may accordingly pay any portion of the expenses of making such roads" (38 & 39 Vic. c. 55, s. 146).

This clause is very explicit and requires no comment, it would however be much better for the urban authority in contemplating a case of this description to execute the necessary works themselves and agree with the person about the expense, for if they are intended to be afterwards taken over it is to be feared that the roads would be very improperly constructed in the first place by the person intending to hand them over. It must be noted that the word "roads" is used in the above clause instead of "streets" as in the other

clauses I have quoted, and also that the word "maintainable" is added to repairable.

Street is the term legally used in the Public Health Act 1875, and is thus defined:

"Street includes any highway (not being a turnpike road) and any public bridge (not being a county bridge), and any road, lane, footway, square, court, alley or passage, whether a thoroughfare or not" (38 & 39 Vic. c. 55, s. 4.) so that whereas in the 150th section of the Public Health Act 1875, any of the above can be dealt with, it is only open for the urban authority to deal with roads under the 146th section of the Act, and it is sometimes rather difficult to define a road for the purposes of the latter section.

CHAPTER XVIII.

NEW STREETS AND BUILDINGS.

ONE of the most important duties devolving upon a "town surveyor" is that of exercising control over any new streets that may be constructed, or any new buildings that may be erected, within the limits of his jurisdiction.

This duty is imposed on him by the following clause of the Public Health Act 1875:

"Every urban authority may make byelaws with respect to the following matters; (that is to say,)

"(1.) With respect to the level, width and construction of new streets, and the provisions for the sewerage thereof;

"(2.) With respect to the structure of walls, foundations, roofs, and chimneys of new buildings, for securing stability and the prevention of fires, and for purposes of health;

"(3.) With respect to the sufficiency of the space about buildings to secure a free circulation of air, and with respect to the ventilation of buildings;

"(4.) With respect to the drainage of buildings, to water-closets, earth closets, privies, ashpits, and cesspools, in connexion with buildings, and to the closing of buildings or parts of buildings unfit for human habitation, and to prohibition of their use for such habitation;

"And they may further provide for the observance of such byelaws by enacting therein such provisions as they think necessary as to the giving of notices; as to the deposit of plans and sections by persons intending to lay out streets or to construct buildings; as to inspection by the urban authority, and as to the power of such authority (subject to the provisions of this Act) to remove, alter, or pull down any work

begun or done in contravention of such byelaws. Provided that no byelaw made under this section shall affect any building erected in any place (which at the time of the passing of this Act is included in an urban sanitary district) before the Local Government Acts came into force in such place, or any building erected in any place (which at the time of the passing of this Act is not included in an urban sanitary district) before such place becomes constituted or included in an urban district, or by virtue of any order of the Local Government Board subject to this enactment.

"The provisions of this section, and of the two last preceding sections, shall not apply to buildings belonging to any railway company, and used for the purposes of such railway under any Act of Parliament" (38 & 39 Vic. c. 55, s. 157).

The result of this power having been so given to urban authorities, is that they have all framed sets of byelaws, which having received the sanction of the Local Government Board, are now law in the several districts.

In the year 1877, it being found that considerable variation existed in the requirements set forth in the byelaws, according to the districts from which they emanated, and experience having shown that the forms of byelaws previously issued by the Local Government Board were inadequate, the Local Government Board in order to assist urban authorities issued a series of model byelaws; amongst the series being a set of byelaws regulating the manner in which new streets should be constructed and buildings erected.*

These model byelaws are too extensive to give in detail, as they contain 99 clauses, but every town surveyor should at once procure a copy, even if his corporation have not adopted them, nor intend to do so.

One of the first difficulties that often presents itself to

* 'Model Bye-laws issued by the Local Government Board for the use of sanitary authorities. New Streets and Buildings, IV.' Printed by George E. Eyre and William Spottiswoode, 1877.

those who have to enforce the observance of the necessary "giving of notices and deposit of plans and sections by persons intending to construct new buildings" is to prove that the building is "new" so as to bring it under the operations of the Act.

In many cases, of course, there can be no doubt where bare land is being built upon, but often after buildings have been partially destroyed by fire, or where extensive alterations are being carried out, some considerable elements of uncertainty as to what is a "new building" are introduced.

The law attempts to settle the question as follows:

"For the purposes of this Act, the re-erecting of any building pulled down to, or below the ground floor, or of any frame-building of which only the frame-work is left down to the ground floor, or the conversion into a dwelling house of any building not originally constructed for human habitation, or the conversion into more than one dwelling house of a building originally constructed as one dwelling house only, shall be considered the erection of a new building" (38 & 39 Vic. c. 55, s. 159).

But the difficulty at once presents itself as to what is meant by the words "ground floor." Does this mean the actual floor level, or the cubical space contained by the walls, floor and ceiling of the "ground floor" (or as it is sometimes called "ground story") of the building? The latter may be assumed to be the correct interpretation, for if we order a man to hang a picture, or to fix a chandelier on the "ground floor," we certainly do not expect to find them placed upon the floor.

It is important that this point should be settled definitely, or some more explanatory term employed in the Act in order to determine what is a new building, for in the present state of uncertainty it may be urged that the whole building must be razed to the ground, whereas if the proper meaning of "ground floor" is taken, would the removal of the super-

structure and destruction of the ceiling only of the "ground floor" bring the new work under the definition of a new building and within the operation of the byelaws?

This uncertainty is now taken advantage of by builders and others, who sometimes find it irksome and inconvenient to be obliged to construct a building in accordance with the byelaws of any town. Somewhat sharp practices are consequently resorted to in order to evade the law, and old buildings are converted into new ones without any powers of interference by the urban authority or their surveyor. This is greatly to be regretted, as unless the building comes within the operation of the byelaws, it is frequently erected without any sanitary precautions or even stability.

Sometimes a so-called repair of a building is commenced by adding a new roof perhaps, at a higher level than the old one; when sufficient time has elapsed to allay suspicion, a new front is erected, and then new back and side walls in due course, the alteration of the interior floors not attracting much attention.

Cases of this description are very troublesome to the town surveyor, as if legal proceedings are to be taken against the offender, it is necessary for the surveyor to make surveys and drawings of the works as they are in progress in order to prove his case, and these might extend over a considerable period of time.* In order to make these surveys it would be necessary for him to enter the premises whilst the works were in progress, but there does not seem to be any powers conferred on him by any Act of Parliament for such a purpose,

* It is open also to question whether in the case of an old building being gradually altered into a new one, it would be possible to prosecute, as there is the following limitation as to proceedings in the Public Health Act 1875: "Any complaint or information made or laid in pursuance of this Act shall be made or laid within six months from the time when the matter of such complaint or information respectively arose" . . . (38 & 39 Vic. c. 55, s. 252). The complaint could not be made when the work was first commenced, as no offence would have been committed, and if made after the work was finished, it might be urged that the offence was commenced more than six months prior, and that the complaint should have been made "when the matter of such complaint or information respectively arose."

so that really he has no power to prevent the occurrences I have mentioned.

It must also not be forgotten that what may sometimes appear to be an entirely new building, may only be an addition to one that existed before the passing of the Act, and although the new work may be ten times as large as the old, still much conflicting evidence may be brought to bear before it can be proved to be a "new building" within the meaning of the Act.

Turning again to section 159 of the Public Health Act 1875, these words will be found as defining also what is a new building: "or the conversion into a dwelling house of any building not originally constructed for human habitation."

It would have been better in the interests of sanitation if the Act had prohibited the conversion of any building at all into a dwelling house without the approval of the urban authority, for as the law stands at present, it is open for an owner of property to convert stables or warehouses, &c., into dwelling houses, by simply asserting and bringing witnesses or other evidence to prove that they were "originally constructed for human habitation" irrespective of whether they are adapted for the purpose or not, thus defeating the intention of the Public Health Act to secure a better description of dwellings than those that were erected before the passing of the Act.

When a dispute does arise with anyone as to whether a building comes within the definition of "new" or not, it is well if possible to agree upon certain points of fact and upon plans, &c., before the case comes into court, and then to endeavour to get the magistrates to "view." This course if pursued often saves lengthy litigation, and a great waste of time and money.

With reference to the deposit of plans of new streets or buildings, the following clause of the Public Health Act 1875 provides that this shall be done:

"Where a notice, plan or description of any work is

required by any byelaw made by an urban authority to be laid before that authority, the urban authority shall, within one month after the same has been delivered or sent to their surveyor or clerk,* signify in writing their approval or disapproval of the intended work to the person proposing to execute the same; and if the work is commenced after such notice of disapproval, or before the expiration of such month without such approval, and is in any respect not in conformity with any byelaw of the urban authority, the urban authority may cause so much of the work as has been executed to be pulled down or removed" . . . (38 & 39 Vic. c. 55, s. 158.).

The result of these clauses of the Act with reference to new streets and buildings is, that some of the most arduous and irksome duties of the town surveyor are embodied in the few words they contain. These duties consist of, first, the careful examination of, and report upon all plans of new streets and buildings; secondly, the constant supervision of these streets and buildings whilst the works are in progress; and each of these duties will be considered in the course of this chapter.

First then, as to the deposit and examination of the plans of new streets or buildings.

The byelaws of which I have already made mention should contain some such clause as the following:

"Every person who shall intend to make or lay out any new street, whether the same shall be intended to be used as a public way or not, shall give notice to the urban authority of such intention, by writing delivered to them at their office, or at the office of their surveyor, and shall at the same time leave or cause to be left at the office of the urban authority, or of their surveyor, a plan and section of such intended new street, drawn to a scale of not less than 1 inch to every 44 feet, and shall show on every such plan the names of the owners of the land through or over which such street shall be

* Plans are usually deposited with the surveyor as being the officer who would be most likely to understand them.

intended to pass, the level, width, direction, the proposed mode of construction, the proposed name of such intended new street, and its position relatively to the streets nearest thereto; the size and number of the intended building lots, and the proposed sites, height, class, and nature of the buildings to be erected therein, and the proposed height of the division and fence walls thereon; and the name and address of the person intending to lay out such new street, and he shall himself sign such plan, or cause the same to be signed by his duly authorised agent.

"Such person shall show on every such section the level of the present surface of the ground above some known fixed datum, the level and rate or rates of inclination of the intended new street, the level and inclination of the streets with which it will be connected, and the level of the lowest floors of the intended new buildings.

"Every person who shall intend to erect any new building shall give notice to the urban authority of such intention by writing delivered to them at their office or at the office of their surveyor, and shall at the same time leave or cause to be left at the said office detail plans and sections of every floor of such intended new building, drawn to a scale of not less than 1 inch to every 8 feet, showing the position, form and dimensions of the several parts of such building, and of the water-closet, earth closet, privy, cesspool, ashpit, well, and all other appurtenances; and together with such plans and sections he shall leave or cause to be left at the office of the urban authority, or of their surveyor, a description of the materials of which the building is proposed to be constructed, of the intended mode of drainage, and means of water supply.

"Such person shall at the same time leave or cause to be left at the office of the urban authority, or of their surveyor, a block plan drawn to a scale of not less than 1 inch to every 44 feet, and shall show the position of the buildings and appurtenances of the properties immediately adjoining, the

width and level of the street in front, and of the street, if any, at the rear of such building, the level of the lowest floor of such building, and of any yard or ground belonging thereto.

"Such person shall likewise show on such plan the intended lines of drainage of such building, and the intended size, depth and inclination of each drain; and the details of the arrangement proposed to be adopted for the ventilation of the drains."

With reference to the deposit of plans as required by the above byelaw, the following suggestions as to the best manner of effecting this may be of some use:

(1.) The town surveyor should see that the person, or his agent, intending to carry out the work, deposits tracings of the proposed street or building signed by himself, so that there should be no after dispute as to what really has been deposited; these tracings should be on good paper properly inked in and coloured so as to be indelible. In some towns it is the practice for original plans to be deposited temporarily with the surveyor, who is expected to have them traced and then returned to the owner, but this not only tends to the possibility of dispute as to the correctness of the tracings, but it also takes up a large amount of the surveyor's time, or of such other officer as may have charge of this branch of the duties.

In order to insure that the plans deposited shall not be afterwards claimed by the person making the deposit, it might be well to add these words to the clause of the byelaws which I have quoted:

"All such plans and sections so left at the office of the urban authority or of their surveyor, shall remain the property of the urban authority."

(2.) It is advisable for the town surveyor to have in his possession a number of printed forms on which application should be made by the person intending to erect a new building and filled in and signed by him or his duly authorised agent. The following is given as a specimen form for this purpose:

To the Surveyor of the Urban Authority of

I hereby give you notice that it is my intention to erect certain buildings in street, and that the following particulars relate thereto:

No.	Questions.	No.	Answers.
1	Christian and Surname *in full*, Address and Occupation of persons for whom buildings to be erected.	1	
2	Number of drawings deposited.	2	
3	Name of architect, if any.	3	
4	Description of buildings and of the materials to be used in construction of same.	4	
5	Situation of buildings.	5	
6	Level, or intended level of cellar, or ground floor, with reference to surface of street.	6	
7	Thickness of walls.	7	
8	Height of building in stories.	8	
9	Area of clear open space at rear or side of buildings exclusively belonging thereto.	9	
10	Distance across such open space.	10	
11	Description of ventilation.	11	
12	Width of street or open space opposite buildings.	12	
13	Size and description of drains, and traps, and if ventilated.	13	
14	Inclination of drains.	14	
15	Description of outlet to drains.	15	
16	How supplied with water.	16	
17	Situation, dimensions, and particulars of apparatus of w.c.'s.	17	

And I herewith leave detail plans and sections of every

floor of such intended new buildings, drawn to a scale of not less than 1 inch to every 8 feet, showing the position, form, and dimensions of the several parts of such buildings, and of the watercloset, privy, cesspool, earthcloset, ashpit, well, and all other appurtenances; and also, a block plan drawn to a scale of not less than 1 inch to every 44 feet, showing the position of the buildings and appurtenances of the properties immediately adjoining, the width and level of the street, the level of the lowest floor of the intended building, and of the yard or ground belonging thereto.

Dated this day of 18

Signature in full,
Address,
Occupation,

A similar form may be prepared relating to plans of proposed new streets, but of course the number of the questions contained in it will be less.

(3.) When the necessary notices have been given and the tracings properly deposited with the surveyor, he should carefully examine them to see if they are in accordance with the byelaws which are in force in his district. They should then be folded and placed in a large envelope, which should be endorsed with the name of the person proposing to carry out the work, the description of the work proposed, the name of the architect, if any, the name of the builder, if any, the date of the deposit, and a blank left for the date of approval. Each envelope should also have a large number stamped upon it.

(4.) These particulars should be entered in a book of reference against a corresponding number, so that at any future date it may be easy to find and refer to any plans that have been deposited by means of an index and the number on the envelope.

(5.) If on examining the plans the surveyor finds anything

in them which does not conform to the byelaws, he should be empowered by the urban authority to return them at once to the person depositing them, without having to wait to lay them before a committee, as this is a great saving of time. In returning the plans the surveyor should write a letter setting forth a schedule of his objections and the particulars of the manner in which the plans and sections fail to comply with the requirements of the byelaws.

(6.) If the plans are redeposited unaltered or showing still some non-compliance with the byelaws, the surveyor must lay them before his committee and explain in what respects they are defective, leaving it to the committee to decide whether they shall be approved or not.

(7.) If the plans are in accordance with the byelaws, the surveyor reports the fact to the committee, whereupon the plans should be at once signed by the chairman of the committee.

(8.) All plans which the committee decline to approve of should be at once returned to the person who deposited them with a written notification of the reasons.

(9.) Plans which are approved of by the committee and afterwards ratified by the general meeting of the urban authority, should be carefully put away in pigeon-holes, so that by means of the reference book previously described they can be easily found at any future time. This is very important, as no extension of a building the plans of which have been thus approved by the urban authority can ever afterwards be carried out without their consent; and the plans of any alteration which would not involve building upon an increased area must be deposited as in the case of a new building.

(10.) A notification in writing should be sent to the person who has deposited the plans when they have been approved by the urban authority; and in sending this notification it is well to draw his attention to the fact that notice must be given to the surveyor of the commencement of the work, in order that

the foundations, drains, &c., may be examined by him before the ground is filled in.

The importance and necessity for the deposit of plans with a sanitary authority cannot be over-estimated, but this deposit is of but little practical good unless it can be insured that all the buildings are erected strictly in conformity with these plans, and this, according to the Act, is the duty also of the town surveyor. As a matter of fact, it is quite impossible for any single person in any large town to perform this duty, and a staff of assistants is consequently necessary if the sanitary authority really wish their byelaws to be enforced.

Anyone who is practically acquainted with the difficulties that even architects experience in superintending buildings they have *themselves* designed, and how much they have to trust to the clerk of works (of which there is generally one to every building), will readily see what an absurdity it is to suppose that a town surveyor, with his multitude of other duties and attendances at committees and meetings, can even pretend to see that the 99 detail clauses of such byelaws as those emanating from the Local Government Board Office, or even those of a less stringent character, can possibly be enforced, especially when it is remembered that many of the buildings he has to inspect have no superintending architect, but are being erected for purposes of speculation by what are commonly known as jerry builders.

Laws may be passed, books on sanitary questions may be written, but until a change is made in the machinery and manner of the inspection of buildings in the course of erection, and a large staff of inspectors or sanitary police or some such officials are kept by a sanitary authority, very little real advancement will be made with the poorer classes of buildings.

It must in fairness to the builder be stated that to erect houses in strict accordance with the model byelaws would probably mean loss of money to him, as they could not

possibly be built with any prospect of a reasonable return upon the outlay. This partly arises from the stringent clauses inserted with respect to the structure of walls and other precautions for the prevention of fires. I cannot help thinking that too much interference is now made by sanitary authorities for the protection of property from fire.* It is not a sanitary question, and is certainly one which chiefly affects insurance companies. Every one should be able to pay his small insurance premium and the companies should look after their own interests, and not expect it to be done by others. If the sanitary authority wish to interfere in the question of fire, why should not the protection of *life* be considered as much as property? Yet no clause can be discovered in the model bye-laws rendering it compulsory to make some provision in dwelling-houses or factories for the easy escape of the inmates in case of fire. Indeed, as the Public Health Act does not authorise the enactment of a byelaw for such a purpose, such a clause would most probably be held to be *ultra vires*.

Another cause of expense to builders is the necessity imposed on them to provide a comparatively large open space at the back or sides of new dwelling-houses, thus sacrificing land, and sometimes making it almost impossible to build at all. This necessity for open gardens or yards at the back of even small labourers' dwellings is in some towns pushed to an extreme. If such houses are erected in a thoroughly sanitary manner in all points of detail, it is questionable if this open space is really beneficial. My experience has shown me that the space is often misused, animals, such as rabbits, chickens, pigeons, &c., being kept there, or it is made into a so-called garden, really a refuse heap which is a receptacle for all the garbage and filth of the house, soon becoming a fruitful source

* Nothing can be more vexatious than the bye-law compelling the party walls of new buildings to be carried up above the roof to at least 12 inches; not only does this frequently spoil the architectural appearance of a building, but it causes great expense in order to keep the wet out: a very difficult thing with a wall treated in this manner.

of disease to the occupants of the house itself and the neighbours. It is also difficult to ensure that the space thus provided and approved of in the deposited plans shall not be built upon at some future period. It would be better if the streets in front of such dwellings were wide, and a narrow street or "drangway" constructed at the back for the dust-cart service, supply of coals, &c. The houses themselves should have their rooms properly and thoroughly ventilated; underground kitchens or living rooms should be prohibited. The drainage, water-supply, and all the apparatus in connection with them, should be perfect but simple. At the back of the house should be a small yard or court well paved with asphalte or other impervious material, in which should be placed the wash-house, w.c., &c. These and public parks and plenty of fresh air in the streets and in the dwelling-houses themselves should take the place of the large open spaces at the back of small dwelling-houses, which, as I have already stated, are generally so much misused.

The model byelaws with regard to new streets and buildings issued by the Local Government Board contain most admirable clauses—valuable suggestions which should receive attention from any town surveyor who has to advise his corporation upon the subject of framing a set of byelaws for his district—but they necessarily contain many clauses which are not suitable equally well for towns in the north, south, east, and west of England.

Many of the clauses are too stringent to be enforced, but this arises not from any fault in the byelaws themselves, but rather from the machinery employed in carrying them into effect. To secure all that they require adequate inspection is needed, and this might be effected if there was a fee charged by the urban authority of any town for the purposes of proper inspection of buildings in course of construction; and although it must be admitted that any provision which increases the cost of construction of small dwelling-houses which shall be

complete in all sanitary requisites is undesirable, the extra cost of such inspection would be too small to be appreciable, while the advantages arising from such improved supervision would, even from a pecuniary point of view, be of immense advantage not only to the community as tending to improve the public health, but also to the owner as ensuring good honest work in return for his money. In larger and more expensive buildings this supervision is exercised by the architect, but as a rule there is no architect employed in the case of small houses, and the builder is accordingly left to his own devices, with frequently unfortunate results.

CHAPTER XIX.

SCAVENGING.

IN a great number of towns in this country the town surveyor has charge of the unostentatious, though very necessary sanitary work of the scavenging of the district over which he has charge, and the following are the clauses of the Public Health Act 1875, under which he carries out his duties:

"Every local authority may, and when required by order of the Local Government Board shall, themselves undertake or contract for—

"The removal of house refuse from premises;

"The cleansing of earthclosets, privies, ashpits, and cesspools;

either for the whole or any part of their district: Moreover every urban authority and any rural authority invested by the Local Government Board with the requisite powers may, and when required by the said board shall, themselves undertake or contract for the proper cleansing of streets, and may also themselves undertake or contract for the proper watering of streets for the whole or any part of their district.

"All matters collected by the local authority or contractor in pursuance of this section may be sold or otherwise disposed of, and any profits thus made by an urban authority shall be carried to the account of the fund or rate applicable by them for the general purposes of this Act; and any profits thus made by a rural authority in respect of any contributory place shall be carried to the account of the fund or rate out of which expenses incurred under this section by that authority in such contributory place are defrayed.

"If any person removes or obstructs the local authority or contractor in removing any matters by this section authorised

to be removed by the local authority, he shall for each offence be liable to a penalty not exceeding five pounds: Provided that the occupier of the house within the district shall not be liable to such penalty in respect of any such matters which are produced on his own premises and are intended to be removed for sale or for his own use, and are in the meantime kept so as not to be a nuisance" (38 & 39 Vic. c. 55, s. 42).

The next clause imposes a penalty on the local authority if they fail "without reasonable excuse after notice in writing from the occupier of any house" to cleanse the ashpit, &c., within seven days if they have "themselves undertaken or contracted for the removal of house refuse" &c., and the next clause is as follows:

"Where the local authority do not themselves undertake or contract for,

"The cleansing of footways and pavements adjoining any premises;

"The removal of house refuse from any premises;

"The cleansing of earthclosets, privies, ashpits, and cesspools belonging to any premises;

"They may make byelaws imposing the duty of such cleansing or removal, at such intervals as they think fit, on the occupier of any such premises.

"An urban authority * may also make byelaws for the prevention of nuisances arising from snow, filth, dust, ashes, and rubbish, and for the prevention of the keeping of animals on any premises so as to be injurious to health" † (38 & 39 Vic. c. 55, s. 44).

* A *rural authority* cannot apparently make any byelaw with regard to the prevention of such nuisances.

† A byelaw under this section "must be limited to imposing upon the occupier the duty of cleansing or removal at such intervals as the sanitary authority may think fit. The mode of cleansing or removal and the precautions to be observed in connection with the process are not matters within the range of such byelaws." *Vide* 'Memorandum to the Model Byelaws issued by the Local Government Board for the use of Sanitary Authorities, No. 1, Cleansing of Footways and Pavements, &c.,' 1877.

There is also another clause in the Public Health Act 1875, which is as follows:

"Any urban authority may, if they see fit, provide in proper and convenient situations receptacles for the temporary deposit and collection of dust, ashes, and rubbish; they may also provide fit buildings and places for the deposit of any matters collected by them in pursuance of this part of this Act" (38 & 39 Vic. c. 55, s. 45).

The result of the above comprehensive clauses upon the subject of scavenging is that the following duties fall upon the town surveyor where that officer is responsible for such work:

(1.) "The removal of house refuse from premises."

This work, like all the rest which follows, can be done either by the local authority themselves or by contract, the former method, as I hope presently to show, being much the best system.

In connection with this first duty of the removal of house refuse, the following points will have to be considered:

(*a.*) What is house refuse?

(*b.*) What is the best manner of storing it on the premises pending the visit of the scavenger?

(*c.*) Which are the best methods for its collection?

(*d.*) Which are the best methods for its disposal?

(2.) "The cleansing of earthclosets, privies, ashpits, and cesspools."

This work where necessary (owing to the want of a system of sewerage) can be carried out simultaneously with the collection of house refuse and in almost the same manner.

(3.) "The proper cleansing of streets."

In connection with this duty the following points must be considered:

(*a.*) The best methods for sweeping and cleansing streets.

(*b.*) If machinery effects such work better and more economically than hand labour.

(*c.*) The extra work involved by the bad construction of streets, or the ill chosen materials of which they are formed.

(*d.*) Whether private streets, courts and alleys, "not repairable by the inhabitants at large," should be swept and cleansed by the local authority?

(*e.*) The ultimate disposal of excessive accumulations of mud.

(*f.*) The removal and disposal of snow.

(4.) "The proper watering of streets for the whole or any part of their district."

In considering this question it is necessary to note:

(*a.*) The best form of vehicle for carrying and spreading the water.

(*b.*) The number, position, and description of standpipes.

(*c.*) Whether vehicles, or fixed standpipes and hose are best.

(5.) If the local authority do not impose a byelaw they must themselves cleanse the "footways and pavements adjoining any premises;" and this in excessively muddy weather, or after a heavy fall of snow, is no inconsiderable work.

(6.) An *urban authority* may make provision for the "temporary deposit and collection of dust, ashes and rubbish."

This involves public dust-bins being placed in suitable positions in the town, the points in connection with this work being,

(*a.*) The most suitable sites for such accommodation.

(*b.*) The materials and form of which they shall be constructed.

Having thus stated all the heads under which the work of scavenging may be grouped, it is necessary to decide what is "house refuse;" for unless this is satisfactorily settled, considerable onus and expense will be put upon the local authority if

they are to include in the removal trade, garden, and other similar refuse.*

It may be assumed that all house refuse which it is the duty of the scavenger to remove, is really so removed by the direction of the local authority without dispute, but that the following articles, which frequently find their way into a domestic dust-bin, are not in the strict terms of the Act expected to be removed by him. (1) Plaster from walls and brick bats, (2) Large quantities of broken bottles and flower pots, (3) Clinkers and ashes from foundries and green-houses, (4) Wall paper torn from the rooms of a house, (5) Scrap tin (but not old tins which have contained meats, &c., and which, although very useless and bulky, may be fairly assumed to be house refuse), (6) All garden refuse such as grass cuttings, dead leaves, and the loppings from trees and shrubs.†

As a matter of fact, out of ninety towns with which I communicated on this subject only thirteen of them directed the removal of both trade and garden refuse without any special extra payment being made by the householder, and this is only done when these materials are placed in the ordinary dustbin or ashpit attached to a house. Several towns, however, it appears remove such materials on special payments being made of sums varying from 1*s.* 6*d.* to 3*s.* per load.

* In Glenn's 'Law of Public Health and Local Government,' 8th edition, in a footnote to section 44, p. 39, several instances are given of *what is not refuse*, such as ashes from furnaces, &c., and it is stated that "the intention of the Act was that only the rubbish arising from the domestic use of houses should be removed."

† The Bromley Local Board issue a card on which is printed, amongst other information with reference to the contract for the removal of house refuse, the following suggestions:—"It is hoped that householders will as far as possible facilitate the systematic removal of refuse by providing suitable dust-bins, and directing their servants that ordinary house refuse only shall be deposited in such receptacles. The following are some of the items of refuse which the contractors are bound to remove, viz.:—cinder ashes, potatoe peelings, cabbage leaves, and kitchen refuse generally. But the contractors are not required to remove the refuse of any trade, manufacture, or business, or of any building materials or any garden cuttings or sweepings."

Disputes frequently arise between the men employed in scavenging and the householder on these vexed questions as to the difference between house, trade or garden refuse: a dispute often raised by the scavengers themselves, in the hope of obtaining a gratuity or reward for the clearance of a dust-bin, which no doubt, legally, they are perfectly justified in refusing to empty; and in order to lessen the chance of such disputes and to attempt to settle this question, the following suggestions may be of value.

It would no doubt be vexatious if any sanitary authority were to absolutely refuse to remove the "garden" refuse from those houses to which a small flower garden was attached, whilst it would on the contrary be an unfair tax upon the general community if the refuse of large gardens was removed without payment. A good rule would therefore be to remove only such *garden* refuse as was contained in the ordinary dustbin or ashpit attached to a house, and that as the removal of any kind of *trade* refuse would no doubt lead to abuses if done gratuitously by the sanitary authority, that this material should only be removed on payment of some sum, which should be previously fixed by the local authority, and each case should be reported to the officer superintending the work before it was removed.

The next question is the important one of the manner and place in which house refuse shall be temporarily stored pending the visit of the scavenger.

The Public Health Act of 1875 enacts that: "Every local authority shall provide that all drains, waterclosets, earth-closets, privies, *ashpits*, and cesspools within their district be constructed and kept so as not to be a nuisance or injurious to health" (38 & 39 Vic. c. 55, s. 40).

And section 35 of the above Act states, "It shall not be lawful newly to erect any house or to rebuild any house pulled down to or below the ground floor without a sufficient water-closet, earth closet, privy, and an *ashpit* furnished with proper

doors and coverings. Any person who causes any house to be erected or rebuilt in contravention of this enactment shall be liable to a penalty not exceeding twenty pounds" (38 & 39 Vic. c. 55, s. 35).

The same Act also gives power to local authorities to enforce provision of ashpit accommodation for houses where such accommodation does not already exist, and to frame bye-laws with respect to ashpits.

There can be no doubt that the position of the dustbin or ashpit, as regards its site with reference to the main dwelling-house, is of primary sanitary importance, for if the garbage and domestic accumulations therein are allowed to remain for a few days, especially when the weather is close, damp, and warm, they become very offensive, and the emanations therefrom may even be highly deleterious and dangerous to health; this effect is aggravated by persons emptying vegetable refuse and other matters which are *wet* into the dustbin, as decomposition of these matters is greatly assisted by this addition, and it would be well that all such matters should be burnt on the kitchen or scullery fire along with a large percentage of the ashes which could be sifted and saved from those which too readily find their way into the dustbin, and are thus wasted. Care would of course have to be taken in this process that no smell or nuisance was caused by the process of burning.

It is open to considerable doubt if the fixed dustbin or ashpit is the best or most sanitary receptacle for the house refuse; they may be necessary and suitable for Public Institutions, or for large isolated private dwellings, or for schools or any places where excessive quantities of refuse may accumulate, but where this refuse is systematically and properly removed by the order of the local authority, at such times and in such manner as will be hereafter pointed out, moveable or portable dustbins, boxes or baskets are far preferable to the large immoveable, inconvenient fixed ashpit, recommended and enforced under the Act.

The next point to consider is that of the collection of the house refuse, which should be effected satisfactorily, economically and expeditiously.

The following are the three methods by which this is attempted :

(1.) By a house to house call at intermittent periods.

(2.) By the scavengers giving notice of their approach by ringing a bell or by other signal, and requiring the householder to bring out the refuse to the cart.

(3.) By placing public dustbins in different localities, and expecting householders in their vicinity to place the house refuse in these dustbins, which are then cleared from time to time by the local authority.

Experience alone can teach which of these is the best method to adopt in any district, and it is usually found that some modification of all three is necessary.

It is, however, difficult sometimes to adopt public dustbins not only on account of their first cost, but from the objections raised by the occupiers of adjacent houses to their being fixed in their neighbourhood.

If these dustbins were constructed with properly balanced self-closing lids, these objections might be overcome, and their first cost would be but trifling when compared with the benefit to be derived by placing them in some of the thickly populated courts and alleys which are unfortunately to be found in nearly every town. Where there are no public dustbins the inhabitants of these courts throw their waste products upon the surface of the streets or courts, from time to time throughout the day, as it cannot be expected nor desired that such materials should remain, even for twenty-four hours, in their one living room, which is frequently over crowded, and has but little spare space even for the common necessities of life ; but that these waste products should be thus strewn over the surface of the street or court is almost equally objectionable, and points to the advantage to be gained by placing in convenient

situations covered dustbins which could be easily emptied once a day.

Undoubtedly the best method for the removal of refuse is the house to house call, but except in suburban districts and for the collection of refuse from the better class of dwelling-houses and public institutions, the expense, delay and difficulty which would be incurred in calling at every house throughout a town, would make it almost impracticable, and consequently this system is universally combined with that which is known as the bell or signal system, which simply means that the scavenging cart in going its rounds has a bell attached to it, or the horse, which bell rings automatically as the cart proceeds on its way ; or the man in charge blows a trumpet, or calls in stentorian tones, "Dust oh!" On hearing this signal, *but not before*, the householder is expected to bring out the refuse in some convenient receptacle, which is then emptied into the cart by the scavenger.

As a matter of fact, the receptacles containing all the waste products of these householders are brought out and are placed in the gutter of the street close to the kerb, long before the cart makes its appearance or can be reasonably expected to do so.

The result of these (generally inappropriate) receptacles filled with heterogenous collections of house refuse being left unprotected in the public streets, is that their contents are quickly strewn about the surface of the street, by their being upset accidentally, or purposely, and the appearance of the street, which has probably been carefully swept and garnished during the night or early in the morning, quickly assumes, especially in a high wind, a very offensive character, and probably has to be entirely re-swept and cleansed before the ordinary traffic of the day commences.

To obviate this evil I must refer my readers to a small book on the subject of scavenging, entitled 'Dirty Dustbins and Sloppy Streets,' published by Messrs. Spon & Co., written by

myself, in which I have suggested moveable iron cylinders being placed in the streets for the reception of the house refuse.

The "house to house" call system in the suburbs of a town may be greatly assisted by a very simple remedy, which has already been tried in some towns with considerable success. It consists in the householder placing a card bearing the letter D, or some other distinguishing mark, in a conspicuous place in a window, when the services of the scavengers are required; these cards should be printed and circulated by the Sanitary Authority of the district, who should state on the back of the card the days on which the scavengers would visit each neighbourhood, with the approximate hour of the day in which they would appear, in order that the householder may not be unnecessarily inconvenienced by being obliged to keep the card for any length of time in his window.

The scavengers in passing observe the signal, and call at the house; otherwise they pass on, unless specially called in by the occupants, thus avoiding any unnecessary delay in their rounds.

A visit from the scavengers either before seven or after ten in the morning is generally very inconvenient for households of a superior class, and should be, if possible, carefully avoided by the sanitary authority.

The cart usually employed for scavenging is that known as the ordinary "tip cart," strongly, if not clumsily, constructed of an oak frame, with elm or deal sides of considerable height; it holds about a couple of cubic yards of material, and costs from sixteen to twenty pounds.

These carts are not only clumsy and heavy, but they give an overweighted diminutive appearance to the horse between the shafts, especially as the quality of horses employed for work of this character is frequently none of the best. The height, too, of the cart is often so great as to necessitate the use of a short ladder, up which the scavenger has to climb, the result being a shower of dust when it is being loaded with house

refuse, and spatterings of mud, when it is being used as a slop cart.

It is difficult also to effectually cover a cart of this description. The imperfect mode at present adopted is to cover it with a tarpaulin, which is tied down as tightly as the circumstances of the case will admit, but which as a rule does not effectually answer the purpose for which it is intended. In towns where the house refuse is not collected separately from the road scrapings, a judicious mixture of the two in the cart considerably assists in preventing any mud from splashing over or the dust from blowing about.

The employment of wooden carts for this work is bad economy, their rough usage, and the mode adopted for emptying them by "tipping," renders their life a short one; a cart in constant work frequently costs from 4*l.* to 5*l.* per annum in repairs, and having but little of the original material of which it was constructed left in it at the end of six years. They are also difficult to cleanse or disinfect.

With a view to obviate these and other objections, several improved carts and waggons have been introduced by different makers, who have styled them by a variety of names. Amongst others they are called dust carts, general purpose carts, sanitary carts, slush carts, tumbler carts, mud waggons, tip waggons, slop waggons, &c. These are constructed with iron bodies fixed upon wooden frames and wheels; they are of various forms and designs, the principal objects aimed at being lightness of construction combined with strength, so balanced as to bear with a minimum of weight upon the horse; economy in their cost has not been lost sight of, and they are usually provided with some special means for emptying, either by being tipped by a chain and windlass, or by some mechanical arrangement of the tailboard; they are built very low upon their axles, so as to be easily filled, are either completely covered over with a moveable lid, or are fitted with hinged side boards, so as to prevent any splashing over of their contents, and as they are

nearly all constructed with iron; they are easily cleansed and disinfected whenever it is thought necessary to do so.

With reference to the important question of the ultimate disposal of house refuse, street sweepings &c., no rules can be laid down, as so much depends upon the position of every town and the character of the district in which it is situated, as the following replies to some questions which I addressed to several English towns will show.

In many towns it is stated that the whole of the refuse is used by brick makers, in others it is simply "tipped to waste." In one case the answer is, "Sold by auction twice a year," but to whom it is sold, and for what purpose, does not transpire. In some towns it appears to be mixed with lime and used as manure upon the fields, and in others it is mixed with the sludge of the sewage farms, and is then ploughed or dug into the soil of the farm. This seems a better plan than that of another town, where it is "given or thrown away," although the difficulty of disposing of the old iron, tins, &c., is not touched upon in any of the foregoing answers. The next reply states that "it is riddled, and the cinders and vegetable refuse are burnt to generate steam, the fine dust is used with the manure manufactory (tub system), the old iron is sold, and the pots, &c., used for the foundations of roads." In one case the whole of the refuse is taken out to sea in hopper barges, and sunk in deep water.* In a great number of towns it is sold by tender for the year, but what eventually becomes of it does not transpire. But the most favoured methods, where it cannot be sold as manure to farmers, seem to be either that of carting it away to some spot outside the town, and there using it for the purpose of filling up hollows and depressions, or that of giving or selling it to brick-makers.

The practice of filling up hollow places with such materials cannot be too strongly deprecated if there is any

* In New York about 800,000 tons of refuse are disposed of annually in this manner.

chance of dwelling houses being erected on them, as the unsanitary condition of sites thus formed has been frequently demonstrated.

Where towns are unable to dispose of their refuse by sale to farmers or market gardeners, the best method, and one which is gaining in popularity every day, is that of its destruction by fire.

With this object in view a Mr Fryer has invented an apparatus which he styles a "Patent Carboniser, for the conversion of garbage, street, and market sweepings, also other vegetable refuse, into charcoal." This apparatus consists of a structure somewhat resembling, externally, a brick kiln. It is divided into hopper-shaped compartments, which at the bottom are furnished with a furnace, fitted with a reverberatory arch. A fire is lighted in this furnace, the necessary combustion being obtained, and the heat maintained, by burning the cinders, which are sifted out of the house refuse for this purpose. All the street sweepings, refuse, garbage, &c., is then thrown in at the top of the kiln, and it is there and then completely destroyed by the action of the fire, and converted into charcoal, which is withdrawn through a sliding door fixed at the bottom of the kiln.*

The next point which has to be considered, and which is the second in order of the list of duties I have given at the commencement of this chapter, is "the cleansing of earth closets, privies, ash-pits, and cesspools."

This is generally effected in conjunction with the collection of the house refuse and the work is carried out at night. Under the Goux-tub system the ashes of the house refuse are largely used as a deodorant or absorbent as a lining for the tub,† but in the pail systems this mixture is not effected until the tubs and refuse arrive together at the depot.

* For a description of the manner in which this is effected at Manchester, see my book on scavenging, to which I have before referred.

† The ashes are mixed with chaff, chopped straw, refuse hay, grass cuttings, dry street sweepings, wool and hair, shoddy, &c., and a small percentage of sulphate of iron or lime.

For descriptions of the manner in which the pail system for the collection of excreta is carried out in Birmingham, I must refer my readers to an article written by myself in a number of *The Sanitary Engineer* of New York published on the 1st Sept. 1881, in which I have entered fully into the method there adopted and its advantages and disadvantages, but which are too long to recapitulate in this chapter.

The next duty which has to be considered is that of "the proper cleansing of streets."

There is no doubt that for the sake of the appearance as well as the health of any town its streets cannot be too well cleansed. Muddy and wet streets cause dampness in the subsoil of neighbouring dwellings, and dust is not only injurious to tradesmen's goods but also to the lungs of those who have to breathe an atmosphere loaded with silicate and organic impurities.*

Street cleansing is effected either by hand-sweeping and hand-scraping, or by machinery. As to which is the most economical much depends upon the value of labour, and also upon the condition of the roads to be dealt with, but in point of time and as a general rule the value of a horse rotary brush-sweeping machine is undoubted, the only time at which such a machine fails to do effective work is on the occasions when the mud to be removed (owing to a peculiar condition of the atmosphere), has attained a semisolidity, and is of a stiff and sticky consistency, when it either adheres to and clogs the brushes of the machine, or is flattened by them on to the road instead of being removed. †

The brushes of a machine last about 180 hours constant

* Professor Tyndall, in his beautiful experiments, has proved that dusty air is alive with the germs of the bacteria of putrefaction, whilst the pure fresh air which he gathered on a mountain peak in the Alps is innocent of such germs, and is absolutely powerless to produce any organisms.

† Dry dust will absorb about ten times its bulk of water, thus swelling considerably and producing the greasy mud so often seen after rain.

work, and then the old stocks can be easily refilled with bass at no great cost. The comparative work which can be done by a sweeping machine is about 11 to 1 of that effected by manual labour, so that the economy involved by the former method is evident.

The strength and durability of the brooms used for the work of sweeping the streets is of some importance, as affecting the ultimate cost of the work, and some care and skill is required in their selection. Bass brooms are better than birch brooms for this purpose, and the bass of which the brooms are made should be sufficiently stout and of regular thickness; it should be tough and elastic, not old, dry, and brittle, each knot should be of uniform size and be firmly set, and the number of knots in each broom head is also a matter of choice. A convenient and fair test of the soundness of a broom is to soak it for a few days in water before issuing it to the sweeper, and then note the time it will last. The handles of the brooms should be made of alder wood.

On the question of the extra work involved in street cleansing by its bad construction or by the materials of which it is constructed, climate must be considered, as well as the amount of traffic it has to bear, and also its gradient and the habits of the people residing in it.*

The Superintendent of the Scavenging Department at Liverpool has made some observations and obtained some valuable information on these points, which he has detailed in a report he presented to the Health Committee of that borough in the year 1877, an abstract of which is as follows:

* In Boston, U.S.A., the macadamised roads are not swept at all, as it is considered that by sweeping off the sand and detritus their durability is much lessened, but their gutters are cleansed as required, and rubbish picked up. (*Vide* 'Minutes of Proceedings Institution of Civil Engineers,' vol. lxiii. p. 368.)

GROSS COST FOR EACH TIME OF CLEANSING 10,000 YARDS SUPERFICIAL OF DIFFERENT DESCRIPTIONS OF ROADWAY IN THE BOROUGH OF LIVERPOOL.

Street.	Description of Pavement.	When paved.	Condition of repair of Roadway.	Area of Carriage-way.	Loads removed in one Month.	Times swept in one month.	Gross Cost per 10,000 Yards Superficial for each cleansing.
				Yds. supr.			£ s. d.
Lord Street	Granite setts, asphalte joints	1877	Very good	4,503	15	26	0 6 5½
North John Street	Ditto	1872	Good	3,287	17½	26	0 8 10½
Tithebarn Street	Granite setts, ordinary joints	1872 and 1874	Bad	5,150	38	26	0 11 2
West Derby Road	Ditto, asphalte joints.	1876	Very good	11,980	35	13	0 9 4½
Great Howard Street ..	Ditto	1877	Good	16,860	85	13	0 14 4½
Great Homer Street ..	Ditto, ordinary joints	Not ascertainable	Moderate	15,900	85	13	0 14 1
Kensington Street	Macadam breasted with setts	Ditto	Good	14,540	76	13	0 14 3½
Stanley Road	Ditto	Ditto	Bad	16,534	186	13	1 8 9½

He adds that the full benefit of the impervious pavements as regards the cost of scavenging has not yet been felt, for almost all the lines of streets so paved are intersected at short distances by streets of ordinary jointed granite setts or macadam, whence a quantity of mud and refuse is dragged by the traffic on to the asphalted jointed roadways, which are consequently debited with the cost of removal of some effete material not instrinsically belonging to them.

Mr. Till, the Borough Surveyor of Birmingham, from investigations he has made on this subject, says that for granite pavement 2 cart loads of mud have to be removed from every 1000 square yards of surface, one third of a load for wood pavement* and 4 loads three times a day (a total of 12 loads) for macadamised roadways.

The ultimate disposal of the material removed from the surfaces of roadways especially when they are macadamised is a difficult matter, as, being chiefly composed of silicate, it is valueless as a manure.

In small towns, except during abnormally muddy weather, it may be mixed with the house refuse and sold to farmers, or the road scrapings themselves may be used as an excellent sand, if thoroughly washed, to mix with lime or cement to form mortar for public works; excessive accumulations of mud, however, must be got rid of in the most economical and speedy manner possible, and this is effected either by filling up old disused quarries with it, or depositing it upon waste lands, or forming embankments for new roads, but in no case should it be used, as I have before stated, upon building sites; it is difficult and expensive to destroy it or partially convert it into other matters by fire, so that if these methods which I have emunerated are impracticable, the only other method left for the disposal of the sweepings or scrapings from the streets is to

* In Regent Street, London, in November 1881, I saw four loads of mud removed from about 1000 square yards of surface, it being then almost new wood pavement.

take them out to sea in hopper barges and sink them in deep water.

The last question that arises on the subject of scavenging before we consider the disposal of snow, is whether the onus of cleansing private courts and alleys which are not repairable by the urban authority should be borne by them or not.

The great difficulty attached to this duty arises from the fact that these private courts and alleys are generally very badly paved, if paved at all, full of pits, where pools of stagnant mud and water collect, and even in the best cases, the interstices between the pebbles, or other paving, are filled with filth arising in great measure from the dirty habits of the people, and this filth it is found exceedingly difficult to dislodge. The remedy for this is to compel the owners of the abutting properties to have the courts and alleys properly paved with asphalte, or other equally impervious material, after which it would be easy for the urban authority to cause them to be swept at least once a day, and flushed with water in the hot weather once a week, but in order to compel the owners to execute this very desirable work it would be necessary to put the complicated machinery of section 150 of the Public Health Act 1875 in force, and the expense to the landlords would be in many cases very disproportionate to the value of their property.

Out of the ninety towns to which reference has before been made, the authorities of only nineteen of them cleanse the private courts and alleys in their jurisdiction, although for the sake of sanitation it is very desirable that such work should be so undertaken by them.

In most towns it is necessary to cleanse its principal streets at least once a day, and this appears to be the practice of nearly all the ninety towns I have referred to; only seven of them, however, appear to have this operation repeated more frequently; in several towns, the horse droppings, &c., are removed at once, under what is called the "orderly" system,

and this is especially necessary in streets that are paved with such materials as wood paving, asphalte, or granite setts. The suburban streets of a town need only be cleansed once or twice a week, except in special cases of extremes of mud or snow, and I will now proceed to discuss the questions involved by a heavy fall of the latter.

Experiments have shown that a cubic yard of fresh fallen snow may weigh as much as 814 pounds or as little as 71 pounds. Assuming that a cubic foot will weigh 16·38 pounds, I estimate that for a fall of 3 inches of snow upon a street 36 feet in width, 20 tons, representing a bulk of about 100 cubic yards, would have to be removed for every 100 yards of length of street if it was thought necessary to clear it away.

Assuming that there are 30 miles of street in a town from which the snow must be removed ; 21,144 loads must be carted somewhere, at a cost of at least 1,500*l.*, assuming that each cart could make ten trips a day, and even then it would take 352 carts a whole week to effect it.

It may be contended that I have taken an extreme case, and that, of course, the snow does not lie for very long upon the ground in the condition in which it fell, and that hourly it is reducing in bulk and weight by being ground up by the traffic, and finding its way in the form of water into the sewers. This may be so, but at the same time it must not be forgotten that the bulk is also being constantly increased by that which is shovelled off the house tops* and brought out from private premises adjoining the streets.

Upon this point Mr. Hayward, the Engineer to the Commissioners of Sewers of the City of London, says† :—

"Snow readily compresses under the traffic, and when removed in carts and shot down elsewhere it may be assumed

* See note under "Other Obstructions and Nuisances," p. 155, 8th edition, Glen's 'Law of Public Health and Local Government.'

† *Vide* 'Report to the Streets Committee of the Honourable the Commissioners of Sewers of the City of London on Melting Snow by Clarke's Apparatus,' by William Haywood, Engineer and Surveyor to the Commission, 1881, p. 9.

that on an average four cubic yards of snow measured as it has fallen is equal to one cubic yard when placed on the apparatus." This computation, however, does not make any allowance for the snow thrown from off the roofs, &c., and it of course greatly consolidates whilst travelling in the cart.

Fortunately for a town surveyor in this country, exceptionally heavy falls of snow are not very frequent, but when they do happen great pressure is put upon his department to cope with it, and one of the greatest difficulties he has to contend against is the disposal of the snow after it has been placed in the cart.

If there is a river close by, it can be taken there and tipped, but this is objectionable if it is a navigable river where dredging has to be done, as it is surprising what a quantity of road scrapings and other matters are always removed with the snow, and these materials naturally sink to the bottom, and add considerably to the cost of dredging.

If there are public parks the snow may be heaped in them, provided no damage is done to the grass or paths, but the snow thus heaped takes a considerable time to melt, the first effect of a thaw being to consolidate it: a better plan is to deposit it upon waste spots, if these are not too far from the streets which have to be cleared.

Tipping the snow down the manholes into the sewers has been tried in London and other cities, but has failed through the snow consolidating, and although lighted gas jets have been turned on to the snow, it has still melted too slowly to be of any practical utility.

Speaking of Clarke's apparatus for melting snow, Mr. Haywood, in the same report from which I have already quoted, says:

"It is seldom that a fall of snow occurs sufficiently large to cause serious interruption to the traffic; heavy snowstorms in fact occur only once in six or seven years; for some years therefore these apparatuses if fixed might not be required.

They would either have to be taken out, stored and refixed yearly or maintained in their places and kept in order there, in either case at an annual expense."

In perusing Mr. Hayward's report it also appears that the cost of this apparatus fixed is about 120*l.*, and the cost of melting the snow 9*d.* per cubic yard.

In order to grapple with this question of the removal of snow, I am of opinion that it is useless to attempt to cart it away while falling, but try to make clear crossings for the foot passengers and to keep the traffic open. If there should be a high wind at the time, and the snow drifts in consequence, cut through the drifts so as to allow the vehicular traffic to continue. Directly the snow ceases to fall put on all available hands to clear the channel gutters and street gratings, in preparation for a sudden thaw, when, if these precautions were not taken, serious flooding and great damage to property might ensue; for the same reason cart away all the snow you can at the bottom of gradients and in the valleys, and also from very narrow streets and passages, &c. In the wider streets use the snow plough, or with gangs of men (in the snow season there is generally plenty of labour obtainable), shovel the snow into a long narrow heap on each side of the street, taking care to leave the channel gutters and gratings quite clear, and a sufficient space between the heaps for at least two lines of traffic. Passages must also be cut at frequent intervals through the heaps, in order to allow foot passengers to cross the street, and also to let the water reach the channel gutters as soon as the snow begins to melt.*

* With regard to the removal of snow from the footpaths, it is highly desirable that this should be effected by the occupiers of the premises adjacent to the street, as otherwise it adds immensely to the work of the local authority. The following interesting remarks by the superintendent of the scavenging department of Liverpool will be no doubt read with great interest:

"The only way to compass the removal of snow from the footwalks of the principal thoroughfares within a comparatively short time, is by sprinkling them with salt, such as is commonly used for agricultural purposes. It is certain that, unaided by the salt, a sufficient number of men cannot be procured for the

The next point to be considered in this chapter is that of "The proper watering of streets for the whole or any part of their district."

One of the earliest methods for watering streets, but one which has, I think, almost entirely died out, on account principally of the large quantity of water used in the process, was that of allowing the water to run down the channel gutters, ponding it back by means of canvas or leather aprons placed across the gutter, and then spreading the water on to the surface of the street by throwing it with wooden shovels. This method, which at first sight may appear clumsy, is an exceedingly good one upon sanitary grounds. It not only lays the dust, but it washes the surface of the street, and it most effectually scours out the gutters and at the same time flushes the sewers, which at the season that watering is necessary is also of great importance to any town. By this process a delightful freshness is given to the air, and the appearance of the cool and limpid water rushing along on each side of the street acts favourably upon the inhabitants. The great objections to this system are

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emergency of clearing snow from the footways of the most important thoroughfares. It has been stated by medical authorities that the application of salt to snow is detrimental to the health of people who have to walk through the 'slush' produced by the mixture, and that the excessive cooling of the air surrounding the places where the application has been made is injurious to delicate persons. It therefore seems that the application of salt to snow should not be undertaken during the day time, but should be commenced not before 11 p.m., nor continued after 6 a.m., and that only such an area of footwalks should be so treated on any one night as the available staff of men can clear by an early hour the following morning.

"To sweep snow from the footwalks whilst the fall of snow continues, and especially during business hours, appears to be wasteful and futile, and to apply salt during the same periods may be held to be injurious to health.

"That the snow of an ordinary fall can be removed from the footwalks by an application of salt an hour or so before they are scraped is an ascertained fact, except at least when a moderately severe frost has preceded, accompanied, or followed the snow-fall, or when the snow has drifted into extensive accumulations. Were it not for the danger to health by excessive cooling of the air, and for the expense attending the operation, all the impervious pavements could be cleared of snow (unless the fall was a heavy one) in a comparatively short time by a liberal application of salt and the employment of the horse sweeping machines as soon as the snow had become sufficiently softened to admit of their use."

(1) the enormous quantity of water that is used in the process, and (2) the difficulty of doing the work after the traffic of the day has commenced.

Somewhat of a modification of this process is what is known as "Brown's System of Street Watering," which may be described as follows:—A lead pipe is laid in the footpath at the back of the kerb on each side of the street to be watered, small gratings or shields being fixed in the pipe at intervals of twelve inches, and the remaining space filled with asphalte; small holes are then bored in the pipe through the openings in the shields. The pipe is connected with the water main in the street, and is provided with the necessary stopcocks, &c. On the water being turned on, fine jets are thrown in different directions upon the surface of the street. The width of roadway that can be watered by this process depends upon the pressure of the water, but it may be fairly assumed that in most towns streets of fifty feet width could be effectually watered in a few minutes by a pipe on each side of the street.

This process has not gained much favour hitherto, principally on account of the large first cost involved, which would amount to upwards of 800*l.* per mile of street, but the expense afterwards should not much exceed the wages of one man at about 3*s.* 6*d.* per day to manipulate the necessary work, and the interest on the outlay and depreciation of the pipes, &c.

The other objections to this system are:—

(1.) The liability of the pipes and perforations to get out of order, especially when allowed to lie idle for so many months in each year.

(2.) The unpleasantness to pedestrians which must be caused whilst the watering is proceeding.

(3.) The inconvenience to the traffic during the process.

(4.) The effect upon the water by high winds, when in all probability it would be blown back across the foot pavement.

(5.) In very broad streets it would be inoperative.

In Paris and other continental cities, and also in several towns in this country, the watering is effected by hose and reels, or by portable iron tubes.

Mr. Parry, C.E., the Borough Surveyor of Reading, has given the following particulars of the system of hand watering adopted in that borough, in which he gives the cost, and describes the utility of that method as compared with the use of water carts:

A water cart (he states) will water twice a day a superficial area of 23,849 yards, and for a length watered one width that means 5,962 lineal yards, or for a double width 2,981 yards, the cost per day of laying on being as follows:—Horse, cart, and man, 8*s.* cost of maintenance of cart, harness, shoeing, &c., 1*s.* 5*d.*, making 9*s.* 5*d.* per day.

With respect to the hand machines he states that he has one of Headley's drum machines, and three of special make, somewhat similar to those used in Paris. They are equal in point of work; and one machine will water 23,740 square yards twice a day, which, it will be observed, is very close to the amount of work performed by a cart.

"Headley's machine cost us (he continues), five years ago when new, 31*l.* 7*s.* 3*d.*, and the repairs and maintenance since that date have been 22*l.*, or an average of 4*l.* 8*s.* per annum, and is just now almost past repair. The other description of hand machine cost each when new 20*l.*, and the repairs and maintenance have amounted to an average of 3*l.* 18*s.* each year. They were in use some time before Headley's was obtained, and they will be of use for a long time yet. The cost of labour per day by the hand machines is for two men at 2*s.* 10*d.* each—5*s.* 8*d.*—as it requires two men to work the machine properly, one to distribute the water, and the other to move the machine and to attach and detach the apparatus to and from the hydrants; add to this 7*d.* per day for maintenance and repairs, will make 6*s.* 3*d.* per day. The quantity of water delivered by the water carts is 0·51 gallons per square yard, and by the hand machine 1·30 gallons."

It will thus be seen that in the case of the cart 24,324 gallons of water are used per diem, and 61,724 gallons by the hand machines, the surface watered being very nearly the same in both cases. Assuming that the water has a commercial value of 6*d.* per 1000 gallons, and adding this to the cost per diem in each case, the total cost stands thus :

Hand machines	£1 10*s.* 10*d.*
Carts	£1 1*s.* 7*d.*

the advantage in point of cost being in favour of the carts ; but the hand machine may water better, especially in broad streets, although in narrow streets or where there is much traffic, this method would be impracticable.

In Paris both hose and carts are used for watering the thoroughfares, the former for the boulevards, the avenues, and a certain number of first-class streets.

The most commonly known method in this country for watering the streets and roads of our towns is that of carrying the water in wheeled barrels, carts, or vans, and distributing it therefrom through a perforated pipe upon the surface of the road as the vehicle is drawn along by a horse attached to the shafts.*

The old barrel upon wheels gave place to a cart, and now we have "Bayley's Patent Hydrostatic Van," which is too well known to almost all town surveyors to need much description. It holds about 450 gallons of water and takes about 9 minutes to fill (this time of course varying with the size of main and pressure of water), and ten minutes to spread the water upon the surface of the road.

With regard to the work that one of these vans will accomplish in comparison to that effected by an ordinary cart,

* In the metropolis of London alone, the watering of the streets and roads employs, in addition to a staff of inspectors and foremen, about 1500 men, and an equal number of horses and carts ; and in order to lay the dust effectually, about 30,000 tons of water must be spread upon the streets every dry day, the cost of this gigantic work being nearly 200,000*l.* per annum upon an average of 120 days when watering becomes necessary.

the following table, compiled from experiments on the question, will be useful:

Cart or Van.	Contents in Gallons.	No. of Loads to cover beat.	Total quantity of Water.	Time.	Difference.	Gain per Cent.
				Hrs. Mnts.	Hrs. Mnts.	
Bayley's van	450	5½	2475	1 23	..	..
Ordinary cart	225	11	2475	1 50	0 27	24½
Bayley's van	450	5½	2475	1 38	..	..
Ordinary cart	237	11	2607	2 10	0 32	25
Bayley's van	450	6	2700	1 45	..	..
Ordinary cart	290	11	3190	2 10	0 25	19½
Bayley's van	450	8	3600	2 15	..	..
Ordinary cart	260	17	4420	3 30	1 15	36

This shows a mean gain of 26 per cent. in favour of the van, and the following tables, made by an inspector in 1873, showing the actual occupation of the ordinary carts and Bayley's vans during a day's work, are extremely interesting, as showing that while the van is engaged in spreading the water the time of the cart is wasted in travelling to and from the stand posts, and when it is borne in mind also that the van spreads water more widely than the cart, there can be no doubt that a saving of at least 30 per cent. can be effected by the substitution of these vans for the old-fashioned cart.

CARTS.

	Filling.	Travelling Full.	Travelling Empty.	Waiting, &c.	Spreading.
	H. M.	H. M.	H. M.	H. M.	H. M.
Paddington	1 45	2 9	1 58	0 20	1 30
St. Saviour's	1 29	2 16	2 4	0 26	1 29
Strand	1 11	2 30	2 18	0 17	1 3
Kensington	4 40	2 2	1 57	0 0	1 54
Chelsea	2 44	1 15	2 14	0 35	1 6

VANS.

Paddington	3 33	1 9	1 3	0 0	3 0
St. Saviour's	2 20	1 4	1 21	0 23	2 58
Strand	2 30	1 25	1 14	0 20	2 23

In the year 1856, Mr. Scott, C.E., the Chief Surveyor of the parish of St. Pancras, kept an account of the daily round of an ordinary water cart, when he found that through an average working day of 10¼ hours, exclusive of the breakfast and dinner hours, the cart took one hour and twenty minutes filling, fifty minutes only in distributing the water on the roads, and eight hours and seven minutes in travelling to spread the water and back to the stand posts. It was obvious that these were placed too far apart, and by the subsequent introduction of additional standposts Mr. Scott found, in the year 1867, that the filling occupied two hours, the distribution one hour and thirty minutes, and the travelling to and fro six hours and thirty minutes; so that it may be assumed, with an ordinary two-wheeled water cart, that two-thirds of the day is spent in travelling, one fifth in filling, and about one-seventh in the actual spreading. But a watch should be kept upon the man who is engaged in this work, otherwise he will idle away his time and the streets remain unwatered. A good check upon this is Mr. Bayley's Tell-Tale, which registers automatically on a dial at the side of the van the number of rounds a man goes each day.

Watering the streets with sea water should be adopted whenever it is feasible, as it not only gives a delightful freshness to the air and dispels iodine, but it also causes the surface of the street to maintain its humidity for a longer period than when fresh water is used, as it impregnates the soil with hygrometric matter. This has been often attempted artificially, by adding common salt to the water used for watering, but it is rather too expensive for the benefit derived.*

Watering the roads with a largely diluted disinfectant

* In Rouen, where chloride of calcium is obtained from the manufactories of pyroligneous acid in the neighbourhood, it is mixed with the water for use on the roads, and it is stated that on a mile of road, 16 feet in width, 5630 gallons of water were necessary daily, but that the same result was attained with 1480 gallons of chloride solution, marking 30° Beaumé, and costing about ¼*d.* per gallon, the humectation remaining good for five or six days with the solution of chloride. With water only in 1093 yards, in four rounds daily, 3520 gallons were used, the cost being 48*s.*; with chloride of calcium the cost was 32*s.* per day.

such as "Sanitas" in the liquid form, is frequently of great benefit, and where it can be afforded, it should be occasionally done, especially in the narrower streets and more crowded districts of a city or town, or when an epidemic has broken out.

With reference to the very important question as to the cost of scavenging, street-cleansing and watering. It is, of course, not possible to lay down any hard and fast lines, as it must necessarily vary considerably according to circumstances; much depends upon whether the district is an urban one, consisting of houses closely packed together, or whether it is suburban, with scattered villas and mansions standing in their own grounds; the question, also, of the distance of the depôts to which the material has to be carted, considerably affects the result of any estimate, as also does the cost of horse hire, the rate of wages, and whether the district is of a hilly or flat nature, and, as I have before shown, the manner in which the streets are formed and paved, the habits of the people, the requirements as to cleansing streets and watering, and last, but not least, the manner of the eventual disposal of the rubbish after removal; all these points must bear with great weight upon any question of cost, and make the results widely different.

On referring to the returns to which I have more than once alluded, it is found that the cost of removing the house refuse and cleansing and sweeping the streets combined, varies considerably in different localities. In one case the sum amounts only to the rate of one half-penny per annum per head of the population of the town, whereas in another case the amount is at the rate of three shillings and sixpence per head. On calculating the average cost per head of population per annum of the ninety towns from which I received replies on this point, I find that it amounts to about tenpence half-penny, after giving credit for any sum of money realised by the sale of the refuse to farmers and others; so that if this work is costing the

ratepayers of a town or city anything under a shilling per head of the whole population every year, they have no cause to grumble.

Before closing this chapter I will make a few observations upon the subject of contracts for work of this description.

There is no doubt that the "dust and slopping" contractor is fast going out of fashion,* as it has been found that the work is far more carefully and systematically carried out without the intervention of a contractor; for if we turn to the articles of agreement or contract usually drawn up between a sanitary authority and a contractor for scavenging, we find that they must be very binding in their phraseology, and enter fully into the details of the work; they should state very clearly the number of times in every week that the contractor shall cause all the ashpits in the districts enumerated to be emptied and cleansed, the manner in which this work shall be performed, and how the materials thus removed shall be disposed of and the place of their ultimate destination. The conditions should further specify what amount of manual, team labour, and carts, are necessary for the work, and also what plant the contractor must keep in the way of ladders, baskets, shovels, and brooms, &c. The conditions should also contain a carefully prepared list of the streets to be swept, and the manner and number of times this work must be executed, and arrange for the disposal of the materials thus removed.

In many such contracts it is found necessary to insert clauses binding the contractor, under all sorts of penalties, to be always at the disposal of and under the commands of the inspector of nuisances, or such other officer or officers as the sanitary authority may appoint. The contractor's men also

* Amongst the questions which I addressed to the surveyors of the principal towns of England in 1879 was the following:—"Is the house refuse collected by the sanitary authority or by a contractor?" and out of the ninety towns from which I received replies, only thirty were found to employ contractors for this purpose, and of these the authorities of two of them proposed to dispense with the services of the contractor, and to administrate the work with their own staff, as they found the existing state of things was thoroughly unsatisfactory.

are forbidden to accept gratuities, and are directed on no account to remove either trade or garden refuse, and they are also enjoined to be "careful to consult the convenience of the householders in their visits, and to thoroughly clean up all dirt and litter that they may cause in the discharge of their duties. If they fail in any or either of these injunctions and commands, or for any other dereliction of duty, the inspector of nuisances, or such other officer as the sanitary authority shall appoint, may summarily dismiss them, without any reference being made on the subject to their employer the contractor, and in fact the conditions have necessarily to be made so stringent and binding as to be either totally inoperative or open to grave abuses, or, on the other hand, the work can be carelessly and improperly executed by the contractor.

The consequence of such binding clauses is that the officers, if they do their strict duty, will probably be engaged in constant disputes and litigation with the contractor as to the due and proper observance of the terms of his contract, and thus their time is much occupied instead of in other more important matters, which is naturally detrimental to the interests of the ratepayers.

I am strongly of opinion that the work of the collection of house refuse and cleansing the streets should be carried out by the local authority with their own officers and staff, and that executing this work by contract is a mistake and a false economy. It is, perhaps, true that it may be done in the latter manner at less actual cost to the ratepayers, but all public work should be done in the best manner possible, irrespective of cost, thoroughly, but without extravagance, and the result of such work, especially where it affects the cleanliness and the appearance of a town, soon fully repays any moderate extra cost that may thus have been incurred, irrespective of the enormous benefit that is conferred upon any community by the reduction of disease and the death-rate by a proper attention to such necessary sanitary work.

CHAPTER XX.

SEWERAGE.

THE Public Health Act 1875 contains a considerable number of clauses dealing with the subject of the sewers of a town, but two of the shortest sections in the whole Act, and yet those that involve a considerable amount of work in the town surveyor's department, are the following:

"Every local authority shall keep in repair * all sewers belonging to them, and shall cause to be made such sewers as may be necessary for effectually draining their district for the purposes of this Act" † (38 & 39 Vic. c. 55, s. 15).

"Every local authority shall cause the sewers belonging to them to be constructed, covered, ventilated, ‡ and kept so as not to be a nuisance or injurious to health, and to be properly cleansed and emptied" § (38 & 39 Vic. c. 55, s. 19).

As to what sewers do "belong" to the local authority, the following section of the Public Health Act 1875 states:

* If the sewers vested in and belonging to a local authority are allowed by their negligence to get out of repair, they are liable to an action for damages (*Vide* 'Fitzgerald's Public Health Act,' 3rd edition, p. 19). Keeping in repair does not, however, include construction of entirely new works. (*Ibid.*)

† The sewers provided by a local authority must be sufficient to carry off the ordinary sewage and rainfall of the district, but they need not be sufficient to carry off an extraordinary flow of water caused by a storm; damage caused by that comes under the definition of damage caused by the act of God, for which there is no individual responsibility (*Ibid.* p. 20). This clause seems to insist upon sewers carrying the rainfall.

‡ See chapter on "Ventilation of Sewers."

§ A local authority is not to be held liable for not keeping their sewers cleansed at all events and under all circumstances, but only where by the exercise of reasonable care and skill they can be kept cleansed. They are, however, liable, in case they make default in observing the requirements, to have an injunction filed against them and to be restrained by injunction from allowing the continuance of the nuisance. (*Ibid.* p. 23.)

"All existing and future sewers within the district of a local authority, together with all buildings, works, materials, and things belonging thereto,

"Except

"(1.) Sewers made by any person for his own profit, or by any company for the profit of the shareholders; and

"(2.) Sewers made and used for the purpose of draining, preserving, or improving land under any local or private Act of Parliament, or for the purpose of irrigating land; and

"(3.) Sewers under the authority of any commissioners of sewers appointed by the Crown,

shall vest in and be under the control of such local authority.

"Provided that sewers within the district of a local authority which have been, or which may hereafter be constructed by or transferred to some other local authority, or by or to a sewage board or other authority empowered under any Act of Parliament to construct sewers, shall (subject to any agreement to the contrary) vest in and be under the control of the authority who constructed the same, or to whom the same have been transferred" (38 & 39 Vic. c. 55, s. 13).

And as to the definition of the word "sewer," the same Act states:

"'Sewer' includes sewers and drains of every description, except drains to which the word 'drain'* interpreted as aforesaid applies, and except drains vested in or under the control of any authority having the management of roads and not being a local authority under this Act."

The result of this acquisition by the local authority of the sewers in their district is, that in most of the old cities and towns a legacy of very defective and imperfect sewers has been inherited, and considerable expense in their repair and maintenance has thus been entailed.

* For the legal definition of "drain," see the chapter on "House Drainage."

A great number of books have been written on the subject of sewerage, and much valuable information has been published from time to time, so that it almost seems superfluous to say much upon the subject; however, a few remarks which are particularly applicable to the work of a town surveyor may be of some service.

The word *sewerage* may be taken as meaning a system of sewers carrying *sewage* which is the fluid and feculent refuse from dwellings and their yards, &c. Sewage is generally found mixed with rain water from the surface of the streets and roofs of houses, together with the liquid waste products from manufactories,* and sometimes, although very improperly, with subsoil water.

A good system of sewerage should embrace the whole of the following requirements :—

(1.) Each sewer should be laid at such a depth as will readily drain the basements of the adjoining buildings.

(2.) Its area and gradient must be so regulated as to make it self-cleansing, and at the same time carry off effectively the maximum quantity of liquid for which it is intended. †

(3.) Each sewer should (unless quite impracticable) be laid in straight lines and with even gradients between man- or lamp-holes, and these gradients must not be excessive, or

* Facilities must be given to enable manufacturers to send the liquids proceeding from their works into the public sewers, provided the sewers are more than sufficient for the requirements of the district, or if the liquids would not prejudicially affect the sewers, or from their temperature or otherwise be injurious in a sanitary point of view. *Vide* Rivers Pollution Act 1876 (39 & 40 Vic. c. 75, s. 7). But this question is often greatly disputed, and has led to much litigation.

† If everything has to be carried in a sewer, the following provisions must be made :—

(*a*) The house sewage which may be calculated from the water supply.

(*b*) Manufacturers' refuse.

(*c*) Rainfall, which is a very uncertain quantity.

(*d*) The subsoil water should certainly be dealt with, but it should on no account be permitted to enter the sewers themselves; separate provision under the main sewers should be provided for this purpose.

damage may be caused to the sewer. A velocity of about 6 feet per second is sufficient.

(4.) Sewers must be laid at proper levels in respect of their intersection with each other, bearing in mind that they are all generally converging to one point.

(5.) Manholes should be of simple construction; circular brickwork upon concrete is a convenient description. They may be made to serve the additional purposes of ventilating shafts, flushing chambers, junction shafts, storm overflows, and side entrances.

(6.) Tributary sewers or drains should not join the main sewers at right angles unless the bottom of the manhole is so constructed as to give the required curve in the direction of the flow of the sewage, and they should join at a height (if of unequal section) equal to the difference of their sectional diameters, the aim of all junctions being to cause as little disturbance as possible in the proper flow of the liquids along their respective channels.

(7.) Sewers should not be constructed of too large a sectional area, but none should be less than 6 inches internal diameter, as house-drains in this country are never less than 4 inches diameter, and the main sewer should of course be larger than its tributaries. It is also rather difficult to ventilate a smaller sewer than 6 inches, and very little is saved by putting in a smaller sewer than that.

Stoneware pipes of greater diameter than 18 inches should never be used. Where larger sewers are constructed they should be either concrete pipes,* or brickwork or concrete should be employed.

The position of the sewer should, if possible, be behind the houses for the following reasons :—

(1.) The waterclosets, sinks, &c., being nearly always at

* Messrs. Sharp, Jones and Co., of Bournemouth, make most excellent concrete pipes up to 36 inches in diameter, which can be economically and advantageously used in many instances, and are gaining every day in popularity with engineers.

the back, a drain under the house (which is always objectionable) is avoided.

(2.) Economy is secured to the owner of the property, as a shorter length of drain is required than if the sewer was in the front.

(3.) A better fall is usually obtained.

(4.) Where there is a separate or partially separate system of sewerage, a double sewer in the street is avoided.

The only objection to this method being that of the chance of the sewer becoming choked or broken when entry has to be made into private property to repair it, but this ought never to happen after once the sewer has been properly constructed. Of course, where houses are closely packed together it would not be possible to carry the sewer at the back, but where it can be done I agree thoroughly with Mr. Rawlinson, C.B., C.E., &c., who, speaking of this method, says, "I know nothing but good of it."

Where the sewer is proposed to be taken through any private lands it is necessary to act in accordance with the following clause of the Public Health Act 1875, and serve the necessary notices, a specimen form of which also follows:

"Any local authority may carry any sewer through, across, or under any turnpike road, or any street or place laid out as or intended for a street, or under any cellar or vault which may be under the pavement or carriageway of any street, and, after giving reasonable notice in writing to the owner or occupier (if on the report of the surveyor it appears necessary), into, through, or under any lands * whatsoever within their district. They may also (subject to the provisions of this Act relating to sewage works without the district of the local authority) exercise all or any of the powers given by this section without

* The definition of "lands" as given in the Public Health Act 1875, is as follows:—"'lands' and 'premises' include messuages, buildings, lands, easements, and hereditaments of any tenure" (38 & 39 Vic. c. 55, s. 4).

their district for the purposes of outfall or distribution of sewage" (38 & 39 Vic. c. 55, s. 16).

The form of notice necessary to be served before entry upon any lands for the purpose of carrying out any sewerage works may be on the following pattern :—

"NOTICE IS HEREBY GIVEN.

"1. That the mayor, aldermen, and burgesses of the borough of , in execution of the powers and authorities given to and vested in them by virtue of the Public Health Act 1875, upon the report of their surveyor, whereby it appears to the said authority to be necessary to enter into, through, or under the lands and premises particularly described in the schedule hereunder written, for the several purposes hereinafter mentioned, the said mayor, aldermen, and burgesses will immediately after the day of enter into and upon the premises described in the said schedule hereto, and on the plan hereinafter mentioned numbered , for the purpose of in, through, or under the said lands and premises , and to construct all other necessary works for all or any of the purposes aforesaid.

"2. The course of the said sewer is indicated by a line drawn on the said plan from the point to .

"And notice is hereby further given that a plan of the intended works, and of the lands and premises upon which it is intended to enter for the construction of the same, is now open for inspection, between the hours of 10 in the forenoon and 4 in the afternoon, and may then be seen at the offices of the borough surveyor, Street, , and a tracing thereof is hereunto annexed.

Dated this day of 18 .

Town Clerk." *

* Notices may be signed either by the clerk to the local authority or their surveyor (38 & 39 Vic. c. 55, s. 266).

THE SCHEDULE REFERRED TO.

No. on plan.	Description of premises.	Where situate.	Owner.	Occupier.

In carrying out works of sewerage the greatest care is necessary in the materials selected and the manner in which the work is executed. Tunnels and shafts must be most carefully timbered, levels very accurately given and adhered to, and for this purpose sight rails and long boning rods can be used with great advantage. In running sands, or where the line of an old sewer is being followed, or in fact anywhere where a good and quick joint is required, "Stanford's" patent jointed pipes should be used.

"This joint is made by casting, upon the spigot and in the socket of each pipe, rings of durable material, which, when put together, fit mechanically into each other, as in a bored and turned joint; it needs no skilled labour in fixing, only a little grease, allows of slight settlement of the pipes without injury, and requires neither cement, clay, nor other extraneous material, the pipes containing a perfect joint within themselves."

Breakages sometimes occur in stoneware pipe sewers after

they are laid, which generally are found on examination to arise from one of the following causes :

(1.) Laying the pipes on a rigid foundation without recessing the sockets so as to give an even bearing.

(2.) Laying the pipes on foundations which afterwards yield or settle.

(3.) Laying the pipes at too great a depth without protection by concrete or otherwise to resist the pressure of the superincumbent earth, or by not sufficiently punning the filling-in, when a sudden settlement will often crack or crush a pipe.

(4.) Accidental or wilful injuries to pipes which are not noticed before the trench is filled in.

(5.) Laying the pipes at too shallow a depth without protection, when heavy traffic or a falling weight upon the surface will crush or crack a pipe.

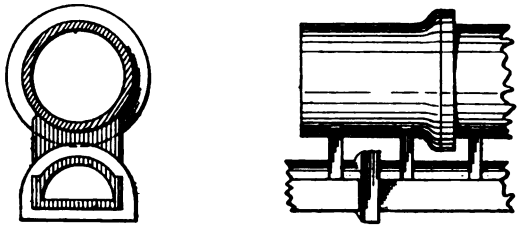
(6.) Defective or weak pipes.*

The following plates give the different forms of sewerage pipes that are now manufactured in this country, in addition to those of common shapes :

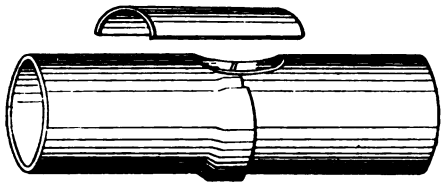
* The thickness of stoneware pipe sewers should be as follows :

Internal diameter of pipe.	Thickness of material.
in.	in.
3	$\frac{1}{2}$
4	$\frac{5}{8}$
6	$\frac{3}{4}$
9	1
12	$1\frac{1}{8}$
15	$1\frac{1}{4}$
18	$1\frac{3}{8}$

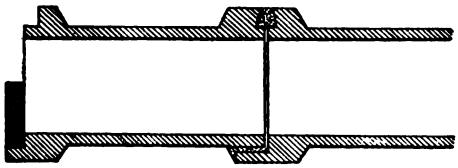
The thickness of fire clay or earthenware pipes should be slightly in excess of those given for stoneware.



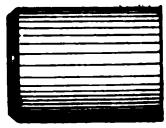
BROOKE'S PATENT SUBSOIL DRAINS AND PIPE-RESTS.



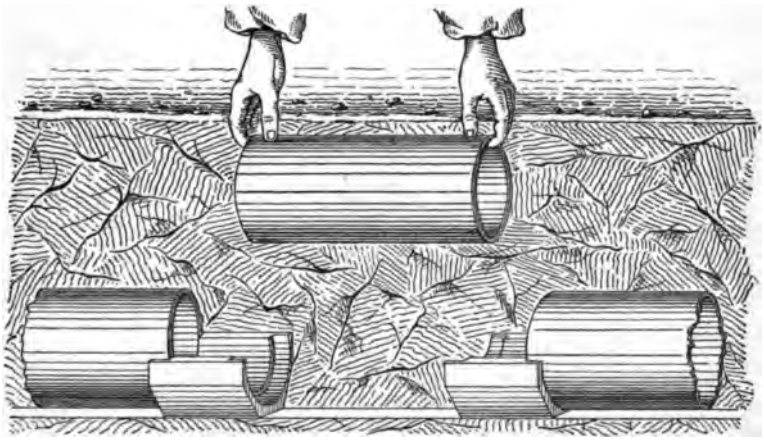
CREEKE'S PATENT CAPPED PIPES.



MAWBEY'S PATENT GROOVED SOCKET-PIPES.



HENRY SHARP, JONES, & CO.'S ROCK-CONCRETE PIPES.



JENNING'S PATENT CHAIR AND SADDLE PIPES.

The chokage in pipe sewers generally arises from one or more of the following causes :—

(1.) Improper gradients.

(2.) Insufficient flush.*

(3.) Foreign articles finding their way into and choking the sewer.

(4.) Defective joints through which the liquid runs leaving solid matters behind.

(5.) An excess of road detritus or of ashes, through the house closets of the poor, finding their way into the sewer.

(6.) Improper bends in the line of sewer.

(7.) Right-angle or improper junctions being formed with the sewer.

(8.) A collapse of the sewer.

A temporary chokage in a small-sized sewer which does not arise from any structural defect can be speedily and effectually remedied by the use of Ben Reed's patent drain-cleaning rods, which are probably too well known to every town surveyor to need any description, but in conjuction with man- or lamp-holes and straight lines of sewers they are very valuable.

Before closing this chapter, a few words upon what is called the " separate system of sewerage " may be of use.

The mistake hitherto made has been to try to absolutely separate all rainfall from the sewers, and there is no doubt that a partial separation of the rain-water from the sewage proper has many advantages ; but it must be understood that a great deal of the rain-water that falls upon roofs of buildings and in back yards and small back streets must of necessity be carried into the sewers, as well as liquid refuse from manufactories. A partial separation thus carried out has the following advantages :

* The patent automatic flushing arrangement by Mr. Rogers Field, C.E., is an excellent apparatus for lessening the chances of a sewer becoming choked from this cause.

(1.) It is not necessary to have sewers of enormous diameter.

(2.) The depth of the surface water conduits need not be so great as that which is necessary for sewers.

(3.) The avoidance of road detritus being washed into the sewers.

(4.) Where the sewage has to be pumped or treated chemically or put on the land, the combined system causes an immense unwieldy bulk of liquid to be at times dealt with.*

(5.) The sewers may be placed at the back of the houses, a great advantage which cannot be carried out under the combined system.

(6.) The regularity in the amount of flow of sewage.

(7.) The accuracy with which the quantity of sewage may be calculated and the sizes of sewers apportioned.

(8.) Economy both to the general rates and also to individuals in carrying out their connections.

(9.) Where old and defective sewers exist they are often fitted to carry surface water, but are quite inappropriate as sewers.

No rules, however, can be laid down with regard to this question, as each town or district must be treated as the case requires.

In conclusion, I will mention the different methods at present in vogue for the sewerage of towns.

(1.) The combined system, where all sewage, surface water, manufacturers' refuse, and subsoil waters are carried in the same sewer.

(2.) Similar to the above, the subsoil water, however, being carefully excluded.

* It is necessary in many towns where the combined system is in force, and the sewage has to be pumped when heavy rains commence, to put temporary clay dams round the street gratings to prevent the surface water from entering the sewers, thus at once showing the inability of the system to deal with flood waters.

(3.) The partially separate system.

(4.) The absolutely separate system, where there are three sets of sewers, one for sewage proper, one for surface water, and one for subsoil water.

(5.) The "Lieurner" system, which professes to remove all sewage by exhausting the air in the sewers and drains.

(6.) "Shone's" pneumatic ejector system, which is described as follows :—

"The ejectors are cast-iron receivers of a suitable form, placed underground at depths to suit the locality, into which ejectors the sewage flows through the ordinary pipe drains from the houses. As the liquid rises in the interior of the ejector, and when full, it lifts a valve and admits compressed air from an engine which supplies the entire district. The ejectors are thus emptied of their contents, which are blown out in about eighty seconds of time, and the sewage passes through cast-iron main pipes of suitable diameters to the land, or other outlet provided to receive it, or it may be distributed upon the waste land as it passes through."

(7.) The dry systems, which consist of—

(*a.*) Earth closets ;

(*b.*) Tubs, as the Goux, &c. ;

(*c.*) Pails, as the Rochdale ;

(*d.*) Middens.

But all these dry systems require some system of sewers to carry off rain-water, slop-water, &c., and in my opinion are not suitable for very large communities.

CHAPTER XXI.

SEWAGE DISPOSAL.

THE magnitude of the question of "sewage disposal" almost decided me to refrain from making any remarks upon it, but on reconsideration I thought a few might be serviceable.

Sewage disposal means the getting rid of the foul water contained in the sewerage system of any community.

Where a dry method is in force for the collection of the excrementitious matters it is called "interception"; the following are some of the systems which effect it:—

Privies, ashpits, middens, cesspools, pails, troughs, the "Rochdale," the "Eureka," the "Goux," Fosses Permanentes, Fosses Mobiles, and Moule's, Taylor's, and Phillip's earth closets.

The collection and disposal of the mass of excrement under these dry systems is found to be a very troublesome matter, and they are at their best but inferior substitutes for water carriage, nor must it be forgotten that sewers and drains are necessary even if a good interception process is in force. I shall therefore confine my remarks to the disposal of water-carried sewage.

Many books have been written, many valuable reports have been prepared and issued, lengthy papers and discussions have been frequent at the meetings of scientific societies, and almost innumerable pamphlets have been published upon this important sanitary subject. Some millions of money have also been spent in trying to deal satisfactorily with this question, not only with a view to the purification of the effluent of the sewage, but also to endeavour to make a profit out of the

residuals.* The result of this literature, discussion, and experiment has led to the following conclusions:

No hard and fast lines can be laid down as to the best method to be adopted for the disposal of the sewage of any town, but the peculiar circumstances of each case must be considered before advice could be given on the subject: geographical position, physical arrangement, habits of the population, and the character and quantity of the sewage of the town being some of the most important.

In any case it is necessary that the transmission of the sewage to the outfall should be effected as speedily as possible, and that the position of this outfall should be such as to cause no nuisance. The contents of the sewers should, if possible, be emptied by gravitation, as pumping is a constant expense, and economy with efficiency must of course be studied.

Up to the present time the following are the methods adopted in this country for the disposal of sewage:

(1.) Passing the sewage in its crude state into the sea or tidal river.

(2.) Passing the sewage in its crude state over large tracts of land; this is called broad irrigation.

(3.) Passing the sewage in its crude state on to small tracts of land previously prepared by deep drainage; this is called intermittent downward filtration.

(4.) Mechanical subsidence of the sewage in large tanks, the effluent passing on to land or into a river.

(5.) Mechanical filtration of the sewage, the effluent passing on to land or into a river.

(6.) The introduction of lime or other precipitant into the sewage, which is allowed to settle in tanks, the effluent passing on to land or into a river.

Very little need be said upon the first of these methods. Many engineers of high standing contend that, where practic-

* It is computed that every ton of liquid sewage which is treated chemically costs about three-quarters of a farthing.

able, the sea or the tidal estuary of a river is the right place for the sewage, as no costly works are necessary, and an abominable nuisance is thus got rid of at once and for ever. To ensure this, however, great care must be exercised in the selection of the site for the outfall. Float observations should be made, not only of the surface tides and currents, but also of those at different depths, and the effect upon the sewage by its different specific gravity from that of the salt water must be allowed for, as well as the difference of level of the tides and the configuration of the adjoining coast line.

The second method, that of broad irrigation, is one that finds considerable favour with a large number of engineers and agriculturists. The great sewage-disposal cry has always been, "Put back on the land what you have taken from it, or some day there will be no beef and no bread.' The difficulty is to always find land in sufficient quantity and so situated as to be available for this purpose. Almost any soil is, however, suitable for irrigation, provided it is well and properly drained. The quantity of sewage which should be used for this purpose per acre of land varies considerably, as will be seen on reference to a table prepared by Mr. Henry Robinson,* where the number of inhabitants to each acre irrigated is in one case (Leamington) stated to be 55, in another (Blackburn) 208,† the average being 137, the number of gallons per head of population per diem being 38.

It may be useful to state here that a hundred tons of sewage will cover an acre of land 1 inch in depth, and that the value of sewage as a manure is said to vary from ½*d.* to 2*d.* per ton, or, calculated in another manner, about 10*d.* per head of population per annum.

The best crops for a sewage farm (in addition to nearly all kinds of market-garden produce) are rye-grass, mangolds, beetroot, cabbages, carrots, potatoes, turnips, rabi, parsnips,

* *Vide* 'Sewage Disposal,' by Henry Robinson, C.E., &c., 2nd edition, p. 79.

† I purposely omit (Kendal) 856, as this is, properly speaking, "filtration."

lucerne, beans, wheat, oats, and barley; the cereals, however, are apt to run rather to straw, and some care is also necessary not to oversewage potatoes and some other root crops. Grazing cattle or cows can also be carried on with advantage, the presence of sewage having no effect either on the milk or flesh of animals fed on sewage farms.

The third method, that of intermittent downward filtration, is really irrigation of land to such an extent as the land will filter or purify the sewage, the effluent passing off pure, irrespective of any effect upon the crops which may be growing upon the land.

Great discussions have arisen (the principal battle-ground being Merthyr Tydvil) as to the maximum quantity of sewage which an acre of properly prepared land will treat, some of the champions of this system contending that a good porous soil properly drained to a depth of six feet will purify the sewage of 6000 persons per acre, others that only the sewage of 250 persons can be so treated.*

There can be no doubt that earth has a most powerful deodorising power. Laboratory experiments have shown that as much as eight gallons of sewage can be filtered through a cubic yard of loamy soil in twenty-four hours, the soil being drained at a depth of six feet, the effluent therefrom having obtained a wonderful degree of purity. Much, however, must depend upon the character of the soil of the filtering area and the strength of the sewage which is being operated upon.

The following description of the manner in which the earth acts upon sewage will be of interest:

"The fæcal matters and other impurities attached themselves to the surfaces of the particles of earth by a kind of cohesive attraction, and in this state were readily attacked by

* For much interesting information upon this and other subjects in connection with sewage disposal, see 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. xlviii. p. 105 et seq. Also the report of a committee of the Local Government Board on Modes of Treating Town Sewage, 1876. 'Sewage Disposal,' by Henry Robinson, C.E., and other works on the subject.

the oxygen of the air. Their organic carbon became carbonic acid, their nitrogen was converted into nitrous or nitric acid, which united with the lime, magnesia, and other basic matters present. Mechanically suspended impurities were arrested as by a sieve, and the water issued from beneath—not indeed fit for dietetic or domestic purposes, but at any rate in a fair state of purity and quite inoffensive to the senses." (*Vide* W. Crookes in the discussion on the Sewage Question by Norman Bazalgette, 'Min. of Proceedings of the Institution of Civil Engineers,' vol. xlviii. p. 164.)

The land thus used as a sewage filter requires constant aëration by being dug over or ploughed, and if this precaution is taken, it is surprising to what a wonderful extent the land will take sewage without becoming what is called "sewage sick." Clay soils are, however, stated to be ill-adapted for this purpose.

The next method, that of mechanical subsidence of the sewage in large tanks, has been attempted in conjunction with irrigation and filtration without much benefit, nor has the fifth method I have mentioned, viz., that of mechanical filtration of the sewage, met with any better result. Artificial filters have been constructed of burnt clay, cinders, coke, charcoal, peat, chalk, gravel, broken stone, sand, spongy iron (this is now being applied very successfully for the purification of water), straw, cocoa-nut matting, wicker-work, and wire gauze of different degrees of fineness of mesh.

The late Mr. Odams spent a considerable sum in endeavouring to strain sewage through revolving screens of wire gauze with but little success, and Mr. Bannehr has striven to achieve the same object by passing sewage over oscillating screens of the like material.

In all these cases of mechanical filtration, however, the effluent has either not been sufficiently pure or the screens and filters have become clogged and refused to act.*

* Under the Rivers Pollution Act, no effluent is allowed to enter a stream &c., if it contains more than three parts of suspended inorganic matter, and one part organic matter for every 100,000 parts of liquid.

The last method that I have mentioned for the disposal of sewage is that of precipitation, or what may be more properly called the chemical treatment of sewage.

Precipitation means the production, by the introduction of chemical substances within the body of the sewage, of certain solid compounds, which, in settling, drag down with them the suspended matters in the sewage, together with a small proportion of the polluting matters which are in solution in the sewage, this proportion varying with the quantity of solid matters deposited. The effluent from the tanks in which this precipitation takes place is then allowed to flow direct into a river or stream, or is still further purified by being passed over land or filtered through deep-drained soils.

Chemical treatment of sewage was first tried in Paris in the year 1740, and since then every effort has been made to extract a valuable and commercial manure from sewage and purify the effluent. Between the years 1865 and 1875 more than 400 patents were taken out in respect of these and other matters in connection with the sewage question.

It is almost needless to say that but few of these patents were of any practical value. Those processes which have some merit and are now best known are, I believe, included in the following list :—

LIST OF CHEMICAL PROCESSES FOR THE TREATMENT OF TOWN SEWAGE.

The A. B. C. (or Sillar's) process
Anderson's process
Bird's ,,
Blyth's ,,
Campbell's ,,
Collin's ,,
Forbes and Price's process
Fulda's process
Goodall's ,,
Hanson's ,,
Higg's ,,
Hille's ,,
Holden's process
Lenk's ,,
Lundy's ,,
Manning's ,,
Scott's ,,
Smith's ,,
Spence's ,,
Stothert's ,,
Suvern's ,,
Whitthread's process
Wickstead's ,,

Space will not permit me to describe these processes, and

probably most of them, if not all, are familiar to my readers. Suffice it to say that in nearly all cases the *modus operandi* is that of mixing certain chemicals with the sewage by mechanical agitation, or by passing the sewage over "salmon ladders," &c., then allowing the sewage to remain perfectly still whilst the solids are gravitating, and then dealing with the effluent in different manners.

Amongst the numerous chemical ingredients which are used for this purpose may be mentioned the following :—

Alum, animal charcoal, ashes, blood, bone ash, carbolic acid, chalk, chloride of lime, chloride of zinc, chloride of iron, clay, creosote, hæmatite, hydrate of lime, lead nitrate, magnesian salts, oxide of manganese, perchloride of iron, salt, soda, sulphate of zinc, sulphate of iron, sulphuric acid, and tar.

One of the great difficulties in connection with the precipitation of sewage is the disposal of the sludge which is left behind in the tanks.

This sludge contains about 90 per cent. of moisture, and if left to dry atmospherically, a thin crust forms over it, thus protecting that which is underneath, and it will not dry for many months. In some cases it is sought to dispose of the accumulations of sludge by digging it into the land ; in others it is mixed with house ashes, &c., and sold as manure. Its bulk, however, in proportion to its manurial value is so excessive as to render it almost valueless, and it is difficult to get rid of it for this purpose even when fortified with ammonia or other chemical. A frequent practice now adopted is to reduce its bulk by exposure or by presses to a semi-dried condition ; in other cases it is dried to a powder by heat, and General Scott has patented a method where, in connection with the lime process, it is burned and manufactured into cement. Sometimes it is squeezed in presses, such as Needham and Kite's or Johnson's, or it is filtered by Milburn's or Weare's apparatus. For drying the sludge by heat, Borwick's or Forrest's machines have been used with some success, but

there is no doubt that the slimy, glutinous, albuminous, offensive mixture technically known as sludge is a difficult matter to dispose of in all sewage works.

In connection with the chemical treatment of sewage, it is of advantage to pass the effluent over land filters on the intermittent downward filtration principle. Another very effective plan is to pass the effluent (or even crude sewage) through land which is thickly planted with the Anacharis or American weed, duckweed, sedges, rushes, reeds, &c., or through beds of osiers or alder trees. An acre of land thus planted is said to purify more than three million gallons of sewage per diem.*

There is no doubt that plants of this description have a powerful action in purifying sewage or foul water of any kind, and where land is scarce this method has many advantages.

It is almost unnecessary to add that where sewage is treated in any other manner than that of throwing it into the sea or river, bulk is a great objection, especially if it has to be pumped.

To obviate this bulk the separate system is of great advantage, and Isaac Shone's new method for ejecting sewage along pipes seems also to be a most desirable invention in connection with this subject.

* *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. xlviii. p. 179.

CHAPTER XXII.

VENTILATION OF SEWERS.

THE necessity for some manner of dealing with the noxious vapours emanating from sewage other than that of letting it find its way from the sewers into the house drains and thence into dwelling houses, has induced the legislature of this country to introduce the following clause in the Public Health Act 1875, which imposes on every local authority the duty of causing their sewers to be ventilated so as not to be a nuisance or injurious to health.

"Every local authority shall cause the sewers belonging to them to be constructed, covered, ventilated and kept, so as not to be a nuisance, or injurious to health, and to be properly cleansed and emptied" (38 & 39 Vic. c. 55, s. 19).

The result of this compulsion upon local authorities to ventilate their sewers has been the introduction of many methods to effect the purpose, the great difficulty being to "ventilate so as not to be a nuisance or injurious to health," the advocates of open ventilation contending that this is effected by having a sufficient number of openings in a sewer to dilute and safely disseminate the foul gas with atmospheric air so that no nuisance is caused.*

Many other methods have been from time to time suggested, some of which have been carried into effect, and I will now proceed to give them in detail, discussing their merits and objections in each case.

* If there is any truth in the "germ theory" of disease, how dangerous must be the practice of open sewer ventilation, a waft of foul air from a sewer carrying with it a germ, and the unsuspecting passer-by is inoculated just as surely as if he had handled or been near the excrements of the diseased person whose evacuations have been passed into the public sewer.

(1.) Open shafts are carried up from the crown of the sewer to the centre or side of the roadway, and there protected by an open iron grid or grating at the level of the street surface.

This is the system which has hitherto found most favour with town surveyors, and is sometimes modified or worked in conjunction with the practice of untrapping all the gully pits and buddle holes at the sides of the roadway, which is an excellent plan if the theory of the atmospheric air dilution at which this system aims is a correct one; in fact, if this dilution by air is all that is necessary to render the foul air in a sewer innocuous and inoffensive, there cannot be too many openings into it.

The objections to this system are as follows:

(*a.*) The foul air escaping into the public streets is often very injurious to persons passing a ventilator, and sewers are buried out of sight, but they are not out of mind so long as we are constantly and unpleasantly reminded of their existence.

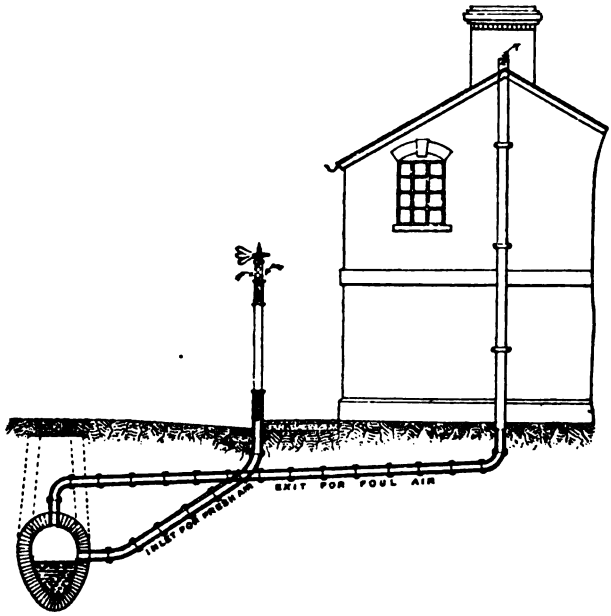
(*b.*) It is found that a change of temperature either of the atmosphere, or of the air in a sewer, will seriously affect the action of a shaft, causing it sometimes to have upcast currents of air, sometimes downcast; the effect of this latter action, especially when it arises from the direction of the wind blowing over or into the shaft, is frequently to drive the impure gases contained in the sewer into the house drains, and from thence into the houses, unless they are so trapped and ventilated as to prevent it.

(*c.*) They are also affected by the fluctuations of the flow of sewage in the sewer, or by barometric changes in the atmosphere.

(*d.*) The situation of the open grids in the street is sometimes somewhat awkward for traffic, and horses will frequently shy at them, they also admit solid road detritus into the sewer unless they are protected by a catch plate of some description.

(*e.*) They are tempting places for children to play over, with what results may be imagined.

(2.) Open shafts are carried up the sides (gable ends if possible) of buildings in the neighbourhood of the sewer; these shafts may be either open at the top, or be furnished with exhaust cowls. This system is sometimes employed in conjunction with inlet shafts at the sides of the street, in the manner shown by the drawing which follows:



This method has the advantage over the first system I have mentioned of carrying the smells further from our reach, but it also has the following disadvantages:

(*a.*) The distance and the number of bends and elbows the gases have to traverse before reaching the external air.

(*b.*) The difficulty of fixing them just at the points where they are most required with reference to the gradients of the sewer, especially if they are to be constructed of such an internal diameter as will ensure their efficiency.

(*c.*) The great objection raised by occupiers and owners of

premises against having them fixed on their premises, both on sanitary and legal grounds.

(*d.*) Their great expense.

(*e.*) The effect of weather upon their currents.

(3.) By making use of the rain-water pipes from adjoining buildings.

This method commends itself as being very economical, and the opportunities thus given for ventilation are so numerous. If sewers are to be ventilated at all* it would seem at first sight that there could not be too many openings from and into them, but this system has the following serious objections :

(*a.*) When raining, little or no ventilation can take place, and this is the very time, owing to the rising of the water in the sewer, that the gases should be allowed free egress if such is considered the best manner of dealing with them.

(*b.*) The position of the head of the rain-water pipe is generally the worst that could be chosen for the egress of the gases, both on sanitary and pneumatic grounds.

(*c.*) The joints of a rain-water pipe are usually none of the best.

(*d.*) The objections persons naturally have to allow the rain-water pipes of their houses to be used for such a purpose.

(4.) By utilising the lamp posts or columns adjacent to the sewer.

The objects of this system are first to obtain a constant upward current from the sewer, and secondly to secure that the foul gases and air shall be consumed and rendered innocuous by being burnt. The objections to this system are—

(*a.*) The lamps are only lit at night, consequently little or no ventilation would be going on during the day.

(*b.*) The number and diameter of the lamps are generally

* The important city of Bristol has no system of sewer ventilation, and yet the death rate of the city, which is by no means specially healthily situated, has not been abnormally high up to this year (1883).

too small to make any appreciable effect upon the ventilation of the sewer.

(5.) By passing or filtering the foul air through charcoal placed in trays or other receptacles in shafts.

The theory of this method is admirable, as the charcoal would arrest all the impurities and flocculent organic matters contained in the foul air, and allow only the pure filtered air to pass into the atmosphere.

It has been found, however, where this method has been adopted, that the charcoal very soon becomes so caked and consolidated from damp and the vibration of the traffic, that it will neither allow the air to filter through, nor absorb the impurities contained in it; these objections and the amount of attention this system requires, has not rendered it very popular with town surveyors, although it has much to recommend it.

(6.) By making use of ordinary chimney shafts.

This method and the one which follows have some merits, the principle being that an upward current is established as an exhaust from the sewer, and also that the foul air is purified by being passed through fire, but both these advantages are only gained when the fires are actually burning; the objections to this system are—

(*a.*) Structural difficulties must often be encountered and overcome.

(*b.*) Possibility of explosion arising from leaks of gas mains into sewers (a by no means uncommon occurrence, as all who have charge of sewers frequently find to their cost).

(*c.*) The objections of owners and occupiers to allow their premises to be thus made use of to carry off a public nuisance for which they as individuals are in no way responsible.

(7.) By lofty shafts erected at convenient positions which are either in connection with furnaces or are simply open to the air.

For a long outfall sewer with no connections this method has many advantages, notably so in the large furnace and shaft erected on the Brighton outfall sewer by the borough surveyor, Mr. Lockwood. But in a general system of sewerage, it was found by experiments made by Sir Joseph Bazalgette, C.B. that the effect of trying to reduce the gases by the action of furnaces was but very small, and that the area over which the effect extended was but very limited: in fact, a sewer may be compared to a perforated tube, the house drains, gully drains, &c., representing the perforations; the effect of an exhaustion by the action of the furnace is simply to suck fresh air into the sewer at all these points instead of removing the foul air for any distance.

High shafts at different points effect a partial clearance of sewer gases, but they are very costly, and the reasons I have previously given against the system of open shafts are practically the same in this and all other modifications of the principle.

Many other methods have been tried from time to time, either to prevent the formation of gases in the sewers, or neutralize or destroy them, some of which are as follows:

By giving a quick velocity of discharge in a sewer; by placing materials within sewers which would absorb the gases as fast as they were generated; by passing deodorants or disinfectants into sewers; by deodorizing or disinfecting all materials before they are allowed to enter a drain or sewer; by placing chemical agents within sewers to give off certain gases which would then, it was conjectured, destroy the noxious properties of the sewer gases; by introducing charcoal into sewers to absorb the foul gases; by laying pipes within the sewers for the purpose of discharging chlorine into the sewer; by employing galvanic agency to disengage or to produce ozone from the sewer gas; by passing the foul air through shafts into which water was constantly injected,

and by endeavouring to extract the foul air by fans driven by machinery.

I have myself patented a plan for "annihilating sewer gases" by allowing them to be absorbed into dry earth, and have tried the system with some very marked and successful results.*

Having thus far considered all the known methods for dealing with the noxious emanations which proceed from sewers, the next point to consider is what these noxious emanations are, and whether they exist in all sewers.

It has been found that even in sewers of the best and most modern construction what is called "sewer gas" is generated in more or less quantity; this arises even from fresh sewage, but is far more noxious and dangerous to health when the sewage has begun to decompose. Even where the sewers are so constructed as to remove all the sewage to the outfall within 24 hours (which has been decided to be the maximum time it should take), there is still an accumulation of slime on the inner periphery of the sewers, owing to the rise and fall of the sewage line, which is constantly manufacturing gases of decomposition.

It is no doubt true that the more perfect the system of sewerage is the less foul air there is in the sewers, but in very few towns will there be found no sewers or drains where temporary obstructions of the sewage do not occur, and where gases are generated, which then find their way into other parts of the sewage system unless they are dealt with in some effective manner.

As to what is the actual composition of this foul air in a sewer little or nothing seems to be known, except that it is

* For further information upon my system for the annihilation of sewer gases, I must refer my readers to a pamphlet written by myself in 1880, entitled 'Sewer Ventilation, or a New and Improved System for the disposal of the Noxious Gases generated in Sewers and Drains,' and also to a paper I read on this subject at the meeting of the Sanitary Institute of Great Britain, held in Exeter in the year 1881.

highly dangerous to health if breathed, and is also very offensive to the smell.

The "fœtid organic vapour," or sewer gas proper, has for its companions in a sewer, sulphuretted hydrogen, a most poisonous as well as unpleasant smelling gas, carburetted hydrogen, due very often to leaky gas mains or services, or to decomposing vegetable matters, carbonic acid gas or carbonic anhydride (choke damp), and some ammoniacal compounds.

The actual component parts, however, of any gases in a sewer must vary considerably with its conditions and locality, &c., in the same manner as they would in any public building or room, and it is impossible to tell, without costly experiments, what gases may be prevalent in any particular portion of a sewer. But whatever may be the analysis of this foul air, there can be but little doubt that it contains organic matter floating about in it as solids, and that it is excessively injurious and even dangerous to breathe, and that it should be caught and destroyed or rendered innocuous, and not be permitted to pass into and contaminate and poison the air we breathe.

Some engineers are of opinion that this foul air always finds its way to the upper portions of the sewerage system, but my investigations into this subject have led me to believe that no rule of this kind can be laid down, for with quick velocities of flow, in some sewers, the gases are carried by friction in the direction of the flow of the sewage, and do not ascend as has been imagined.

Whatever system of ventilation of the main sewers in any town may be adopted, it is imperative that the house drains connected with them should be properly trapped and ventilated, and this is in my judgment of even greater importance than the ventilation of the main sewers. On this point I have given more explanations in the chapter upon "House Drainage."

In conclusion, let me refer my readers to a most exhaustive discussion, and very valuable information contained in the chapter entitled "Ventilation of Sewers and Drains" in Mr. Baldwin Latham's 'Sanitary Engineering,' in which may be found almost everything that is at present known upon this important subject.

CHAPTER XXIII.

PUBLIC CONVENIENCES.

IN almost every town in the United Kingdom public urinals are now erected, although it is not often that good water-closet accommodation is provided, except at hotels and railway stations, over which the local authority have no jurisdiction; or perhaps if they do provide any accommodation of this description it is only in connection with the public parks or in the markets, museums, &c.

The clause of the Public Health Act which empowers an urban authority to spend money out of the district rates for this purpose is as follows:

"Any urban authority may if they think fit provide and maintain in proper and convenient situations, urinals, water-closets, earthclosets, privies and ashpits and other similar conveniences for public accommodation" (38 & 39 Vic. c. 55, s. 39).

It is not my intention to enter into the merits or otherwise of the many descriptions of urinals and latrines that have been brought to the notice from time to time of every town surveyor by enterprising manufacturers and patentees, but only to give a few suggestions upon the subject.

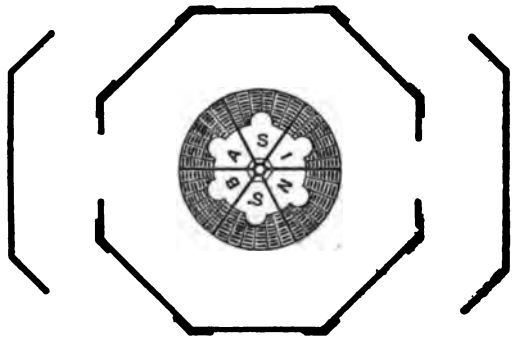
Public urinals ought to be erected by the urban authority as a matter of convenience to the peripatetic portion of any community, and also to prevent nuisances being committed in improper places.

In selecting sites for urinals the town surveyor must take care that after erection they shall not be offensive or a nuisance to any persons living in the vicinity, and that they shall be so placed that although they may be

easily found, the persons using them shall be effectually screened.*

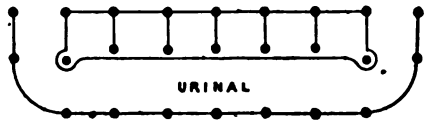
Urinals are better constructed of iron rather than of brick-work or more solid workmanship, in order that they can be readily removed. It is surprising what an uproar is sometimes raised in a neighbourhood by the erection of a urinal; this clamour occasionally has so much effect upon the urban authority that they order the removal of the urinal, although it may not have been erected many days, and if it has been substantially built a considerable waste of the public money is thus involved.

Where a urinal is constructed with basins, as by the following plan, the basins may be of iron or good stone ware



or similar construction, these being always kept full of water which is constantly although slowly changing.

Stall urinals may be some modification of the following plan, and be constructed of iron with slate partitions, or the



* The urban authority have an absolute discretion as to the sites they select. They cannot, however, erect public conveniences so as thereby to cause a nuisance, even though the convenience is wanted and the locality chosen suitable. (*Vide* 'Public Health and Local Government Act,' by F. V. Fitzgerald, 3rd edition, p. 33.)

partitions may be of iron covered with plate glass where soiled, the stalls should not be less than 24 in. in the clear, and water must be kept constantly flowing over the soiled portion either from a perforated pipe or a spreader.* A very excellent arrangement is to have a trench or trough cut at the foot of the stall for the whole length of the urinal, which is kept constantly full of water and occasionally flushed, thus avoiding nuisance in a very satisfactory manner.

Provision must of course be made to efficiently drain and light all public urinals, and arrangements should be made by which they can be thoroughly washed once or twice a day, so as to keep every part scrupulously clean. Urine after a very short exposure exhales a most fœtid and unpleasant odour, from the decomposition of its nitrogenous matter. Carbolic acid, chloride of lime, sanitas, or other disinfectant should also be used, especially in warm weather.

If the interior of a public urinal or latrine has to be painted a light colour, it is well to mix a little sand with the paint, so as to prevent as much as possible that literature and art which so often disfigures establishments of this description. An excellent composition with which to treat urinals, although it is of a somewhat dark tint, is a mixture of common coal tar and naphtha, which not only gives a clean and polished appearance to the place, but is also an excellent deodorant and disinfectant.

With regard to public W.C. accommodation, this, as I have before stated, is not very often provided by an urban authority,† although common public latrines are sometimes erected. These are generally used by rather rough persons, and should be constructed in a strong and simple manner.

For this purpose stoneware bowls or basins placed over a drain and fitting into ordinary right-angled junctions placed

* The quantity of water usually required to each stall when kept constantly running is about half a gallon per minute.

† For an excellent specimen of such public accommodation, that at Liverpool near the St. George's Hall should be inspected.

vertically are simple and effective as well as very economical in construction. Slate, iron, or wood seats may be placed on these basins, which should be kept half full of water. A periodical and sudden flush which carries the whole contents into the nearest sewer can be arranged for so as to work automatically by the introduction of a cistern and one of Mr. Roger Field's flush syphons at the upper end of the system.

For further information on the subject of urinals, water-closets, latrines, and all similar subjects, let the town surveyor refer to Mr. George Jennings or Messrs. Macfarlane, who have an endless variety of designs and appliances in connection with such matters.

CHAPTER XXIV.

ARTIZANS AND LABOURERS' DWELLINGS, &c.

THE Artizans and Labourers' Dwellings Act 1868 (31 & 32 Vic. c. 130) was in effect incorporated in the Public Health Act 1875 so that "every urban authority shall within their district, . . . have, exercise and be subject to all the powers, rights, duties, capacities, liabilities, and obligations within such district exercisable or attaching by and to the local authority" (38 & 39 Vic. c. 55, s. 10).

The mode of procedure is as follows:

Where the "officer of health" * finds any premises in a condition or state dangerous to health so as to be unfit for human habitation, he shall report the same in writing to the clerk of the local authority. The local authority must then refer such report to a surveyor or engineer,† who shall thereupon consider the report so furnished to him, and report to the local authority what is the cause of the evil so reported on, and if such evil is occasioned by defects in any premises, whether the same can be remedied by structural alterations and improvements or otherwise, or whether such premises or any or what part thereof ought to be demolished (31 & 32 Vic. c. 130, s. 6).

Upon the receipt of this report from the surveyor the local authority sends copies to the owner of the premises, giving him opportunities of attending before them and of appealing against the report, and if his objections are overruled,

* The term "officer of health," as respects any urban sanitary district in England, means the medical officer of health appointed by the urban sanitary authority under the Public Health Act 1875 (42 & 43 Vic. c. 64, s. 3).

† The town surveyor is usually employed for this work.

a plan and specification of the works (if any) and an estimate of the cost of such works, must be prepared by the surveyor, and these in turn may be inspected by the owner and objected to by him in writing, and he may also attend before the local authority, and if he makes good his objections the local authority may direct the plan, specification and estimate to be amended, and the works would then be executed in accordance with the amended plans, &c. (31 & 32 Vic. c. 130, s. 8).

Persons who are aggrieved by any order of the local authority may appeal against it, but failing this, if the owner does not within two months diligently proceed with and complete the same in conformity with the specification to the satisfaction of the surveyor, the local authority may either order the premises to be shut up, or to be demolished, or may themselves execute the required works in conformity with the specification (31 & 32 Vic. c. 130, s. 18).

If the requirements of the order involve the total demolition and not the improvement of the premises, the owner shall within three months proceed to take down and remove them, and if he fail to do so, then the local authority may pull down and recoup the expenses by a sale of the old material (31 & 32 Vic. c. 130, s. 20).

The above Act was amended in 1879 by the "Artizans and Labourers' Dwellings Act (1868) Amendment Act 1879" (42 & 43 Vic. c. 64), the most important clause affecting the action of the town surveyor being as follows:

"Notwithstanding anything in the Act of 1868, the owner of any premises specified in an order of the local authority made under that Act, and requiring him to execute any works or to demolish such premises, may within three months after service on him of the order, require the local authority in writing to purchase such premises" (42 & 43 Vic. c. 64, s. 5).

The amount of compensation to be paid to the owner is to be settled by arbitration if no agreement can be arrived at,

such arbitration to be carried out in a manner provided for by certain clauses in this Amendment Act 1879.

Sec. 9 of the same Act also provides for the repayment (by sale of old materials, &c.) of the cost incurred by the local authority in executing any works under the Acts.

This Act has again been amended quite recently (August 1882) by "An Act to Amend the Artizans and Labourers' Dwellings Acts" (45 & 46 Vic. c. 54), the most important clause affecting the working of this Act being as follows :

(1.) "If in any place to which the Artizans and Labourers' Dwellings Act 1868 applies the officer of health finds that any building, although not in itself unfit for human habitation, is so situate that by reason of its proximity to or contact with any other building it causes one of the following effects, that is to say :

"(1.) It stops ventilation or otherwise makes or conduces to make such other buildings to be in a condition unfit for human habitation ; or

"(2.) It prevents proper measures from being carried into effect for remedying the evils complained of in respect of such other buildings,

in any such case the officer of health shall make a report to the local authority in writing of the particulars relating to such first-mentioned building (in this Act referred to as 'an obstructive building') stating that in his opinion it is expedient that the obstructive building should be pulled down, and shall deliver the report to the clerk of the local authority.

"(2.) The local authority shall refer such report to a surveyor or engineer to report thereon, and to report as to the cost of acquiring the lands on which such obstructive building is erected, and of pulling down such building."

The local authority then consider the reports of the officer of health and of the surveyor, and proceed to give copies to the owner of the lands in question, who has liberty of appeal,

&c., as before given in the Act 1868. The lands may be acquired by the local authority by agreement or compulsorily under the Lands Clauses Consolidation Acts, and the obstructive building, "or such part thereof as may be obstructive," may be pulled "down, and the whole site, or such part thereof as may be required to be kept open for the purpose of remedying the evils" kept as an open space.

The owner of the land may, by giving due notice, declare that "he desires to retain the site of the obstructive building, and undertake either to pull down or to permit the local authority to pull down, the obstructive building," in which case he retains the site, and is compensated only for the building.

These recent amendments to the old Act of 1868 are of the greatest importance, for they aim at the easy improvement of courts and alleys, by opening them where houses have been erected across the entrance, in some cases depriving the courts and alleys of light and air, and leaving only a small covered archway through which the occupants can enter.

The Act has only too recently become law for me to give any particulars with regard to its working, but it appears to be a most valuable sanitary Act.

Prior to these amendments of the Act 1868, it was felt that it dealt only with isolated buildings, and consequently, in order to improve large areas, the "Act for Facilitating the Improvement of the Dwellings of the Working Classes in Large Towns" was passed in 1875 (38 & 39 Vic. c. 36), since which date, like the Act 1868, it has been twice amended, once in 1879 (42 & 43 Vic. c. 63), and again in 1882 (45 & 46 Vic. c. 54).

The object of the Act of 1875 was to facilitate the removal of portions of towns, especially of the courts and alleys in the poorer and more densely-populated parts.

The Act is to be put in force where an official representation is made by the medical officer of health to the local

authority of an urban sanitary district (which must contain a population of at least 25,000) that "any houses, courts, or alleys within a certain area" are "unfit for human habitation, or that diseases indicating a generally low condition of health amongst the population have been from time to time prevalent in a certain area," and that this is attributable to the bad arrangement or bad condition of the streets and houses, or "other sanitary defects," which can only be remedied by "an improvement scheme for the rearrangement and reconstruction of the streets or houses" (38 & 39 Vic. c. 36, s. 3).

The improvement scheme to be prepared on receipt of this report by the local authority must be accompanied by "maps, particulars, and estimates" (no doubt these must be prepared by the surveyor, although no mention is made as to who shall prepare them), and this scheme may "provide for widening any existing approaches to the unhealthy area, or otherwise for opening out the same for the purposes of ventilation or health." It must distinguish "the lands proposed to be taken compulsorily," and by the Act 1875 it was necessary to "provide for the accommodation of at the least as many persons of the working class as may be displaced in the area with respect to which the scheme is proposed in suitable dwellings, which, unless there are any special reasons to the contrary, shall be situate within the limits of the same area or in the vicinity thereof" (sec. 5).

So much practical difficulty was experienced in carrying this latter part of the clause into effect, that in 1879 a short Act was passed (42 & 43 Vic. c. 63), which by the 4th section amended that part of the original clause as to the provision of accommodation for the working classes as follows:

"Where it is proved to the satisfaction of the confirming authority . . . . that equally convenient accommodation can be provided . . . . at some place other than within the area or the immediate vicinity . . . . and it is also proved to the

satisfaction of such authority that the required accommodation has been or is about to be forthwith provided." The confirming authority may be satisfied with such provision, and for this purpose the local authority may make use of any lands belonging to them, or purchase any that are suitable (42 & 43 Vic. c. 63, s. 4).

This part of the Act has again been amended in the year 1882 by 45 & 46 Vic. c. 54, which in section 3 enacts as follows:

". . . . and where any such improvement scheme comprises an area situate elsewhere than in the metropolis or the City of London, it shall, if the confirming authority so require (but it shall not otherwise be obligatory on the local authority so to frame their scheme), provide for the accommodation of such number of those persons of the working class displaced in the area with respect to which the scheme is proposed in suitable dwellings to be erected in such place or places either within or without the limits of the same area as the said authority, on a report made by the officer conducting the local enquiry, may require . . . ."

Having thus far given the *modus operandi* under which the Act has to be enforced, it is necessary to see what are some of the town surveyor's duties in connection therewith.

First, there are the "maps, particulars, and estimates" which have to be prepared, and these involve—

(*a.*) Accurate surveys of the area;

(*b.*) A reference of all the properties included:

(*c.*) A census of the population of the area;

(*d.*) A valuation of all the properties;

(*e.*) A plan of the proposed new streets, &c.

(*f.*) An estimate of the cost of the whole work.

In addition to this it is necessary for the local authority to "impose suitable conditions and restrictions as to the elevation, size, and design of the houses and the extent of the accommodation to be afforded thereby, and to make due pro-

vision for the maintenance of proper sanitary arrangements," and this naturally involves detailed drawings of the buildings to be erected.

In the same clause (38 & 39 Vic. c. 36, s. 9) it is stated that the local authority may engage with any society, &c., to carry the whole or any part of the scheme into effect, but "the local authority shall not themselves, without the express approval of the confirming authority, undertake the rebuilding of the houses or the execution of any part of the scheme, except that they may take down any or all of the buildings upon the area, and clear the whole or any part thereof, and may lay out, form, pave, sewer, and complete" all the necessary streets, &c., which shall thenceforth be public streets repairable by the inhabitants at large.

It is scarcely necessary to say that the enforcement of this Act involves a considerable expenditure of work and time in the office of the town surveyor.

The buildings which are erected on the sites dealt with under this Act are generally of the "high block" class, as it is found that the labouring man prefers to live near his work, and land is generally too expensive in such localities to admit of the erection of any other description of buildings.

As to whether this class of dwelling is as healthy as ordinary cottages or houses, the following death-rates for the year 1879 will be some guide :

The London Improved Industrial Dwellings	16·4 per 1000
The Peabody Trust Dwellings	17·2 ,, ,,
The Metropolitan Association Dwellings	14·3 ,, ,,
The Newcastle Improved Industrial Dwellings ..	12·0 ,, ,,
The general death rate for the Metropolis at the same date being	21·2 ,, ,,

It is of course necessary that the sanitary arrangements of industrial dwellings of the block type should be very perfect, and as to the manner in which they should be erected the

following words of Mr. John Price, who for twelve years had lived in one of them himself, can be here given with advantage:*

"Model dwellings are therefore most appreciated by working men when placed near the scene of their daily labour. The arrangements most preferred are those which bring the fewest families or persons in contact with one another on a flat or landing. As a rule the buildings should not exceed four stories in height; the staircases should be about four feet in width, and broken by short landings, lighted by large windows open to the external air; the window-sills should not be less than three feet from the floors for the safety of young children, and for the same reason well staircases should be avoided. The steps of the stairs should only have a 6-inch 'rise,' for the more easy accommodation of old people and young children; they should be fire-proof, and well lighted with gas on an evening. There should be a thick layer of deafening between the floors. The waterclosets should be placed in an offshoot from the main building, opening on to each landing, and well ventilated by open windows and air bricks. The watercloset apparatus should be as simple and effective as possible. Patents depending upon the proper working of valves and ball-cocks should be avoided, as the fruitful cause of trouble and expense; little reliance must be placed on their proper use by tenants where more than one family have access to them. I have seen excellent closets stopped up with cloths and all manner of earthenware and hardware, children of careless parents being the principal offenders; what is everybody's duty is often most neglected. It will be found most economical in large buildings of this class to appoint a person whose duty it should be to attend to the proper flushing of waterclosets daily. I would suggest

* *Vide* 'Industrial Dwellings from a Sanitary point of View,' by John Price, Resident Agent, Newcastle-on-Tyne Industrial Dwellings Company, read September 28th, at the Congress of the Institute, held at Newcastle-on-Tyne.

that there should be a large cistern under the roof (distinct from the cistern used for domestic purposes), a ¾-inch feed pipe should lead to each w.c., which should consist of a simple metal or earthenware pan, provided only with a tap, flushing rim, and plug, placed under the seat securely, and under the sole control of the attendant, who, by the necessary daily inspection, would detect any stoppage or injury to the fittings. The expense of such supervision would probably be soon saved in plumbers' bills. Of course the soil-pipes should be well ventilated above the roof of the building, and all drains and sinks should be properly trapped. The attendant on his daily rounds would also be able to see that these are kept in proper order. The dust-shaft, extending to the full height of the building, should have proper hoppers connected with it to prevent the dust coming from the lower or upper landings; a nuisance sometimes complained of in block dwellings. The washhouses should be placed on the roof or in the yards, fitted with set pots and requisite conveniences. The soft water from the roofs should be stored in tanks for washing and domestic purposes—it will be much appreciated by sensible tenants, and save the water bill greatly.

"The great desiderata of these large blocks of buildings is ample playground for the children, without which they play upon the stairs, and are often the cause of strife amongst neighbours. I know those who have experience in the matter may say that it is more easy to state what is desirable than what is practical. The enhanced value of land in all our large towns precludes any liberal investment on what appears so financially unremunerative as playgrounds, yet they are essential adjuncts wherever there is an infantile population. Mr. Powell, on behalf of the London Trades' Unions, enumerated before Sir Richard Cross's Committee certain objections which the working classes of London entertained against the earliest erected blocks of dwellings, amongst which was their barrack-like and uninviting appearance, and also their want of

playgrounds for children. Recently these defects have been greatly remedied."

A few words are necessary upon the "Labouring Classes' Lodging Houses Acts" (14 & 15 Vic. c. 34; 29 & 30 Vic. c. 28; 30 & 31 Vic. c. 28).

The object of these Acts was to empower urban authorities, under certain restrictions and after certain formalities, to appropriate any lands vested in them or at their disposal, or to purchase or rent the necessary lands for the purpose of erecting suitable buildings for lodging-houses for the working classes, or to convert any buildings into lodging-houses, and "repair and improve the same respectively with all requisite furniture, fittings, and conveniences"; and further powers are given in the Acts for the urban authority to contract with persons for different objects, &c.

I am unable to give any experiences of the working of these Acts, for I do not know of any urban authority which has carried them into effect, the Artizans and Labourers' Dwellings Improvement Acts having virtually superseded them.

The following copy of the bye-laws as sanctioned by the Treasury in 1867 in connection with the Labouring Classes' Lodging Houses Acts may, however, be of interest, as well as the table of sizes of rooms which follows:

Separate watercloset accommodation to be provided for each tenement, or else, where watercloset accommodation is to be used in common by the occupants of two or more tenements, separate accommodation must be provided for each sex. Such accommodation may be either watercloset, earthcloset, or privy.

Each tenement to have a dustbin or the use of a dustbin common to several buildings.

Each tenement to be well lighted by external windows made to open.

Each tenement to have ready access to water.

Where several tenements in one building, proper ventilation to be provided for the passages, staircases, &c.

The drains to be well constructed.

Parties to whom moneys to be advanced to enter into covenants with the Public Works Loan Commissioners, that where there are several tenements in one building they;

(*a.*) Will cause the passages, staircases, &c., to be kept clean;

(*b.*) Will cause the waterclosets, &c., to be kept in good repair;

(*c.*) Will cause the dustbins to be emptied at intervals of seven days;

(*d.*) Will take precautions against any interruption in the supply of water;

(*e.*) Will keep the windows in good order and repair, and the chimneys swept;

(*f.*) Will keep the drains in proper order;

(*g.*) Will allow inspection by Commissioner of Works to see that the above covenants are observed.

Number of cubic feet in each room of the several classes of tenements (none of less than two rooms) for which money has been authorised to be advanced:

Class.	One Room of cubic feet.	One Room of cubic feet.	One Room of cubic feet.	One Room of cubic feet.	One Room of cubic feet.
Class I. of two rooms	715	1,219			
Ditto	816	994			
Ditto	995	1,020			
Class II. of four rooms	960	960	960	960	
Class III. of five rooms	372	675	1056	1056	1232
Ditto	446	459	459	781	1468

It may be information valuable to a town surveyor, if before closing this chapter I draw attention to the provisions of the Municipal Corporations Act 1882, sec. 3, which gives corporations power to convert any corporate land into sites for working men's dwellings, although the corporation are not authorised to erect the dwellings thereon.

CHAPTER XXV.

DEFECTS IN DWELLING-HOUSES, &c.

THERE are many defects in dwelling-houses with which it is the duty of the sanitary inspector to deal, such as the Bake-house Regulations Act, offensive trades, nuisances rendering houses unfit for human habitation, &c., but I propose to give in this chapter, in addition to those with which I have already dealt, such subjects under this head as come within the duties of the town surveyor.

The first which I propose to treat is that of the question of

Cellar Dwellings.—These are at all times objectionable even if the clauses of the Public Health Act 1875 be strictly carried out, and the surveyor should discourage them as much as possible. Nothing more can be said with reference to them than is contained in the provisions of the above Act, which are as follows:*

"It shall not be lawful to let or occupy or suffer to be occupied separately as a dwelling, any cellar (including for the purposes of this Act in that expression any vault or underground room) built or rebuilt after the passing of this Act, or which is not lawfully so let or occupied at the time of the passing of this Act" (38 & 39 Vic. c. 55, s. 71).

And with regard to existing cellar dwellings they are only to be let or occupied on the following conditions:—

"Unless the cellar is in every part thereof at least

* Any cellar in which any person passes the night shall be deemed to be occupied as a dwelling within the meaning of this Act (38 & 39 Vic. c. 55, s. 74).

seven feet in height, measured from the floor to the ceiling thereof, and is at least three feet of its height above the surface of the street or ground adjoining or nearest to the same; and

"Unless there is outside of and adjoining the cellar and extending along the entire frontage thereof, and upwards from six inches below the level of the floor thereof up to the surface of the said street or ground, an open area of at least two feet and six inches wide in every part; and

"Unless the cellar is effectually drained by means of a drain, the uppermost part of which is one foot at least below the level of the floor thereof; and

"Unless there is appurtenant to the cellar the use of a watercloset, earthcloset, or privy, and an ashpit, furnished with proper doors and coverings, according to the provisions of this Act; and

"Unless the cellar has a fireplace with a proper chimney or flue, and an external window of at least nine superficial feet in area clear of the sash frame, and made to open in a manner approved by the surveyor (except in the case of an inner or back cellar let or occupied along with a front cellar as part of the same letting or occupation, in which case the external window may be of any dimensions, not being less than four superficial feet in area clear of the sash frame).

"Provided that in any area adjoining a cellar there may be steps necessary for access to such cellar, if the same be so placed as not to be over, across, or opposite to the said external window, and so as to allow between every part of such steps and the external wall of such cellar a clear space of six inches at the least, and that over or across any such area there may be steps necessary for access to any building above the cellar to which such area adjoins, if the same be so placed as not to be over, across, or opposite to any such external window" (38 & 39 Vic. c. 55, s. 72).

Where two convictions in respect of the same cellar have

taken place within three months, the local authority may close it, and recover any expenses incurred by them in the execution of this duty (38 & 39 Vic., c. 55, s. 75).

The next defect in a dwelling-house which will be considered is that of

Insufficient W.C. accommodation.—A new house may not be erected without "a sufficient watercloset, earthcloset,* or privy" under a penalty not exceeding twenty pounds † (38 & 39 Vic. c. 55, s. 35).

And with regard to existing premises:

"If a house within the district of a local authority appears to such authority *by the report of their surveyor* or inspector of nuisances to be without a sufficient watercloset, earthcloset, or privy . . . . the local authority shall by written notice require the owner or occupier of the house within a reasonable time therein specified, to provide a sufficient watercloset, earthcloset, or privy . . . . or either of them as the case may require. If such notice is not complied with the local authority may, at the expiration of the time specified in the notice, do the work, provided that where a watercloset, earthcloset, or privy has been and is used in common by the inmates of two or more houses, or if in the opinion of the local authority a watercloset, earthcloset, or privy may be so used, they need not require the same to be provided for each house" (38 & 39 Vic. c. 55, s. 36).

If the local authority approve, an earthcloset may be constructed instead of a watercloset, but in this case they should make arrangements for the supply of the dry earth and the removal of its contents.

* "In this Act (P. H. Act 1875) the term 'earth closet' includes any place for the reception and deodorization of fæcal matter constructed to the satisfaction of the local authority" (38 & 39 Vic. c. 55, s. 37).

† In case of several houses together, it has been held as not necessary to have separate accommodation for each house, if there is sufficient for them collectively. (Clutton Guardians *v.* Pointing, 4 Q. B. Division 340, 48 L. J. M. C. 137.)

The necessary form of notice to be served in connection with insufficient w.c. accommodation may be as follows:

To the owner of the house No. *in the borough of* .

Whereas the above-mentioned house is situate within the district of the mayor, aldermen, and burgesses of , the urban sanitary authority for the borough of : And whereas it appears to the said urban sanitary authority that the said house is without a sufficient watercloset, earthcloset, or privy: Now the said urban sanitary authority do hereby require you, the said owner, within from the date of this notice to provide a sufficient watercloset for the use of the inhabitants of the said house. And take notice, that if you do not within the time above specified provide a sufficient watercloset, as aforesaid, to the satisfaction of the said urban sanitary authority, they will themselves, at the expiration of such time, do the necessary work to provide such closet accommodation as aforesaid, and proceed to recover the costs and expenses thereby incurred in manner provided by the Public Health Act 1875.

Dated this of , 188 .

Surveyor to the said Mayor, Aldermen and Burgesses.

And where the case demands, the following note may be added below the above notice:

"NOTE.—The urban sanitary authority may, if they so determine, require a separate watercloset to be provided for each house, or they may permit a watercloset to be used in common by the inmates of two or more houses,* but in either case the closet itself must be properly constructed and provided with due means of ventilation. The urban sanitary authority

* It is not always possible for a separate w.c. to be provided for each house, hence the wisdom of the law which makes it permissive for a local authority to allow a group of tenements to be provided for by several waterclosets close together.

will approve of the existing closet accommodation if it is perfected by means of the following works being carried out. (Specification of work required to be done must here be inserted.) The whole of the work to be executed in a workmanlike manner and to my entire approval.

"It is, however, to be understood that the above notice requiring the work to be executed within one month will be rigidly enforced; and if at the expiration of that time the work be not completed, the urban sanitary authority will themselves proceed to execute the necessary work to provide proper closet accommodation in such manner as they may deem most advisable, without pledging themselves to the adoption of the method above suggested."

Surveyor to the said Mayor, Aldermen and Burgesses.

With regard to watercloset accommodation for factories, it appears to rest entirely with the town surveyor to draw the attention of the sanitary authority to any case where he considers this is deficient, as by the following clause:

"Where it appears to any local authority by the report of their surveyor that any house is used or intended to be used as a factory or building in which persons of both sexes are employed or intended to be employed at one time in any manufacture, trade, or business, the local authority may, if they think fit, by written notice require the owner or occupier of such house, within the time therein specified, to construct a sufficient number of waterclosets, earthclosets, or privies and ashpits for the separate use of each sex.

"Any person who neglects or refuses to comply with any such notice shall be liable for each default to a penalty not exceeding twenty pounds, and to a further penalty not exceeding forty shillings for every day during which the default is continued" (38 & 39 Vic. c. 55, s. 38).

In providing closet accommodation which is to be used in common by the occupants of a number of houses, it must be

remembered that it should be of the most simple description. Any one acquainted with the working of waterclosets situated in courts and alleys will know how badly they are treated, and into what a fearful state of disrepair and filth they speedily fall, as the great difficulty the sanitary inspector always finds is to have them kept clean ; "What is everybody's business is nobody's." And although by clauses 40, 41, 46, &c., of the Public Health Act 1875 persons causing a nuisance can be punished, it is a difficult matter to detect the person in fault, unless of course it is a structural defect, when the owner can be summoned if it is allowed to remain uncured.

For this reason what are known as "Fowler's closets," or some modification of this principle, should be adopted in all such localities where earthclosets or some of the dry systems are not in force, as they are without any complicated valve apparatus or anything of the kind.

The last point to consider in this chapter is that of *Houses without a proper supply of water.*

"Where on *the report of the surveyor* of a local authority it appears that any house is without a proper supply of water, and that such a supply can be furnished at a cost not exceeding that authorised by any local Act, or where there is not any local Act, not exceeding twopence a week, or at such other cost as the Local Government Board may determine, the local authority shall give notice in writing to the owner, requiring him, within a time specified, to obtain such supply, and to do all such works as may be necessary for that purpose,* and in default of his doing so may carry out all necessary works themselves for obtaining such supply" (*vide* 38 & 39 Vic. c. 55, s. lxii.).

It is not very often that a house is found without any

* A similar provision is made requiring the keeper of a common lodging house to obtain a proper supply of water (38 & 39 Vic. c. 55, s. 81), but it does not appear to be the express duty of the town surveyor to draw attention to this, as it does in the more general clause.

supply of water at all, for if that from the mains is not laid on it is generally found that the house is supplied from a well or from a stand-pipe in a court, or some similar source. If the water is derived from an impure well or other contaminated source, the following clause of the Public Health Act 1875 must be enforced in order to close the well or compel the discontinuance of the polluted supply, when a "proper" supply of water can be enforced in the manner I have described:

"On the representation of any person to any local authority that within their district the water in any well, tank, or cistern, public or private, or supplied from any public pump, and used or likely to be used by man for drinking or domestic purposes, or for manufacturing drinks for the use of man, is so polluted as to be injurious to health, such authority may apply to a court of summary jurisdiction for an order to remedy the same; and thereupon such court shall summon the owner or occupier of the premises to which the well, tank, or cistern belongs if it be private, and in the case of a public well, tank, cistern or pump, any person alleged in the application to be interested in the same, and may either dismiss the application, or may make an order directing the well, tank, cistern, or pump to be permanently or temporarily closed, or the water to be used for certain purposes only, or such other order as may appear to them to be requisite to prevent injury to the health of persons drinking the water.

"The court may, if they see fit, cause the water complained of to be analysed at the cost of the local authority applying to them under this section.

"If the person on whom an order under this section is made fails to comply with the same, the court may, on the application of the local authority, authorise them to do whatever may be necessary in the execution of the order, and any expenses incurred by them may be recovered in a summary manner from the person on whom the order is made.

"Expenses incurred by any rural authority in the execution of this section, and not recovered by them as aforesaid, shall be special expenses" (38 & 39 Vic. c. 55, s. 70).

It is an established fact that wells within a town must always be regarded with some suspicion, and where they exist either publicly or privately the local authority would do well to have the water from them analysed with a view to having them closed. Even cisterns, if not frequently examined and cleansed, will cause the water that is stored in them to become polluted, not only from the dust of the air settling in them and the natural impurities of the water passing through them, but frequently from foreign objects falling into them and decaying, such as rats, mice, cats, and in one case that I know of, a sirloin of beef, and in another a plumber! These remained in the cistern until the colour, smell, and taste of the water drew the attention of the drinkers to "something being the matter!" The cure for the chance of such cases as these is of course the constant supply.

CHAPTER XXVI.

HOUSE DRAINAGE.

IT would not be possible in one chapter of a book of this description to enter into all the details and necessary apparatus in connection with house drainage. I propose only to point out some of the town surveyor's duties in connection with this subject, and to add a few remarks which may be of some service.

The definition of the word "drain" as given in the Public Health Act 1875 is as follows:

"'Drain' means any drain of and used for the drainage of one building only, or premises within the same curtilage, and made merely for the purpose of communicating therefrom with a cesspool or other like receptacle for drainage, or with a sewer into which the drainage of two or more buildings or premises occupied by different persons is conveyed" (38 & 39 Vic. c. 55, s. 4).

Although this definition is very clear, it occasionally happens, especially in old towns, that some doubt arises as to whether an existing conduit for sewage is a "drain" or a "sewer"* for though a conduit is of small size it may be found to be carrying the sewage of two or more buildings, and thus is really "a sewer belonging to the local authority."

This difficulty often leads to litigation where a notice having been served upon an owner of property to put in a new drain in place of one that has been found on examination to be defective, the new work is of course commenced at the junction with the main sewer, and it is not until the new so-

* For definitions of the word "sewer," see the chapter on Sewerage.

called drain is nearly completed that it is found to be "used for the drainage" of more than one building, and is in fact "a sewer into which the drainage of two or more buildings or premises, occupied by different persons is conveyed" (see clause quoted above), and is therefore repairable by the local authority (38 & 39 Vic. c. 55, s. 13).

Where the town surveyor is in any doubt as to whether the conduit is a drain or a sewer, he should test from whence the sewage comes by passing diluted white lime or carbolic acid down the adjacent water-closets and watching whether it flows through the conduit or not, but even here he is sometimes at fault if the drains are old and dilapidated, as they do not reach the point he is watching and he is thus misled.

In connection with the question of house drainage the town surveyor has the following duties to perform:

(1.) To inspect all new drains that are constructed in connection with existing buildings within his district.

(2.) To inspect all drains of new buildings that are constructed within his district.

(3.) To inspect all defective drains within his district, serve the necessary notices in respect thereof, and inspect the works he has required to be executed whilst they are in progress.

(1.) With reference to the first of these duties the following is the clause of the Public Health Act 1875 which bears upon the point:

"The owner or occupier of any premises within the district of a local authority shall be entitled to cause his drains to empty into the sewers of that authority on condition of his giving such notice as may be required by that authority of his intention so to do, and of complying with the regulations of that authority in respect of the mode in which the communications between such drains and sewers are to be made, and subject to the control of any person who may be appointed by that authority to superintend the making of

such communications. Any person causing a drain to empty into a sewer of a local authority without complying with the provisions of this section shall be liable to a penalty not exceeding twenty pounds, and the local authority may close any communication between a drain and sewer made in contravention of this section . . . . " (38 & 39 Vic. c. 55, s. 21).

The first thing therefore that a local authority has to do is to frame the necessary regulations and appoint a "person to superintend the making of such communications."

The following is given as a specimen form of the manner in which these regulations may be compiled :*

Regulations made and ordained by the Urban Sanitary Authority for , as to the giving of notice before any drains are made to communicate with the sewers of the said Urban Sanitary Authority; regulating the mode in which such communications are to be made; and appointing the person under whose superintendence and control the work is to be executed.

1.—No communication shall be made with any sewer belonging to the said Urban Sanitary Authority, nor any drain made to empty therein, unless notice of an intention so to do, signed by the owner or occupier of the premises to which

* The New York Board of Health require that earthenware drain pipes connecting dwellings with street sewers shall be hard and salt glazed, sound and cylindrical; at least $\frac{4}{5}$ths of an inch thick if 5 inches in diameter, and $\frac{3}{4}$ of an inch thick if 6 inches in diameter. Pipe must be connected with hydraulic cement of the best quality. No "tempered up" cement can be used. The pipes must be laid with such good alignment that the inspector can see through the entire line from the house to the sewer, and every section must be bedded in cement so as to have a firm bearing, not only at the hub, but along its entire length. The inside of the drain must be freed from all cement which may have oozed through at the joints, and from all other obstructions. Before the drain is covered notice must be sent to the Health Department, by the owner or plumber, that the inspector may visit and examine the work, and the Board of Health will not approve or permit a drain which has not been examined by one of its inspectors and found to be properly constructed.

such drains belong, be left at the office of the borough surveyor two days previously ; and such notice must specify the point at which it is desired that communication shall be made, and the time at which it is proposed the work shall be commenced, and any person not complying with these regulations will be liable to a penalty not exceeding twenty pounds.

2.—Work required to be done in connecting any house drain or drains with the main or public sewer, shall be executed in the following manner :

The ground to be excavated to the required depth with all possible expedition, the work to proceed by night and day ; and there shall be maintained during the progress of the work all such fencings, hoardings, struttings, and shorings, as may be necessary for or in consequence of any of the works, for the protection of the public, and of all buildings and property whatever, near to or liable to be affected by the work, which shall also be well watched and lighted.

The shoring and strutting of the excavation is to be done in such manner, with poling boards, waling pieces and struts, as the surveyor shall consider necessary.

All surplus earth or material is to be carted away as speedily as possible. Care must be taken where the excavation is made in a road or path to keep separate the surface material from the lower, so as to replace them in their proper positions.

The excavation shall in all cases where practicable be in open cutting, and not by shafts and headings.

The junction with the main sewer to be done in the following manner :—

The drain shall in no case be less than four inches internal diameter, and shall be constructed of well-burnt glazed socketed stoneware pipes, circular, perfectly true in bore, and straight, with whole socket joints free from flaws, blisters, cracks, or other defects, set in Portland cement joints with a uniform fall, well bedded on well-rammed and solid ground, the sockets

being sunk into it so as to give an even bearing. No shafts or sudden falls will be allowed.

Where the junction is with a sewer constructed of pipes, one length of the sewer (or more if necessary) shall be removed and an oblique proper glazed socket junction pipe, set in Portland cement, inserted in its place.

The junction with the sewer shall be of the same size as the drain.

Where the junction is with a brick or stone sewer, the connection shall be made at such height above the invert as the surveyor shall determine, and be made with a glazed socket pipe obliquely in line of current of main sewer, properly bedded in with cement, cut off so as to take the form of the main sewer and offer no obstruction to the proper flow of sewage therein, or with a properly constructed stoneware block junction.

On completion of the junction, which shall be made before any of the pipe drain is laid, it shall be inspected by the surveyor, and the work must not be further proceeded with until such inspection has been made and the junction pronounced satisfactory. The drain shall be properly trapped between the sewer and the house, with a syphon of such form as the surveyor shall direct, and be at its inlet end or other extremity carried up open its full diameter to above the roof line.

The excavation is to be filled in within six inches of the surface of the ground, with layers of earth not more than six inches in thickness, carefully rammed or punned with iron punners of not less weight than 10 lbs.

The surface of a roadway must be brought up to its proper level with the surface material kept separate, and properly broken or other approved road metal, and the roadway where broken shall be kept in repair by the person opening the ground for a period of twelve months after the completion of the work.

If the excavation is made under a footpath or paved road, the paving must be made good and kept in repair for a similar period.

3.—A. B. C., the present borough surveyor, and his successors in office, or the person for the time being acting as or discharging the duties of borough surveyor, are hereby appointed as the person or persons to superintend the making of such communications with the public sewers as aforesaid.

(1.) Notwithstanding the stringency of the above regulations it is very difficult to ensure that the whole of the new drain is properly executed by the person who is carrying out the work, for if he wishes to deceive the surveyor's department it is not very difficult to do so in works of this description. It would be far better if all drains of dwelling houses could be constructed solely by the staff of the local authority, and failing any general act upon the subject, that they should be able to obtain private powers to do so.

It is illegal for anyone to touch the surface of either roadway or footpath for any purpose whatever* without the consent of the urban authority (see 38 & 39 Vic. c. 55, sec. 149), and especially to touch or interfere with the main sewers. All such work could be done better and cheaper, both for the ratepayers and the owners of property, if carried out by the trained staff of the local authority; nothing would be gained by scamping the work, and one of the worst stumbling blocks in the interests of sanitation would be removed by this simple and effective measure. Gas and water companies invariably refuse to allow anyone to interfere with their mains or services, but execute the work with their own men; how much more important is it that house drains and sewers should be equally protected. If a gas or water main or house service leaks through defective work it is quickly detected and remedied; not so with a drain or sewer, the deadly gases may be oozing

* See chapter on "Breaking up Streets."

through defective joints or the foul liquid may be poisoning the soil under the adjacent dwelling houses, and many victims may suffer before the cause is ascertained, and even then laborious legal machinery has to be put in force before it can be rectified.

The only objections that can be raised to the plan I so strongly advocate are, first, the interference with the trade connections and interests of builders and others; and secondly, the responsibility incurred by the local authority to execute thoroughly sound and good work, and the difficulty they might afterwards experience if it was necessary to find fault with their own work. The first objection should really have no weight when lives are at stake, and the responsibility incurred by the second objection ought not to be shirked.

Until some alteration is made in the present law the town surveyor must be as vigilant as he can, and endeavour to induce the public to look more closely themselves into such all-important points.

(2.) The next duty of the town surveyor is to inspect all drains of new buildings that are being constructed in his district.

I have dealt with this subject in the chapter on "New Buildings." The model bye-laws to which I have there referred contain some excellent principles in reference to this matter, and too much power cannot be given to a local authority in respect of house drains, even to the extent of prohibiting any one else to construct them. The main sewer, shared in common as it is by all the inhabitants of a town, must be looked upon as a common danger, and each house that connects with it should so far as possible be severed from it; at the same time the drain must be so constructed that the sewage reaches the sewer as quickly and as completely as possible, without any nuisance or knowledge of the unpleasant nature of its contents or those in the sewer reaching the inhabitants of the house: this is the key-note of all house

drainage, and many excellent books and descriptions of this class of work have been from time to time written.

(3.) The next duty of the town surveyor is to inspect all defective drains within his district, and serve the necessary notices, &c.

This duty is embodied in the following clauses of the Public Health Act, 1875 :

"Where any house within the district of a local authority is without a drain sufficient for effectual drainage, the local authority shall by written notice require the owner or occupier of such house, within a reasonable time therein specified, to make a covered drain or drains emptying into any sewer which the local authority are entitled to use, and which is not more than one hundred feet from the site of such house; but if no such means of drainage are within that distance, then emptying into such covered cesspool or other place not being under any house as the local authority direct; and the local authority may require any such drain or drains to be of such materials and size, and to be laid at such level and with such fall, as on the report of their surveyor may appear to them to be necessary.

"If such notice is not complied with, the local authority may, after the expiration of the time specified in the notice, do the work required, and may recover in a summary manner the expenses incurred by them in so doing from the owner, or may by order declare the same to be private improvement expenses.

"Provided that where, in the opinion of the local authority, greater expense would be incurred in causing the drains of two or more houses to empty into an existing sewer pursuant to this section, than in constructing a new sewer and causing such drains to empty therein, the local authority may construct such new sewer, and require the owners or occupiers of such houses to cause their drains to empty therein, and may apportion as they deem just the expenses of the construction of such

sewer among the owners of the several houses, and recover in a summary manner the sums apportioned from such owners, or may by order declare the same to be private improvement expenses" (38 & 39 Vic. c. 55, s. 23).

The above clause is the most simple under which this duty can be carried out, provided it can be proved that the house* is "without a drain sufficient for effectual drainage," and for this purpose it would probably be necessary to enter the premises and open up and examine the drain, unless, of course, it was a case where no drain existed to the house at all, or was evidently and notoriously without "effectual drainage." In order to enter for this purpose the requisite powers are conferred in the following clause of the Public Health Act 1875:

"The local authority, or any of their officers, shall be admitted into any premises for the purpose of examining as to the existence of any nuisance thereon, or of enforcing the provisions of any Act in force within the district requiring fireplaces and furnaces to consume their own smoke, at any time between the hours of nine in the forenoon and six in the afternoon, or in the case of a nuisance arising in respect of any business, then at any hour when such business is in progress or is usually carried on.

"Where under this Act a nuisance has been ascertained to exist, or an order of abatement or prohibition has been made, the local authority or any of their officers shall be admitted from time to time into the premises between the hours aforesaid, until the nuisance is abated, or the works ordered to be done are completed, as the case may be.

"Where an order of abatement or prohibition has not been complied with, or has been infringed, the local authority, or any of their officers, shall be admitted from time to time at all

* The definition of house is as follows:—"House" includes schools, also factories and other buildings in which more than twenty persons are employed at one time. (38 & 39 Vic. c. 55, s. 4)

reasonable hours, or at all hours during which business is in progress or is usually carried on, into the premises where the nuisance exists, in order to abate the same.

"If admission to premises for any of the purposes of this section is refused, any justice on complaint thereof on oath by any officer of the local authority (made after reasonable notice in writing of the intention to make the same has been given to the person having custody of the premises), may, by order under his hand, require the person having custody of the premises to admit the local authority, or their officer, into the premises during the hours aforesaid, and if no person having custody of the premises can be found, the justice shall, on oath made before him of that fact, by order under his hand authorise the local authority or any of their officers to enter such premises during the hours aforesaid.

"Any order made by a justice for admission of the local authority or any of their officers on premises shall continue in force until the nuisance has been abated, or the work for which the entry was necessary has been done" (38 & 39 Vic. c. 55, s. 102).

The above clause also gives the necessary powers of entry where the following clause of the Public Health Act is enforced with reference to defective house drainage, instead of the 23rd section which I have quoted.

"On the written application of any person to a local authority, stating that any drain, watercloset, earthcloset, privy, ashpit, or cesspool on or belonging to any premises within their district is a nuisance, or injurious to health (but not otherwise), the local authority may, by writing, empower their surveyor or inspector of nuisances, after twenty-four hours' written notice to the occupier of such premises, or in case of emergency without notice, to enter such premises, with or without assistants, and cause the ground to be opened, and examine such drain, watercloset, earthcloset, privy, ashpit, or cesspool. If the drain, watercloset, earthcloset, privy, ashpit, or cesspool

on examination is found to be in proper condition, he shall cause the ground to be closed, and any damage done to be made good as soon as can be, and the expenses of the works shall be defrayed by the local authority. If the drain, watercloset, earthcloset, privy, ashpit, or cesspool on examination appear to be in bad condition, or to require alteration or amendment, the local authority shall forthwith cause notice in writing to be given to the owner or occupier of the premises requiring him forthwith or within a reasonable time therein specified to do the necessary works ; and if such notice is not complied with, the person to whom it is given shall be liable to a penalty not exceeding ten shillings for every day during which he continues to make default, and the local authority may, if they think fit, execute such works, and may recover in a summary manner from the owner the expenses incurred by them in so doing, or may by order declare the same to be private improvement expenses " (38 & 39 Vic. c. 55, s. 41).

In acting upon the above clause it is well to note the machinery that is necessary in order to secure success in the event of a prosecution.

(1.) The notice to the local authority of the existence of a nuisance arising from a drain, &c., must be in writing, and that authority must then proceed to consider the notice.

(2.) If they agree to take action the local authority may empower their surveyor to enter the premises (with or without notice as the case may require) but this order to him must also be in writing.*

(3.) If the surveyor is allowed by the occupier of the premises to enter (and in default he must put the 102nd section which I have quoted in force) he may then open the ground "with or without assistants."

* Notices, orders, and other such documents under this Act may be in writing or print, or partly in writing and partly in print ; and if the same require authentication by the local authority, the signature thereof by the clerk to the local authority or their surveyor or inspector of nuisances shall be sufficient authentication (38 & 39 Vic. c. 55, s. 266).

(4.) If he finds a defective drain he must then report to the local authority in writing, unless he has been primarily invested by the local authority with such powers as will dispense with such report.*

(5.) The local authority shall "forthwith cause notice in writing to be given to the owner, &c." to do the work.

(6.) If the owner executes the work the surveyor must supervise its execution.

(7.) If this work is not done within a reasonable time the local authority "may if they think fit" execute the works; the surveyor has probably to carry them out, after having obtained the necessary permission to enter for the purpose.

(8.) The costs of the work have to be recovered.

Anyone acquainted with local government will know how difficult and tedious such processes must necessarily be, the delay between the meetings of the local authority being quite sufficient to make the matter in dispute last a considerable time, and this delay is extremely undesirable where a nuisance arising from a defective house-drain is in existence.

There seems to be no doubt that the clauses which are given in the Public Health Act 1875 empower the local authority to specify without dispute the class of work they think necessary in order to remedy any evils arising from a defective drain, but it is a pity that some more simple process cannot be introduced to improve the sanitary condition of a

* Having obtained admission to the premises, the inspection of the alleged nuisance should be so conducted as to enable the local authority to determine whether it exists, or whether it existed at the time the notice was given, and whether, although it has since been removed or discontinued, it is likely to recur or to be repeated; and in all cases it will be the most expedient course to reduce to writing the result of the inspection. When the inspection is made by an officer of the local authority, it will also be expedient for that authority, on receiving the report of their officer formally and in writing, to record the conclusions to which they have come after considering his report in order to ground further proceedings. (*Vide* 'Law of Public Health and Local Government,' by W. C. and A. G. Glen, 8th edition, p. 81.)

house without the necessity of so much laborious legal machinery.

There is still one other clause in the Public Health Act 1875, which refers to house drainage, and it is as follows:

"Every local authority shall provide that all drains, water-closets, earthclosets, privies, ashpits, and cesspools within their district be constructed and kept so as not to be a nuisance, or injurious to health" (38 & 39 Vic. c. 55, s. 40). But this clause is usually taken to apply rather to nuisances arising from temporary defects than to more important structural defects in a drain, and such nuisances come more under the cognizance and duties of the inspector of nuisances than those of the town surveyor.

It would not be possible, as I have already stated, in one chapter to give all the detail descriptions of house drains and the necessary apparatus in connection therewith, and besides very many excellent books, pamphlets and papers have been from time to time written on this important subject.* Before, however, bringing this chapter to a conclusion, I will give a list of the essential requirements of all good house drainage which may be of some use to the town surveyor:

(1.) A house drain should be constructed of stoneware pipes (not earthenware or fire clay), these are generally salt glazed, and should be perfectly smooth or even slippery inside, the pipes must be of true circular section and thickness of material, and straight in the direction of their length, with whole sockets of proper depth, and free from any cracks,

* For ample information on the subject of house drainage and similar subjects see the following books, etc.:—Bailey Denton's 'Sanitary Engineering'; Baldwin Latham's 'Sanitary Engineering'; Buchan's 'Plumbing'; Slagg's 'Sanitary Work'; Hart's 'Manual of Public Health'; Hellyer's 'Plumber and Sanitary Houses'; Galton's 'Healthy Dwellings'; 'House Drainage,' by W. A. Tylor; Philbrick's 'American Sanitary Engineering,' and many others, besides the numerous reports of the "Health of Towns Commission," and several articles in the *Sanitary Record*, the *Sanitary Engineer of New York*, and Mr. Rawlinson's 'Hints,' all of which should be studied by the town surveyor.

blisters, sand holes, or other defects. As even the most carefully manufactured pipes vary somewhat in diameter of sockets; &c., it is well to have them sorted before commencing the work; it is scarcely necessary to add that no "seconds" should be allowed on the works.

(2.) The internal diameter of the drain should not be too large; 6 inches may be considered as a maximum, 4 inches is generally quite sufficient to carry off all the sewage from an extensive establishment, even if all the water from the roofs or a portion of them is included.

(3.) The inclination is governed by circumstances, but about 1 in 60 is found to be a very convenient fall for many hydraulic, and other reasons.

(4.) The jointing of the pipes should be executed with great care; if cement joints are made each pipe should be jointed separately, and it should be seen that no cement is left in the drain. Sometimes tarred gaskin is used to prevent this, and Stanford's patent joints are excellent where running water or sewage has to be contended with, or great despatch of the work is necessary.*

(5.) The sockets of the pipes should be sunk into the ground at the bottom of the trench so as to give an even bearing, which amongst other benefits dispenses with the chance of settlements.

(6.) No pipes should be allowed to be covered in until they have been inspected by the town surveyor or his assistants, and in order to test the soundness of the joints, it is a good plan to fill the drain with water, having first stopped up the lower end, and note the effect.

(7.) Drains should not pass under buildings if it can be avoided, but if unavoidable they must be buried in good

* In some parts of the north of England taper pipes are used about 20 inches in length, the internal diameter of the larger end being slightly greater than the external diameter of the smaller end, thus allowing the small end of one pipe to enter the large end of another. Continuous lengths of cement pipes made *in situ* are also now being introduced.

concrete, and relieving arches turned to any walls passing over them. In America iron pipes are used under houses.

(8.) Care must be exercised, in filling in over pipes, not to break or injure them.

(9.) The trap to a house drain should be a "Buchan" or other similar syphon with a good cascade action, its position must be guided by circumstances.

(10.) The drain should end at the outside wall of the house and be carried up the wall its full diameter to above the roof for ventilation, an inlet for fresh air being essential on the house side of the trap; if the drain has to pass under the house it must be similarly carried up on the other side.

(11.) The connection with the main sewer has been already described.

In conclusion I would urge the necessity of a register of all drains being kept that are examined by the surveyor's department. This can be done by having a series of numbered note-books kept solely for this purpose, and all the information thus acquired should also be plotted on the map of the town if on a sufficiently large scale.

The necessity of correct plans of the drainage of buildings cannot be over-estimated, especially for hospitals, asylums, workhouses, schools, or other public buildings, and even for the smallest dwelling house such a plan would often prove to be the greatest boon to the occupier or owner as well as at all times to the town surveyor, the medical officer of health, and the inspector of nuisances.

CHAPTER XXVII.

PUBLIC PLEASURE GROUNDS AND STREET TREES.

AMONGST the clauses of the Public Health Act 1875 which affect the duties of the town surveyor will be found the following:

"Any urban authority may purchase or take on lease, lay out, plant, improve, and maintain lands for the purpose of being used as public walks or pleasure grounds, and may support or contribute to the support of public walks or pleasure grounds provided by any person whomsoever.

"Any urban authority may make bye-laws for the regulation of any such public walk or pleasure ground, and may by such bye-laws provide for the removal from such public walk or pleasure ground of any person infringing any such bye-law by any officer of the urban authority or constable" (38 & 39 Vic. c. 55, s. 164).

There are very few, if any, cities or towns in this country that have not availed themselves of this clause, even if they did not already possess one if not more public parks or pleasure grounds of some description, these having either been given by some benevolent citizen or acquired in some other manner by the urban authority.*

Included in the powers given by the above clause are no doubt those regulating the acquisition and support of recreation or public playgrounds, public walks, or old city walls or other places, and disused burying grounds.†

In connection with the above clause of the Public Health

* By the "Commons Act 1876," powers were given to acquire and lay out commons for purposes of public recreation, etc.

† Upon this latter point *Vide* 24 & 25 Vic. c. 61, s. 21.

Act, the town surveyor may have the following duties to perform:

To advise his corporation upon the value, suitability, and desirability of any site that is intended for use as a public park or recreation ground, and after its acquisition to adapt it for the requisite purposes. To effect this it must be drained and laid out with carriage-drives, walks, lawns, flower-beds, plantations, and sometimes streams, waterfalls, and lakes. He must design and erect the necessary lodges, entrance gates, fences, shelters, seats,* band-stands, and fountains, and must afterwards superintend the maintenance of these and the rest of the works in connection with the pleasure ground.

It would be impossible to lay down any rules for the guidance of a surveyor in carrying out these works, for each case must be dealt with as its exigencies require, and a great deal of common sense, as well as engineering, architectural, and artistic skill must be displayed by him in carrying out any works of this description, details of which could not possibly be given in a book of this size dealing with so many subjects.†

A few suggestions may, however, be of some service on these points.

Public playgrounds for children should be composed of large, level, well-rolled, gravelled spaces, with a few trees for shade, and some sheds for shelter. Turf soon gets spoiled and worn bare, when it is not so pleasant as well-rolled gravel, as it is far more dusty in dry weather and very damp in wet, besides having an uncared-for appearance.

* As a preservative against the malicious disfigurement of wooden seats, I have seen the following inscription placed upon some seats in an old public park, "Never cut a friend," and it had apparently the desired effect.

† As an instance of the size and importance works of this description may assume, the Bois de Boulogne, Paris, is an example. It covers an area of 2000 acres, of which one half is forest, one quarter is grass, one-eighth roads, and about 70 acres is water. One of the most beautifully arranged public parks in this country is Sefton Park, Liverpool, where the most perfect arrangements of lawns, plantations, lakes and drives, have been carried out.

In public parks, shrubs planted singly directly on the lawns without any beds around them have a very pleasing look, although it adds somewhat to the difficulty of mowing the grass. The grass itself is greatly improved if it is well dressed with manure in the spring and constantly watered all the year round.

Paths should be gravelled in the autumn, care being taken to wait until all the leaves have fallen, which are swept up and removed at once. A good fence for a path, if any protection is necessary, is either a strained wire fence or cast-iron hoops representing bent sticks. They are both cheap, and stand well against weather and rough treatment.

A very economical and neat border to the footpaths can be made from the old used-up flagstones from the foot pavements of the streets, these cut up and placed on edge, especially if in conjunction with a pitched channel gutter of pebbles, look remarkably well.

Ornamental flints make a pretty border, but they are nasty things for a child to fall upon.

For flower-beds a flat border or edge of ivy has a very telling effect. If there are ponds or lakes in the park there should be a broad path or road close to the water's edge. It is surprising what a great advantage in effect this has over the plan of leaving a strip of green between the path and the water.

The selection of the proper shrubs for a park and their distribution is a matter that requires the advice of an expert gardener. The following list of ordinary shrubs that will thrive well almost anywhere in this country may however be of use for reference:

Aucubas.
Azaleas.
Box.
Berberises.
Euonymus.
Hollies.
Ivies.
Laurels.
Lilacs.
Mahorrias.
Pampas grass.
Privet.
Rhododendrons.
Thorns.
Yuccas.

With regard to the selection of trees, this also requires skilled advice, but a list is given further on in this chapter, of trees suitable for street planting, which may be also some guide in this respect.

In high gales of wind the surveyor may be expected to endeavour to save valuable trees in a public park from being blown down. This may sometimes be effected by a judicious application of chains or ropes, but the better plan is to keep all trees well pruned and as free as possible from "top hamper" and undue leverage from overhanging limbs.

On the pruning of trees and the removal of large limbs I must refer my readers to a most admirable little book recently published in America, being a translation from the celebrated 'Treatise on Pruning Forest and Ornamental Trees, by A. des Cars," which enters most fully into the subject, and being of great practical value, should be studied by anyone who has anything to do with the care of forest or other trees.*

With regard to the planting of trees along the sides of streets, our French neighbours are much in advance of us.† It is true that in this country, owing to the much larger consumption of coal as a domestic fuel, there is more soot in the air, but it is erroneous to suppose that trees will not thrive well in England. No doubt the moisture of our climate causes the soot or "blacks" to adhere to the leaves and limbs of the trees, but for that reason deciduous and not evergreen trees should be selected for planting in towns, and these, if well chosen and carefully planted, will most undoubtedly fully repay their first cost and maintenance by the additional beauty

* 'A Treatise on Pruning Forest and Ornamental Trees,' by A. des Cars, translated from the 7th French edition, with an introduction by Charles S. Sargent, etc. Published by A. Williams and Co., Boston, U.S.A., 1881.

† In Paris in the year 1880, there were 90,000 trees in the streets, besides 20,000 more in the cemeteries. (*Vide* Report of Mr. Till, the Borough Surveyor of Birmingham, 20th December, 1880.) There are also upwards of 8000 seats in public places; the trees and seats costing nearly 100,000*l.* per annum to maintain.

to the street, the agreeable shade they cast, and their generally healthful action on the population.

In selecting trees to plant along the sides of the streets or roads in any towns, it is well to bear in mind that the following qualities are necessary :—

The tree must be hardy; it must not be affected by a long-continued drought; heat must not wither it nor make it look rusty; it must be able to withstand dust, smoke, soot, foul air, and the insidious attacks of insects, and be able to recover from any malicious or accidental injury it may receive.

The tree must be of rapid growth, and develope a straight, clean stem with shady foliage. It must be graceful either in full leaf or when bare as in winter; its roots must not require too much room, and they must be able to withstand the effects of pollution or rough treatment.

Although the foregoing list of requirements may seem rather formidable, yet amongst the trees whose names now follow there will be found some which meet many, if not all of these requirements, and which, if properly planted with all reasonable care, may be expected to thrive if planted at the sides of the streets in any town in this country.

LIST OF TREES SUITABLE FOR PLANTING AT THE SIDES OF STREETS.

Western Plane.	Sycamore.
Lime.	Copper Beech.
Maple.	Pawlonia.
Horse Chestnut.	Oilantus Glandulosa.
Elm.	Laburnum.
Tulip tree.	Lilac.
Lombardy Poplar.	Almond.
Ash.	Peach.
Willow.	Hawthorn.
Beech.	Acacia.
Birch.	Double Cherry, etc.
Oak.	

Of the above list the western plane for many reasons is the most desirable. Its freshness when it bursts into

green buds is well known, and it is proverbial for its hardiness.

The lime was at one time the most popular tree for this purpose, but it has several defects, the most notable being that its leaves wither before the summer is over, and the tree assumes a lifeless look at a time when most shade and freshness are required of it.

Of the remainder of the trees I have enumerated some are slow in growth, which is a considerable drawback; others are not wholly free from being affected by cold winds in the spring or by lice in the winter, and the assistance of an expert is very necessary in selecting trees for this important purpose.

Whatever trees are selected, the following precautions should be taken:

The young tree should have been well nourished in its nursery before removal, and should on no account be planted in the street until its stem is nearly 10 feet in height and about 3 inches in diameter. The stem should be clean and straight, and the whole tree symmetrical.

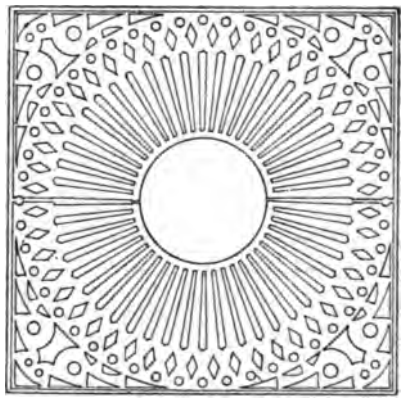
The great difficulty in this country is to obtain sufficient numbers of trees of the exact size and description, when it becomes necessary to plant out a street. They have often to be imported, when it is found that they are frequently unsuited both for soil and climate, besides being very costly; thus many failures have arisen in consequence. To obviate this necessity in Paris the Government have for many years instituted and maintained special nurseries where trees are grown for this purpose alone, these nurseries being situated at Passy, the Jardin Fleuriste, and Petit Buy, no less than 115 men being constantly employed in the work. Some further particulars will be given presently on the cost of this work.

The trees thus nourished and selected should be planted in the autumn, for there is a well-known saying that "a tree

planted before Christmas can be *ordered* to grow; if planted after Christmas it must be *asked* to do so"; and there is no doubt that if trees are planted too late in the season great difficulty in getting them to grow is generally experienced.

The excavated pits must be well drained, and filling the bottom of the pit with rubble is a good plan. The further the tree can be planted from the kerb the better, so as not only to give it a larger body of soil, but to lessen the risk of killing the tree by the pollution of the ground with gas from a defective main, and also excess of moisture from the channel gutters. The distance apart of the trees is a matter of choice. In Paris this is only 16 to 18 feet, but I think half a chain (33 feet) is quite close enough; it economises trees and gives plenty of room for the limbs of each tree to spread, and the intermediate lamp-posts, watering hydrants, or other standards are not crowded out.

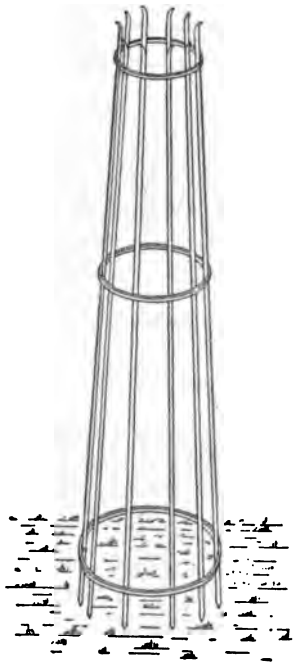
Each tree should have a cast-iron grating around its roots similar to the following drawing:—



This should be about 4 feet square. It prevents the ground getting hard about the trees, and permits air and water to enter to the roots. It also makes it easy to give any

attention to the trees that they may require when young, such as manuring, digging, &c.

The tree should also be protected with a slight iron grill or railing to prevent mischievous persons from cutting their names on the trunk, climbing up into the tree, or breaking off its branches whilst still young. The following sketch shows the description of grill necessary, which is light, cheap, and at the same time effective.



The following interesting particulars of the manner in which street planting of trees is conducted in Paris will be useful, and are given *in extenso*:*

"When the boulevarde is marked out and levelled, if the soil is of bad quality, as is nearly always the case, trenches are

* *Vide* 'The Parks, Promenades, and Gardens of Paris,' by W. Robinson, F.L.S., 1869, p. 128.

dug in the footway from one end of the boulevarde to the other. The width of this trench is usually about 6 feet, and its depth 4 or 5; and before filling it in drain-pipes are laid along the sides made with lapped joints so that the roots shall not enter between them. The trench is then filled with good garden earth, raising it a little higher than the level so as to allow for settling. In this ground the trees are planted about 6 yards apart. They should be carefully chosen with perfect roots, and moderately pruned. Formerly the stem was cut at about 9 feet from the ground, but this had the bad effect of preventing the top of the tree from being straight, and the practice has been given up. The trees are next staked and tied with wire over a neat wad of straw, which prevents all injury to the stem. A protecting cage, neither heavy nor very expensive, is placed round the tree to prevent accidents; and if the weather be at all dry at the time of planting, the trees are copiously watered."

The cost of planting a tree in the Paris boulevarde is thus given:*

	fr. c.
15 cubic metres of excavation at 4 francs	= 60·00
15 cubic metres of vegetable mould at 4 francs ..	= 60·00
Training poles about 5 metres in height	= 1·50
	121·50
Average deduction of 15 per cent. resulting from letting by tender	18·23
Price by contract	103·27
Pipe drainage and materials	11·15
Watering appliance (average)	2·50
Cast iron grating round the base	46·69
Transport of tree from nursery	2·00
Planting, including stakes	3·00
Iron basket (to protect stem)	8·70
The tree	5·00
Labour for planting	1·69
	184·00

* *Vide* 'L'Architecte,' 20th November, 1880, p. 370.

The maintenance of each tree costs 1·58 francs.

The total cost, therefore, of each tree capitalised reaches about 8*l.*, and its life is said not to exceed twelve years.

Before closing this chapter it is well to advert to the evident importance that the legislature attach to the planting and preservation of trees along the sides of the public streets in this country and their desire to protect them, as the following clause of the Public Health Act 1875 will show. "... Any person who, without the consent of the urban authority, wilfully displaces or takes up, or who injures the pavement, stones, materials, fences, or posts of, *or the trees* in any such street shall be liable to a penalty not exceeding five pounds, and to a further penalty not exceeding five shillings for every square foot of pavement, stones, or other materials so displaced, taken up, or injured; he shall also be liable in the case of *any injury to trees* to pay to the local authority such amount of compensation as the court may award" (38 & 39 Vic. c. 55, s. 149).

It is a great source of regret that mischievous persons can be found who by their wilful malice injure the trees planted at the sides of streets out of the public funds and with great expense and trouble.

CHAPTER XXVIII.

PUBLIC ABATTOIRS.

THE following is the clause of the Public Health Act 1875 which empowers an urban authority to establish public slaughter-houses (or "abattoirs" * as they are sometimes called) for the purposes of the district they govern:

"Any urban authority may, if they think fit, provide slaughter-houses, and they shall make bye-laws with respect to the management and charges for the use of any slaughter-houses so provided.

"For the purpose of enabling any urban authority to regulate slaughter-houses within their district, the provisions of the Towns Improvement Clauses Act 1847, with respect to slaughter-houses, shall be incorporated with this Act.†

"Nothing in this section shall prejudice or affect any rights, powers, or privileges of any persons incorporated by any local Act passed before the passing of the Public Health Act 1848, for the purpose of making and maintaining slaughter-houses" (38 & 39 Vic. c. 55, s. 169).

The great necessity for the establishment of one or more public slaughter-houses in any town can only fully be realised by persons who will take the trouble to inspect those which are private; they are generally placed near the shops of the butchers for the sake of convenience, the result being that they are situated in the central portions of the town and are thus surrounded by closely packed dwellings. The

* The word "abattoir" is a French word from "abattre" to fell, it is used in this country to designate a group of slaughter-houses.

† The clauses referred to are contained in 10 & 11 Vic. c. 34, and are ss. 125, 126, et seq.; they refer to the registration, licensing and management of private slaughter-houses, and need not be commented upon here.

private slaughter house often consists of a stable or shed which has been converted into an ill-designed slaughter-house, badly paved, with imperfect drainage; they are frequently not sufficiently lighted, ventilated or drained, and are utterly unfitted for the purposes for which they are used.

Their position also is often so badly chosen that the children in the vicinity resort there to see the animals killed, and the poor beasts have in some cases to be driven through a narrow passage into the slaughter-house itself, where, trembling at the sight and smell of the blood and carcasses of its dead companions, it remains tethered until its turn comes to fall a victim to the blow of the slaughter-man: a blow which sometimes has often to be repeated before its object is attained, owing to the bad light and cramped surroundings of the place.

As these slaughter-houses are generally rented by the butcher using them at large rentals (such accommodation being scarce), it is not to be expected that he will spend much money to improve property which is not his own; but notwithstanding the loss of weight incurred by the animal to be slaughtered thus fretting and sweating in its terror, the damage to the meat by its being dressed in the same locality with the live beast, steaming and smelling in the vicinity, and the exorbitant rents demanded, still there are great objections always raised by butchers in towns to the establishment of public slaughter-houses. These objections are based by them on the following grounds:

They contend that the carriage of the meat from the slaughter-house to their shop deprives them of some of their profits; that slaughtering their animals in the presence of other butchers leads to disparaging remarks and trade jealousies, and that they sometimes are robbed of fat, tools, &c.

These arguments are groundless if the public abattoir is

properly designed, is in a suitable locality, and is well managed.

There are no powers by which butchers can be compelled to abandon private slaughter-houses, and use those provided by the urban authority, so long as the bye-laws of the authority are not infringed; but as the law stands at present, private slaughter-houses may be licensed (10 & 11 Vic. c. 34, ss. 125, 126) or registered (10 & 11 Vic. c. 34, s. 127), and the only manner in which they could be closed (which would then compel the butcher to use the public abattoir) would be by putting the 129th section of the same Act in force, which states that the justices before whom any person is convicted of killing or dressing cattle contrary to the provision of the Act, or of the non-observance of any bye-law or regulation of the local authority, in addition to the penalty may suspend *the licence* for any period not exceeding two months; or in the case of the owner of any *registered* slaughter-house may forbid for any period not exceeding two months, the slaughtering of cattle therein. For a second or other subsequent like offence, in addition to the penalty the justices may revoke the licence or absolutely forbid the slaughtering of cattle in the particular house or yard. In such an event the local authority may refuse to grant any *licence* whatever to the person whose licence has been revoked, or on account of whose default the slaughtering of cattle in any *registered* slaughter-house has been forbidden.

With reference to the establishment anew of the business of a slaughterer of cattle in London, the following particulars required to be deposited by the applicant with the Metropolitian Board of Works will be useful.

A plan of the premises and sections of the building drawn to a scale of ¼-inch to the foot and showing the proposed or existing arrangements for drainage, lighting, ventilation, and water supply, with a key plan of the locality, have to be deposited, as well as replies to the following questions:

(1.) State what place for the accommodation or poundage of the cattle about to be slaughtered is provided; if such place has an entrance way for the cattle otherwise than through the slaughter-house; if separated from the slaughter-house by a brick partition with a door; and also what provision is made therein for watering animals.

(2.) State if slaughter-house and its poundage is within 20 feet of an inhabited building; and if it has any entrance opening directly on a public highway.

(3.) State if the entrance to the premises is apart from and independent of any shop or dwelling-house; if from a street at the side or rear; and also the height of the entrance gates.

(4.) State the dimensions of the slaughter-house, length, breadth, height to eaves, and construction of the roof; and give similar information about the poundage.

(5.) State if slaughter-house and poundage are drained by glazed pipes communicating with public sewer, or how; how drains are trapped; and if gratings have openings greater than three-eighths of an inch across.

(6.) State if floors are below level of outside road or footway, and if paved with asphalte, or flag-stone set in cement, or how.

(7.) State how walls of slaughter-house are constructed, and if they are covered with hard smooth and impervious material to a height of at least 4 feet; and, if so, state what material is used, and to what height it is carried.

(8.) State how slaughter-house and poundage are lighted, if with lantern, sky, or side-lights, or otherwise.

(9.) State how ventilated, if by openings, windows, louvre boards, or otherwise.

(10.) State what provision is made for water-supply, the capacity of the cistern, and at what height it is placed above floor level.

(11.) State if any watercloset, privy, urinal, cesspool, or

stable, is within, or communicates directly with the slaughter-house.

(12.) State if any rooms or lofts are constructed, or proposed to be constructed, over the slaughter-house.

(13.) State if the premises will be provided with all the necessary and most approved apparatus and tackle for the slaughtering of cattle.

Having thus far dealt with private slaughter-houses, I will now turn to the question of the provision of public establishments of the kind by the urban authority, for it is usually the duty of the town surveyor to advise his corporation upon such a matter.

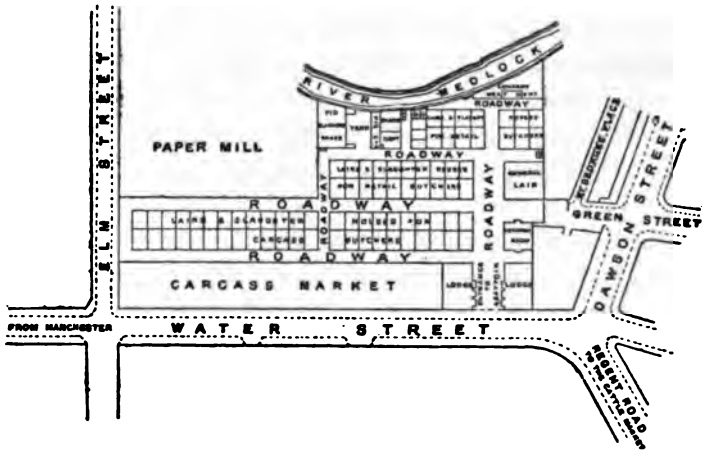
First, as to the site of the proposed public abattoir, this depends greatly upon what sites are at the command of the town; it should if possible be near the cattle market to prevent the passage of animals through the streets, not only on account of the great public inconvenience, but also the loss of weight to the animal* and the heated and bad state into which its blood becomes from the exercise, and the violent blows of the drovers' sticks.

The site would be isolated and yet not too far from the shops of the butchers, or the cost of carriage of the meat will be considerable; it is almost needless to say that it should be easily and effectively drained, and the more air with which it can be surrounded the better. It is imperative that the entrance for the live beasts should be separate from the exit of the dead meat, and the approach roads to the site should not be narrow.

In laying out the site every town surveyor must use his own judgment, but the following plan on which the site of the excellent public abattoir at Manchester is laid out may serve as some guide for this purpose, although of course this establishment is on a very large scale indeed, and is in

* An ordinary beast is said to lose 3 cwt. in weight in a journey from Edinburgh to London.

connection with a carcass market more than 500 feet in length :



PLAN OF MANCHESTER SLAUGHTER-HOUSE.

In designing an abattoir on a large scale provision for the following accommodation should be considered.

(1.) *Lairs for cattle and pens for sheep.*

These should be separated from the slaughter-house by a smaller temporary lair in which the beast whose turn has come can be fastened to the halter by which he is dragged into the slaughter-house, the sides of the door-way being lined with iron for this purpose. The paving of the lairs may be of asphalte, but care must be taken that near the door of slaughter-house, the paving is of pitchers or something that is not at all slippery, as here the frightened beast often struggles and draws back when he sees the "engines of destruction" in the slaughter-house, and smells the blood of those who have gone before.

The lairs must be thoroughly well drained, lighted, and ventilated, and troughs for hay and water placed for each beast, for although the animals are not expected to remain long in the lairs before being killed, still it is very important

that they should be well and kindly treated, and rest, so that they may obtain their normal condition before being killed.

A door easily closed should shut off the lair from the slaughter-house, as it is open to question, if animals do not see with fear the hapless fate of their comrades; for this and other obvious reasons the animals must on no account be permitted to pass through the slaughter-house to reach the lair.

The lairs should be well lighted artificially, as a great deal of slaughtering is conducted before and after daylight.

The slaughter-houses.

These may be separate or in one long building used in common by the butchers; both systems have their advantages and disadvantages.

The long building has the advantage of greater economy in erection and of management, as one inspector can see from end to end of it. Where also a large site is not available greater advantage can be taken of a slaughter-house erected on this plan, as several butchers can slaughter in turn; the lairs, however, must be kept separate. The butchers do not like this plan, but prefer privacy, and a great deal of "horse play" is sometimes indulged in by the slaughtermen at work in a large building. The method of payment for the use of a slaughter-house of this description cannot well be by rent, but by head of animal slaughtered, and this is open to the objection of possible fraud. It is necessary also to have separate slaughter-houses for the sheep and the pigs.

Whether the slaughter-houses are constructed separately or in one long building, the detail requirements are much the same.

The pavement of the floor should be placed on concrete and it should be constructed of some material that is easily cleansed, is impervious to moisture, and is not slippery either wet or dry. It must also be of sufficient durability, and be

strong enough to bear the weight of the dead-meat carts which have to back in over it under the beams carrying the carcasses, should there be no dead meat market in connection with the slaughter-house as at Manchester, Dundee, &c.

The requirements of such a floor are met by good natural compressed or mastic asphalte. The necessary holes for the reception of the flaying sticks used in many parts of England can be easily managed by inserting either small brass sockets specially made, or more simply by pieces of gas-pipe cut into lengths of about an inch set tight in the asphalte.

The walls of the slaughter-house must be of sufficient strength to carry the beams or girders of the overhead hoisting gear, as well as some tons of hanging carcasses, as will presently be explained.

The inside of these walls must be lined to a height of about 6 feet above the floor line with some material which is impervious and easily cleansed. Glazed white tiles or bricks are sometimes used for this purpose, but are apt to get chipped or broken, and I have found that asphalte, although dark in colour, answers the purpose admirably, and is much cheaper.

With regard to the drainage of the slaughter-house, this should, if possible, be so arranged that there are no gratings or gully-pits in the house itself. The floor should fall about 1 in 30 from the lairs to the cart doors, so that everything should pass outside into a gutter in which the necessary gratings and gully-pits can be arranged. If this is thought to be objectionable, pits with double gratings, the lower one being only a plate with perforated holes, can be placed in the slaughter-house so as to prevent any solid matter whatever from entering the drains, and these pits can be united by short drains with gully-pits outside. The double grating should in any case be inserted, as by this means all

solid matter is kept out of the drains: a very important consideration.

The cart doors should be made sliding, and not hinged, or great inconvenience will be experienced, and they must be made wide enough for the carts to back in easily.

In some slaughter-houses the killing ring to which the beast is attached whilst the blow from the poleaxe is given * consists of a strong horse-shoe shaped piece of iron projecting about 24 inches from the wall at a height of about 18 inches, and having a ring in the top curve, thus—

whilst in others the killing ring is on the floor, thus—

and in others an iron pillar standing up from the floor is used, which is considered the best plan, as the beast should stand in a natural and easy position at about a right angle from the feller.

The lighting of the slaughter-house should be effected from the roof, as a good and steady light is essential to the men engaged in this business. An awkward cut may seriously damage good beef or mutton. Care must, however, be taken to exclude the glare of the sun, and the ventilation should be carefully arranged by louvres easily manipulated.

* The pole-axe should be of the American pattern, which has a head hollow and very sharp round the periphery. The practise is, after the blow is struck and the animal felled, to plunge a thin cane into the wound, which passes down the spine, causing instantaneous death whilst the animal is lying stunned.

Water should be plentifully laid on at a good pressure, so as to ensure thorough flushing, &c., and the necessary taps should be recessed in the walls, as everything in a building of this description should be kept as flush as possible, or it will be damaged. In some slaughter-houses hot water is laid on, and this is a great boon to the butchers and much appreciated by them.

Gas must of course be laid on, as much slaughtering takes place during the night.

The machinery for hoisting the beasts and slinging the carcasses requires to be effective, simple, and very strong, as it is subjected to the roughest treatment, and such machinery has been patented and is erected by Messrs. John Meiklejon and Son, of Dalkeith, on very reasonable terms.

This machinery hoists the beast by simply pulling on an endless chain. It remains suspended at any height, and can be equally easily lowered. The divided carcass can be placed upon hooks at any point along the girders above without being touched, and it can be taken off again and lowered on to a man's shoulders or into the cart direct, and in fact, speaking from my own experience, this machinery is very perfect.

* The following is from the patent specification of this machinery :

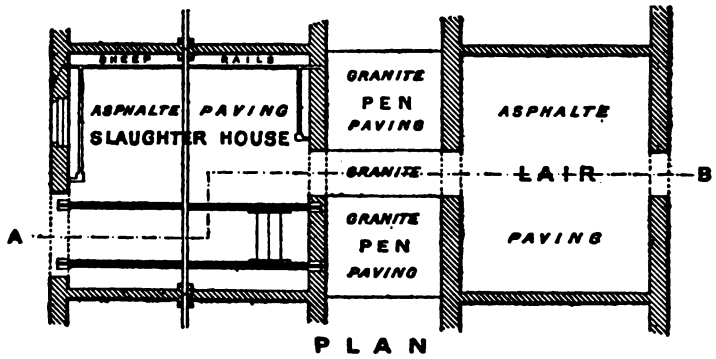
"Letters patent to John Meiklejon, of Westfield Iron Works, Dalkeith, in the County of Mid-Lothian, Scotland, for the invention of new or improved machinery and appliances to be used in hoisting, removing, dividing, and hanging on hooks, taking off these hooks again, and loading carcasses and other bodies in abattoirs, carcass and meat markets, and other places."

"The machinery and appliances above referred to enable the operations above named to be performed without the necessity of the butchers touching the meat. Also enables carcasses to be conveyed from abattoirs to carcass market on a travelling hoist (hereafter described), same being provided with rows of fixed jointed hooks or loops, attached to rails on which the hoist runs, so that the travelling hoist is enabled to hang the carcasses or bodies on to such hooks or loops. Also enables a butcher to hang a carcass on any of these hooks or loops, and pick them off again, and load on a vehicle, without moving or touching any of the other carcasses hanging on the other hooks. Also enables all operations to be performed, from hoisting when killed to loading when sold or removed from market."

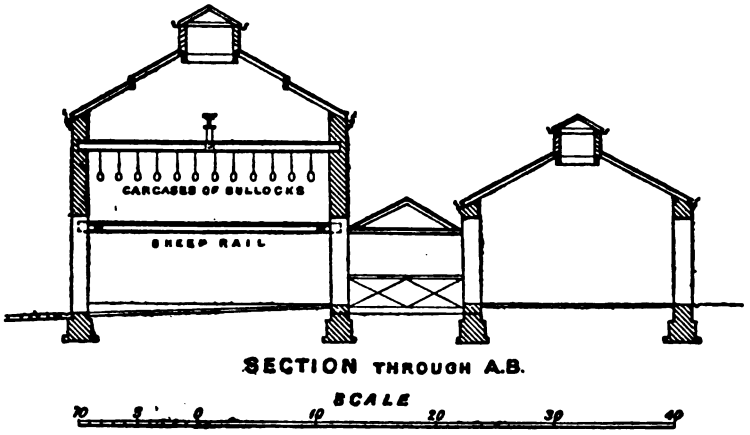
The carcasses of the sheep are hung by hand upon hooks projecting from rails which are placed at a convenient height around the walls of the slaughter-house.

In some abattoirs the sheep slaughter-houses are distinct from those used for killing beasts, and this method has many advantages.

Before proceeding to describe the further requirements of an abattoir or group of slaughter-houses, I think the following plan will be of use to show the arrangement which I have described with regard to lairs and slaughter-houses :—



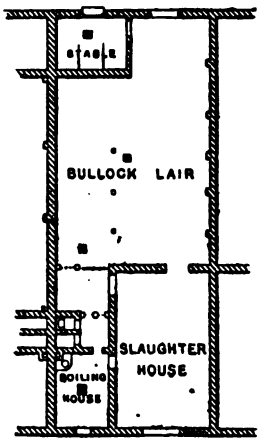
PLAN



SECTION THROUGH A.B.

SCALE

The following plan shows the arrangements adopted in the Metropolitan Cattle Market slaughter-houses:



METROPOLITAN CATTLE MARKET SLAUGHTER-HOUSES.

(3.) *The condemned meat department.*

This should consist of a lair for suspected cattle, a lair and slaughter-house for the condemned cattle similar to that already described, and a condemned meat store: this being the place where not only all the diseased animals' carcasses are temporarily stored pending destruction, but also any meat of sound beasts that may have gone bad after killing, &c. The whole of the meat thus placed in the condemned store must be taken to the boiling-down house, where it is destroyed by being boiled down to fat, which is disposed of for various trade purposes.

The following description of the method employed for this purpose at the Deptford Foreign Cattle Market will here be of use:*

"There are several killing houses for diseased cattle, and excellent apparatus for boiling down condemned meat. For

* *Vide* 'Report on the New Cattle Market and Abattoirs proposed to be erected at Carolina Port, Dundee,' by William Mackison, F.R.I.B.A., &c.

this purpose two boilers are suspended from a strong platform through which they pass, and the bottoms of them are several feet above the floor. They are each 4 feet 6 inches in diameter and 10 feet in length under platform. At the bottom the cylinder tapers to 2 feet 8 inches in diameter. Under this there is a semispherical bottom to the boiler hinged and kept shut by a back-weighted lever and screws. On the top of each there is a semispherical cover and safety valve.

"There is an iron crane and windlass for lifting off and on the covers. After the boilers are charged with diseased meat the covers are made secure and steam let into them near the bottom. There is a cock in the bottom of each for running off the liquid at certain stages into a trap grating in the floor under it, and conducted into a cement cistern outside of the boiling-house, from which it is periodically removed. Whether any use is made of the tallow produced I am not informed. The bones when removed are quite porous, of a very white colour, and nearly as light as cork. I presume that they will be sold for being converted into bone manure. I understand these large boilers are not very often used, and that a small close galvanized iron cylinder, 2 feet 9 inches in diameter, and 2 feet 6 inches high, placed 15 inches above the ground, having cock at bottom, steam pipe at side, and portable lid, does most of the work very efficiently."

(4.) *The pig-killing department.*

This should be separate from the ordinary slaughter-house, as the styes for pigs must be differently arranged to the cattle lairs, and a boiler house is necessary, as boiling water must be had for scalding and dressing the carcasses. Special iron troughs with false bottoms have been arranged by Messrs. Meiklejon, which greatly facilitate this part of the butcher's work, and simple hoisting apparatus over these troughs lifts the carcase in and out, and carries it off to the cooling or hanging room, which must of necessity be separate from the killing and scalding rooms. Drainage, lighting, ventilation

and floors should be similar to those described for the slaughter-houses, and plenty of lime wash can be used with advantage here as well as in the main slaughter-house.

(5.) *The blood house.*

The blood of the slaughtered animals, which formerly was allowed to run away, has been found to contain a most valuable aniline dye, and for this purpose it is now collected and taken to the blood-houses, where in order to obtain this dye it is necessary to place the blood in shallow tins, where it is warmed by steam-pipes, the liquid is then drawn off, which is the albumen from which the dye is extracted, the residuum left in the trays is of the consistency of jelly, and is sold for manure.

(6.) *The tripery.*

This is provided in large abattoirs for the purpose of preparing the tripe and feet of the slaughtered animals, and in the Glasgow public slaughter-houses this is effected by the corporation free of charge by special machinery adapted for the purpose.

(7.) *The tallow market.*

Where tallow is melted down, and moulded in shapes for manufacturers' uses.

(8.) *The hide store.*

This is where the hides and sheep skins are weighed and temporarily stored, sometimes in connection with this are—

(9.) *Sale rooms;* for the hides, skins of sheep, &c., and tallow.

In addition to the above requirements may be mentioned,

(10.) *A superintendent's dwelling-house and office.*

(11.) *A gate keeper's dwelling-house and office.*

(12.) *A weighing machine and office.*

(13.) *A convenient room* for the meetings of the committee of the corporation having charge of the slaughter-house.

(14.) *Waiting rooms* for dealers, drovers, slaughtermen, and butchers, &c.

(15.) *Store-rooms and a joiner's workshop.*

(16.) *Stables and shedding* for the horses and carts of the jobbers and butchers, &c.

(17.) *Lofts for straw and hay;* the former should be provided free by the corporation, the latter on payment of so much per diem for each beast.

(18.) *The necessary urinal and w. c. accommodation.*

With regard to the provision to be made for storing the dung and waste refuse from public slaughter-houses, I am strongly of opinion that there should not be any fixed receptacle for such matters, but that covered carts should be provided, which could stand in convenient positions and be removed every day, a fresh and clean cart being substituted at once for the one removed; by this means all nuisance is avoided.

Speaking of public abattoirs, in a recent lecture on Industrial Nuisances, Dr. C. W. Chancellor, of the Maryland State Board of Health U.S.A., gives some advice on the management of slaughter-houses. He says: "During the process of slaughtering as much care as possible should be taken to prevent the discharge of blood or other animal matter upon the floor of the slaughter-house, upon the surrounding earth, or into an open stream. The contents of the viscera should, with the blood, offal and other garbage, be placed in impervious, covered, moveable receptacles, constructed of galvanized iron or other non-absorbent material, and removed from the premises without undue delay. Where hides or skins are necessarily retained for a day or two before they can be removed, they might without injury be advantageously brushed over on the fleshy side with a solution of carbolic acid or some other antiseptic. Fat should be freely exposed to the air in a cool place. As soon as the slaughtering is completed the whole slaughter-house, floor and walls, should be thoroughly washed. All the vessels and implements used in the slaughtering should be kept clean and sweet. Deodorizers may sometimes be used with advantage."

There can be no doubt that whereas private slaughter-houses are frequently a most injurious nuisance to the neighbourhood in which they are placed, owing to their situation and construction, and a visit to one of them is likely to give a strong impetus to vegetarianism, the public abattoir, on however large a scale, if properly constructed and managed, need be no nuisance whatever, and every town in the kingdom should endeavour to obtain one, not only on account of the nuisance caused by private slaughter-houses, but for the incentive which is given to butchers to abstain from slaughtering diseased or unwholesome animals, the prevention of cruelty, and the material benefits derived in a proper establishment for the best methods of dressing the meat.

CHAPTER XXIX.

MARKETS.

UNDER certain conditions urban authorities are empowered to provide markets in their district by the following clause of the Public Health Act 1875 :

" Where an urban authority are a local board or improvement commissioners, they shall have power, with the consent of the owners and ratepayers of their district, expressed by resolution passed in manner provided by Schedule III. to this Act, and where the urban authority are a town council they shall have power, with the consent of two thirds of their number, to do the following things, or any of them, within their district :

" To provide a market place, and construct a market house and other conveniences, for the purpose of holding markets :

" To provide houses and places for weighing carts :

" To make convenient approaches to such market :

" To provide all such matters and things as may be necessary for the convenient use of such market :

" To purchase or take on lease land, and public or private rights in markets and tolls for any of the foregoing purposes :

" To take stallages, rents and tolls in respect of the use by any person of such market :

" But no market shall be established in pursuance of this section so as to interfere with any rights, powers, or privileges enjoyed within the district by any person without his consent " (38 & 39 Vic. c. 55, s. 166).

In many towns, markets both for cattle and general merchandise have been already established, and the duties of the town surveyor are simply to execute the necessary altera-

tions and maintenance of the buildings in connection with them, but there may be occasions on which he has to advise his corporation upon the acquisition of land for the purpose of laying it out as a cattle market, and afterwards the erection of the necessary pens and buildings, and a few remarks upon the subject may be of some service.

The site for a cattle market should be selected, if practicable, near to a railway station, so as to avoid as much as possible the dangerous and objectionable practice of driving cattle and sheep through the streets, and for the same reasons it should be near the public slaughter-houses if there are any in the town. Plenty of space should be provided in the market for the cattle to move about in, for it must be remembered that many of them which are sent to market are unused to the bustle of a town, and are wild and untractable, and have never in their lives been subjected to either penning or tethering.

The site must be easily and effectively drained, it should be somewhat isolated with respect to neighbouring buildings, the more air that can be got to sweep through it the better.

The accommodation necessary in a cattle market must vary considerably with the requirements of the district, but the following list may be given for selection:

(1.) Pens or lairs for fat beasts.

(2.) Pens or lairs for store cattle.

(3.) Pens or lairs for cows with calves.

(4.) Pens or lairs for calves.

(5.) Pens for sheep.

(6.) Pens or styes for pigs.

(7.) Covered sheds or stables for horses.

(8.) A space for showing horses off.

(9.) Sheds for agricultural implements.

(10.) Shops for the display of seeds, ropes, tarpaulins, sacks, etc.

(11.) Accommodation for auctioneers.

(12.) Lodges and offices for the superintendent or gate keeper.

(13.) A weighing machine and office.

(14.) A corn exchange (this is sometimes provided in the general market).

The entrance to a cattle market may with advantage be provided with double sets of gates, with a space between in which flocks of sheep or herds of cattle can be temporarily penned; a wicket gate in the second set of gates will enable the toll collecter to count the number of animals easily as they pass through into the market.

The paving of the market should be of granite pitches, as it is essential that it should not be slippery, or the cattle, which usually arrive in a very excited condition, will fall and injure themselves; this description of paving is also fairly impervious, and is easily cleansed.

The paving of the lairs and pens may, however, be of asphalte.

For the cattle there may be enclosures for loose bullocks as well as divisions in which the cattle are tethered; these divisions and enclosures may be constructed of brick walls about 4 feet 6 inches in height, or posts and rails of wood and iron, strongly fastened iron rings about 4 feet apart are necessary to which the beasts must be tethered.

The paving must be kept high towards the head of the beast in order to show him off to the greatest advantage.

Large painted signboards should be fixed over the entrance of each compartment, to designate to which class it belongs, in order to avoid confusion or mistake. There should be drinking troughs for all cattle, and hydrants should be fixed all about the market, so that it can be thoroughly flushed and washed down.

The sheep-pens can be constructed with iron or wood posts and rails with the whole of one side opening as a gate, they should be about 3 feet in height, and the floor should

slope up from the point at which the purchaser will stand in order that the sheep at the far end of the pen may not appear diminutive.*

The gates of the sheep-pens should be strongly stayed, as they make most convenient seats on which the drovers and heavy farmers sit whilst they drive their bargains.

With regard to the dimensions of the pens and lairs, the following sizes are suggested as sufficient spaces for different animals, in the modern bye-laws, emanating from the Local Government Board in 1877, with respect to markets:

For every horse	8 feet by 2 feet.
For every ox or cow	8 ,, ,, 2 ,,
For every mule or ass ..	5 ,, ,, 1 feet 6 inches.
For every calf	5 ,, ,, 1 ,, 3 ,,

For every sheep, goat or pig (of medium size) 4 feet superficial.

The pens for calves and the styes for pigs should be covered, and their floors should be about 3 feet 6 inches above the general level of the market, as animals of this description are generally brought in carts, and they could thus be easily moved out and in.

These pens and styes must of course be thoroughly well drained and ventilated.

* The following is a description of the manner in which the sheep are penned in the cattle market of la Villette at Paris :—"The enclosures or pens are all of iron, those for the sheep have a centre railing 3 feet 3 inches high, and cross railings 1 foot 9 inches high; the former with three horizontal rails and vertical rods, and the latter two horizontal rails and vertical rods. There is a distance of 15 feet betwixt the high railings, which is divided into three by iron posts 21 inches high. The first row of these posts is placed at a distance of 3 feet from the low cross railing at the passage, the second row 18 inches from the first, the third 3 feet from the second, and so on. The sheep are placed in line side by side as close as they can stand, with their heads up to the low rail. A moveable hurdle of wood is then set on edge between the sheep in rear and the iron posts just described. A passage of 18 inches is left clear, and then another row of sheep and another passage, and so on. In this manner a great number of sheep are put into little space, in such a way as all can be examined with the greatest ease." (*Vide* 'Report on the New Cattle Market and Abattoirs proposed to be erected at Carolina Port, Dundee,' by W. Mackison, F.R.I.B.A., &c., Town Surveyor, Dundee).

With regard to the weighing machine, this should be of the best manufacture, and be of sufficient size to weigh a large wagon. It is better to have what is called a "self contained" iron foundation, and pit for the weighbridge rather than one of masonry. A convenient size for this weighbridge would be 15 feet in length by 12 feet in breadth.

With reference to the rest of the provisions I have enumerated, they require no special comment, but must necessarily be left to the discretion of the town surveyor and the wishes of his corporation.

Markets for general merchandise are usually handsome buildings, which are erected in the most central positions of the town; they contain:

(1.) The corn exchange (this is sometimes erected in the cattle market).

(2.) The fish market.

(3.) The dead meat market (this is sometimes erected in connection with the public slaughter-houses).

(4.) The game and poultry market.

(5.) The fruit, vegetable and flower market.

(6.) The butter, eggs and cheese market.

(7.) The miscellaneous goods market.

(8.) Public conveniences.

(9.) Offices and dwelling for the clerk of the market.

(10.) Committee room for the market committee.

The floor of the market should be on a level as much as is practicable with the adjacent streets; steps up or down are objectionable for the public, and galleries or upper floors should also be avoided unless the available area of the site is limited.

The interior of the building should be lofty, and it must be thoroughly well ventilated; the great fault with nearly all existing markets is the cutting draught to which buyers and sellers are usually subjected.

Plenty of light is essential, but the rays of the sun should

be excluded by frosted glass or other contrivance, or the goods exposed for sale will be damaged.

The floor should be of asphalte or other similar material; it is surprising what a "mess" is always made in a market.

The stalls must be so arranged as to show to best advantage the goods offered, and plenty of "gangway" should be left between them for the passage of the public.

Fish stalls should be constructed of iron, slate or similar material, plenty of water being provided in this department; fish-washing troughs filled with running water are very desirable, and a fountain can be introduced with pleasing effect.

Butchers' stalls should be of thick wood to resist the chopping, and plenty of standards and rails provided with iron hooks must be fixed above them.

A great number of moveable iron "offal boxes" should be placed in different parts of the market, which must be cleared at least once a day, and the market should be frequently flushed and cleansed with water from hydrants fixed in different parts of the building.

Many other points will no doubt suggest themselves to town surveyors, who have the important work of designing either cattle or general markets to undertake, but the few suggestions which have been given may be of some use.

CHAPTER XXX.

CEMETERIES.

AMONGST the many duties that a town surveyor has to perform is sometimes included that of laying out land for a large burial ground or cemetery, and its management after construction. Power is given to all local authorities to become burial authorities by the Public Health Interments Act 1879, and so strongly is the need felt for what is called extramural interment, that the Local Government Board may compel a local authority to provide and maintain cemeteries. Power is also given for the compulsory purchase of land for this purpose (see sections 175, 176, of the Public Health Act 1875), and the cemetery may be placed either within or without the district over which the local authority exercise their jurisdiction, and many other privileges are granted in order to encourage the acquisition of land so far removed from habitations as to make the burial ground as sanitary as the practice of burying human bodies can be made.

Land once consecrated or used for burial cannot afterwards be sold or used for secular purposes, except of course by an Act of Parliament; "footpaths may, however, be provided in a consecrated but disused burial ground, and the ground may be planted, so as in effect, though not nominally, to make it a public garden." *

A cemetery must not be constructed within 200 yards of any dwelling house, without the consent in writing of the owner, lessee, and occupier of such house; but there is no prohibition upon anyone to prevent their

* *Vide* 'Fitzgerald's Public Health Act,' p. 130, 3rd edition.

building a house close to a cemetery after it has been established.*

Chapels may be built in cemeteries for the performance of the burial services, and the grounds may be laid out and embellished as the local authority may deem fit. The cemetery must be enclosed by walls or other sufficient fences or iron railings 8 feet in height; it must be properly sewered and drained, but such drainage must not flow into any "stream, canal, reservoir, aqueduct, pond or watering place."†

Cemeteries are divided into consecrated and unconsecrated portions by bond stones or other suitable marks; a chapel must be built upon the consecrated portion, although it does not seem to be compulsory to do so upon the unconsecrated portion.

The selection of a proper site on sanitary and other grounds for a cemetery is one of the greatest importance, and a town surveyor, or anyone who has this duty to perform, cannot do better than keep the following words of the well-known sanitary engineer Mr. Eassie before him:‡

"A well-chosen cemetery is one whose soil is dry, close, and yet porous, permitting the rain and its accompanying air to reach a reasonable depth, and so expedite decay. The formation is also well covered with vegetable mould, which assists in neutralising any hurtful emanations, and encourages the growth of shrubs. The subsoil is also of such a kind as to need no under draining, and such as will prevent the water lodging in any grave or vault. It will also stand exposed to the north or north east winds which are dry, and which do not hold the putrefactive gases in solution, like the moist south or south westerly winds."

"An improperly chosen graveyard may be said to be one where the soil is dense and clayey, and impervious to

* *Vide* 'Fitzgerald's Public Health Act,' p. 131, 3rd edition. Foot note to clause x. Cemetery Clauses Act 1847.

† Cemetery Clauses Act 1847, s. 20.

‡ *Vide* 'Cremation of the Dead,' by William Eassie, C.E. &c. &c., p. 50.

moisture. It will be insufficiently drained, necessitating the use of planks to walk upon in wet weather. It will be too close to the abodes of the living, too small to permit proper planting, the graves covered, it may be with flat stones which prevent the passage downwards of the air and rain, and surrounded moreover by high walls which exclude the fresh air. The ground will be stony and insufficiently covered with vegetable soil. No natural outfall will exist, and the drainage water must be pumped up, the bare idea of which is horrible. It will be near also to water-bearing strata, or to a reservoir. Long before decomposition has taken place owing to the smallness of the site, and the impossibility of obtaining any more land except at high building prices, the organic matter hidden out of sight will be far too large in proportion to the area."

Dr. Parsons, in a memorandum prepared by him on the "Sanitary Requirements of Cemeteries" and published by the Local Government Board in their eleventh annual report, says:

"The soil of a cemetery should be of an open, porous nature, with numerous close interstices, through which air and moisture may pass in a finely divided state freely in every direction. In such a soil decay proceeds rapidly, and the products of decomposition are absorbed or oxidised. The soil should be easily worked, yet not so loose as to render the work of excavation dangerous through the liability to falls of earth. It should be free from water or hard rock to a depth of at least 8 feet. If not naturally free from water, it should be drained if practicable to that depth: to this end it is necessary that the site should be sufficiently elevated above the drainage level of the locality, either naturally, or, where necessary, by filling it up to the required level with suitable earth."

"Loam, and sand with a sufficient quantity of vegetable mould, are the best soils; clay and loose stones the worst.

A dense clay is laborious to work and difficult to drain; by excluding moisture and air it retards decay, and it retains, in a concentrated state, the products of decomposition, sometimes to be discharged into graves opened in the vicinity, or sometimes to escape through cracks in the ground to the surface. A loose, stony soil, on the other hand, allows the passage of effluvia."

And with reference to the site to be chosen for a cemetery he further states:

"Nevertheless, in view of the evils which in former times have undoubtedly arisen from the practice of intramural sepulture, and also because the erection of houses near a cemetery interferes with the free play of air around and over it, it is desirable that the site of the cemetery should be in a neighbourhood in which building is not likely to take place, and also that so far as practicable a belt of ground should be reserved between the graves and the nearest land on which a house may be built, in order to obviate to some extent the risk of contamination of ground-air and subsoil water with decomposing matters. This is especially necessary where houses are constructed with cellars. It is, therefore, highly desirable that interments should not be made up to the extreme edge of the cemetery, and it would be possible without great waste of space to reserve in all cases a strip of ground free from interments, 15 to 30 feet in width, around the whole cemetery on the interior of the boundary fence. This strip would afford room, on the inside for a gravel or asphalte walk to give access to all parts of the cemetery, and on the outside next the fence to a belt of shrubs or trees, the rootlets of which, penetrating the soil, would arrest and assimilate any decomposing matters percolating to the exterior of the cemetery. Obviously a cemetery should not be placed on elevated ground above houses, where the soakings from it may percolate to the sites and foundations of the dwellings below. . . ."

"Sites are of course unsuitable which are liable to be flooded or to landslips, or which are in danger of being washed away, or encroached upon by streams or the sea. Very steep sites are not desirable. The cemetery should be accessible by good roads from all parts of the district."

As to the unsuitability of clay as a soil for cemeteries, Louis Créteur in "Hygiene in the Battle Field" says, that the bodies of soldiers slain during the Battle of Sedan were buried in chalk, quarry rubble, sand, argillite, slate, marl, or clay soils, and the work of disinfection lasted from the beginning of March till the end of June. In rubble the decay had fully taken place, but in the clay the bodies kept well, and even after a very long time the features could be identified.

With regard to the amount of land necessary for a cemetery, Dr. Parsons calculates that about a quarter of an acre of land for every thousand of the population of the community to whom the cemetery belongs, is the "usually estimated minimum," but this is far too small a proportion even for a cemetery possessing every advantage, and he further states, "The desirability of providing more than this bare minimum of space is obvious, and is generally recognized." It must be remembered that as a rule, quite one-sixth of the total area of a cemetery is taken up by the roads, paths, ornamental grass or beds of flowers and shrubs, the chapels, mortuaries, lodges, &c., and sufficient width should be allowed between each grave space to permit every grave being reached without trampling on others: a standard of 110 burials per acre has sometimes been taken, but this appears to me to be rather a small one.

In laying out ground for a cemetery, the following are some points that require careful attention:

(1.) The position of the entrance or entrances; there should if possible be only one, as a lodge is necessary at each, which entails expense.

(2.) The best position for the lodge or lodges, the chapels and mortuary.

(3.) The direction of the roads in the cemetery: these must be wide enough for the hearses and mourning coaches, and there must be convenient places provided for turning round.

(4.) The direction of the paths:* these and the roads should be as straight as possible, so as to economise available burial ground, paths should be sufficiently wide to allow an entrance to be made in them to the adjoining vaults or walled graves, these being frequently covered with a massive tomb or ledger very difficult to remove. The vaults and walled graves, being of a better class, are generally put in the borders of the burial ground, close to the paths.

(5.) In some soils deep and careful drainage is necessary. This should be carried out with ordinary drain pipes laid at a depth of at least 10 feet, and so communicating with each other and the grave spaces, that even in a clay soil each grave as it is sunk should be found free from water.

(6.) Surface drainage, especially of the roads and paths, is also necessary.

(7.) Provision must be made for the disposal of the soil excavated from the graves, as very little punning or ramming of the soil thrown in after a burial should be permitted, and thus there is always a large quantity of material to be otherwise disposed of.

The cemetery must be divided into Church or consecrated ground, Dissenters' ground, and Roman Catholic ground, in such proportions as may be found to suit the particular requirements of the locality in which the cemetery is placed.

These divisions must again be subdivided into sections according to the class and description of the proposed grave, and each of these subdivisions and grave-spaces must be

* The roads and paths in a cemetery require to be carefully made, in order that they may be available during any weather.

accurately marked with a distinguishing letter and number, so that on reference to a plan and a register book, any person's grave may be easily found, however long a time may have elapsed since the interment took place, and although no headstone or mark over the grave is there. It is needless to say, that the plan of the cemetery has to be most carefully prepared, and the ground equally carefully set out, to prevent any chance of error occurring, or serious consequences might result. It may be well to remark that no body can be removed after burial without an order from one of Her Majesty's principal Secretaries of State, or by faculty from the Bishop in consecrated ground.*

The following description of the different sections necessary in a large cemetery may here be of use, the fees chargeable for the privilege of burying in each section advancing with the letters appropriated to the sections.

Section A. This is appropriated to workhouse paupers or very poor persons only,† the depth‡ of the grave may be limited to 6 feet, and the size should be 9 feet by 4 feet; only coffins made of wood should be allowed in this section.§

* 20 & 21 Vic. c. 81, s. 25.

† The following is a description of the manner of burying the poorer people in the cemetery of Pere la Chaise, near Paris. (*Vide* 'The Parks, Promenades, and Gardens of Paris,' by W. Robinson, F.L.S., &c., p. 109.) "A very wide trench or fosse is cut wide enough to hold two rows of coffins placed across it, and 100 yards long or so. Here they are rapidly stowed in one after another, just as nursery labourers lay in stock 'by the heels,' only much closer, because there is no earth between the coffins, and wherever the coffins, which are very like egg-boxes, only somewhat less substantial, happen to be short so that a little space is left between the two rows, those of children are placed in lengthwise between them to economise space; the whole being done exactly as a natty man would pack together turves or mushroom spawn bricks." . . . Let us hope that whatever else may be "taken from the French," we may never imitate them in their cemetery management.

‡ Depth of burial varies from 6 to 10 feet, but there must be 4 feet of earth upon the top of the last coffin if an adult, 3 feet if a child.

§ A proper grave should be dry when opened, and have a sufficiency of soil over the coffin to absorb any gases of decomposition; it should allow an adjoining grave to be opened without collapsing, and should if possible dispense with the necessity of shoring or close timbering the sides, and should allow sufficient space for a headstone to be placed over it.

Section B. This is of a slightly superior class to the last, the depth and size may however be the same, but a larger fee can be charged, and the position of the section with reference to the paths should be better and more convenient.

Section C. This is again superior to either of the former sections. Extra depth and size may be allowed, and the position should also be better.

Section D. In the previous sections only "common" graves as they are called should be allowed. In this section either walled graves, vaults, tombs or common graves may be placed, the common graves may be of extra depth and size, the space for a vault may be 8 feet 6 inches by 6 feet.*

This section should be exclusively the borders of the paths and other spots easily accessible and prominent to view.

Section E. This is the best section. No common graves should be allowed in it, and the spaces allotted for burial may be isolated and of various sizes according to agreement and payment. Here costly tombs and monuments are erected, the position of the section being generally near the chapels.†

In all the above sections it is necessary to provide for the burial of children: these require smaller space and in some instances they can be buried with their mother, but in separate coffins. Unfortunately it is necessary to allow rather a large percentage of available space for the interment of children, as the infant mortality in this country is so excessive.

In connection with the question of the plan and the sections

* In a tomb or walled grave, the coffin should be enclosed in an air-tight case, by means of a stone cemented down which must never again be moved; or concrete may be used. It is a good plan to put some charcoal with the coffin to absorb any gases of decomposition in case of the vault opening accidentally at any future time, and in order to guard against such an occurrence it is better to leave at least 2 feet of earth on the top of the grave below the surface of the ground in walled graves.

† "No body shall be buried in any vault under any chapel of the cemetery or within 15 feet of the outer wall of any such chapel." (*Vide* s. 39, Cemetery Clauses Act 1847.)

for burial, it may be well to give the following rules and regulations for the management of a cemetery :

Cemetery Rules and Regulations.

(1.) All charges for interment, monuments, and gravestones must be paid at the time the order is granted ; no kind of work allowed to be done, or any corpse brought on the ground without the production of an order.

(2.) Certificates of death to be produced (showing the name of the parish, &c., and all other requisite information) on paying the fees.

(3.) Two days' notice to be given for interment in graves, (exclusive of Sunday,) and three days if a vault or brick grave be required. In default, an extra charge will be made for working by night.

(4). The time when the funeral procession will be on the ground to be named in the notice. An extra fee of will be charged when the funeral procession is minutes later than the time appointed, and for every minutes afterwards.

(5.) The hours of interment are from A.M. to P.M. from Michaelmas to Lady-day, and from A.M. to P.M. from Lady-day to Michaelmas.

(6.) All brick or stone work in the graves, and all foundations and fixing of memorials, or planting, shall be under the supervision and control of the local authority or their appointed agent.

(7.) No grave or vault shall be re-opened by other persons than members of that family without the written consent of the parties interested and of the local authority. An extra fee for the interment of strangers will be charged at the discretion of the local authority.

(8.) In all unbricked graves, coffins of wood only shall be used. No interment will be allowed nearer the surface than four feet for an adult, or three feet for a child under 12 years.

Every coffin in a bricked grave or vault to be separately entombed in an air-tight manner.

(9.) No palisades or iron railings to exceed feet in height, except with the special consent of the local authority; and no palisades, or enclosure of any description will be permitted to a grave until a headstone or tomb has been erected.

(10.) A drawing of every monument or gravestone to be submitted for approval, and a copy of the intended inscription, if it contains more than name, age, and date. Inscriptions to be arranged so as to face the paths as far as practicable. Any question which shall arise touching the fitness of any monumental inscription, placed in any part of the consecrated portion of the ground, shall be determined on appeal by the Bishop of the Diocese.

(11.) All graves and vaults, monuments, gravestones, fencing or other enclosures, to be kept in repair by the persons interested in their preservation. If suffered to go out of repair and become unsightly, the local authority will remove them altogether, and they will not be allowed to be replaced without the consent of the local authority. Graves will be kept in order by the local authority for a fee of per annum.

A plan of the ground, showing each grave space, is kept at the office of the surveyor to the local authority and may be seen without charge.

The public are admitted to the cemetery, on weekdays, from 7 A.M. to 8 P.M. from Lady-day to Michaelmas, and from 8 A.M. to 5 P.M. from Michaelmas to Lady-day. On Sundays, from 2 to 8 P.M. in summer and 2 to 5 P.M. in winter.

All further information may be obtained at the office.

The local authority forbid any gratuity being received by their servants.

The local authority reserves a right, from time to time, to make any alteration in the foregoing charges and regulations.

In connection with the above rules, a scale of fees of the charges for interments must be prepared as well as for head-stones, foot-stones, ledgers, and tombs, or for enclosing any grave with kerbing, iron-railings, posts and chains, &c.

The practice of allowing persons to plant small shrubs and trees upon the graves of their friends, should be deprecated, as not only do they tend eventually to make a cemetery look untidy but they are placed so close to the graves that when they grow up their roots often split open a vault or walled grave, and even damage valuable tombstones.

Trees which are suitable for cemeteries, and which would thrive even in a town atmosphere, are the weeping willow, cypress, yew, cedar, juniper, birch, ash, weeping elm, and a considerable number and variety of drooping and other deciduous trees. These should, however, be planted under the control of the local authority, as otherwise a cemetery would soon be overrun by them.

The regulations issued by the Secretary of State for the Home Department in January 1863, for burial grounds provided under the Burial Acts, may be of use for reference, and are given *in extenso:*

(1.) The burial ground shall be effectually fenced, and, if necessary, under-drained to such a depth as will prevent water remaining in any grave or vault.

(2.) The area to be used for graves shall be divided into grave spaces, to be designated by convenient marks, so that the position of each may be readily determined, and a corresponding plan kept on which each grave space shall be shown.

(3.) The grave spaces for the burial of persons above 12 years of age shall be at least 9 feet by 4 feet, and those for the burial of children under 12 years of age, 6 feet by 3 feet, or if preferred, half the measurement of the adult grave space, namely, 4½ feet by 4 feet.

(4.) A register of graves shall be kept in which the name, age, and date of burial in each shall be duly registered.

(5). No body shall be buried in any vault or walled grave unless the coffin be separately entombed in an air-tight manner; that is, by properly cemented stone or brickwork, which shall never be disturbed.

(6.) One body only shall be buried in a grave at one time, unless the bodies be those of members of the same family.

(7.) No unwalled grave shall be re-opened within 14 years after the burial of a person above 12 years of age, or within eight years after the burial of a child under 12 years of age, unless to bury another member of the same family, in which case a layer of earth not less than 1 foot thick shall be left undisturbed above the previously buried coffin; but if on re-opening any grave the soil be found to be offensive, such soil shall not be disturbed, and in no case shall human remains be removed from the grave.

(8.) No coffin shall be buried in any unwalled grave within 4 feet of the ordinary level of the ground, unless it contains the body of a child under 12 years of age, when it shall not be less than 3 feet below that level.

For further information upon the subject of the Interments Act 1879 and much useful information in connection with cemeteries, I refer my readers to 'Notes and Practical Suggestions upon the Interment Act 1875,' by T. Baker, Esq.

I cannot close this chapter upon cemeteries without a few words upon a subject which is analogous, cremation; and although I am aware that this is a debateable question, still it is impossible for me to be silent, as from my official experience on the practice of burial, I am so deeply convinced that cremation should be substituted for it for very many weighty reasons, that I feel it is necessary for me to give them.

They are as follows:

(1.) Nothing can be more unsanitary or dangerous to the living than the burial of the dead. This has been enlarged upon over and over again by men who have well studied the

subject and are competent to give an opinion and to that opinion I add my testimony.

(2.) Nothing can be more loathsome and degrading to the dead bodies of our friends or more revolting to our feelings, than the horrible practice of placing the remains of those we love in the soil of a common churchyard or cemetery, to be devoured with other bodies by worms.

(3.) In placing a dead body under ground we can never be sure how long the remains will be left undisturbed, a new street or railway will soon destroy all traces of its resting place,* and even the law only allows a grave to remain undisturbed for a short 14 years.

(4.) In the event of friends or relations dying abroad their remains cannot be sent home for burial except at great expense, cremation would reduce the body to a few beautiful silvery ashes which could easily be brought home and secured on arrival in a suitable and safe position.†

(5.) Cremation is the most respectful and beautiful manner for the disposal of dead bodies, and need not alarm (on religious grounds ‡) any more than the practice at sea of lowering the dead bodies overboard to be eventually eaten and digested by marine animals.

(7.) Cremation would settle at once and for ever the vexed question of burial in consecrated or unconsecrated ground, and all the unseemly quarrels which have taken place in connection with it from time to time.

* In a beautiful out-of-the-way valley in Wales, there is a pretty village with a quiet churchyard far from the "busy haunts of man," yet here it is found necessary to disinter all the bodies, as this churchyard will soon be 30 feet under the surface of the water of an immense reservoir now being constructed to supply the living with drinking water, and it would not be right to leave the bodies there.

† The body of Lord Balcarres was (as is now history) removed from the mausoleum in his own grounds, and only recovered after a most painful interval; this desecration could not have happened had his body been cremated and the ashes suitably secured.

‡ I believe it was Lord Shaftesbury whose remark on this point was, "What would have become of the blessed martyrs, if destruction by fire was to annul their chances of resurrection?"

(8.) The great extent of land that is now wasted in public burial grounds and cemeteries.*

There is no reason, even if cremation should take the place of burial, why the fees for clergymen and others should not remain as at present, and the unpleasant assistance of the British-ghoul, the undertaker, with his long face at the ceremony and still longer bill afterwards, could easily be dispensed with.

The opponents of cremation urge that it would be more expensive than burial, and consequently out of the reach of the poorer classes, and also that it would cause so much difficulty in detecting cases of poisoning, that it would tend to encourage persons to poison others who happened to be in their way, or objectionable to them, and thus crime would go unchecked.

If these are the only objections they are easily to be overcome.

First, by constructing public crematories, where for a few shillings a day sufficient heat could be maintained to consume almost any number of bodies, whilst the present great expense of maintaining large cemeteries with their attendant guardians and other costs would be dispensed with; and

Secondly, by instituting a scientific and independent enquiry as to the cause of every death which occurs. This is so

* The metropolis alone has in addition to the numerous burying grounds near its parish churches, &c. (many of which have been, however, dug up and destroyed), the average of which it would be difficult to determine, the following cemeteries, which may be called extra mural:

Woking Cemetery	500 acres
Ilford and Leytonstone Cemetery	168 ,,
Norwood and Nunhead Cemetery	40 ,,
Highgate Cemetery	40 ,,
West London at Brompton	40 ,,
Abney Park Cemetery	32 ,,
Kensal Green Cemetery	18 ,,
Victoria Cemetery	———
Tower Hamlets Cemetery	———
Colney Hatch Cemetery	———

much required at the present day for the sake of the public health, that even if cremation is never introduced it should be at once enforced, so that those who have charge of the public health could have exact and reliable knowledge of the causes of all the deaths throughout the United Kingdom, and thus obtain such valuable information as would greatly assist in the daily fight to subdue and overcome deaths from preventable causes.

CHAPTER XXXI.

MORTUARIES.

As the Public Health Act 1875 contains several clauses bearing upon mortuaries, a few words upon this subject will not be altogether inappropriate.

The great and terrible evils arising from the practice of keeping corpses in inhabited rooms by the poorer classes were pointed out by Mr. Chadwick in the year 1843* and the following clauses upon this subject and the necessity imposed upon the local authority to provide proper mortuaries are contained in the Public Health Act 1875 :

"Any local authority may, and if required by the Local Government Board shall provide and fit up a proper place for the reception of dead bodies before interment (in this Act called a mortuary), and may make bye-laws with respect to the management and charges for use of the same; they may also provide for the decent and economical interment, at charges to be fixed by such bye-laws, of any dead body which may be received into a mortuary (38 & 39 Vic. c. 55, s. 141).

"Where the body of one who has died of any infectious disease is retained in a room in which persons live or sleep, or any dead body which is in such a state as to endanger the health of the inmates of the same house or room is retained in such house or room, any justice may, on a certificate signed by a legally qualified medical practitioner, order the body to be removed, at the cost of the local authority, to any mortuary provided by such authority, and direct the same to be buried

* *Vide* 'A Supplementary Report on the Results of a Special Enquiry into the Practice of Interments in Towns,' by Edwin Chadwick, 1843.

within a time to be limited in such order; and unless the friends or relations of the deceased undertake to bury the body within the time so limited, and do bury the same, it shall be the duty of the relieving officer to bury such body at the expense of the poor rate, but any expense so incurred may be recovered by the relieving officer in a summary manner from any person legally liable to pay the expense of such burial.

"Any person obstructing the execution of an order made by a justice under this section shall be liable to a penalty not exceeding five pounds" (38 & 39 Vic. c. 55, s. 142).

From these clauses it would appear that a mortuary or mortuaries are an absolute essential in every town, although it does not appear necessary to have a separate mortuary for any "body of one who has died of any infectious disease," but it may be taken to the mortuary which has been provided for the reception of dead bodies generally. It may also be assumed that bodies may be viewed by a coroner's jury in the mortuary, although a post-mortem examination cannot be made in it, as by the following section:

"Any local authority may provide and maintain a proper place (otherwise than at a workhouse or at a mortuary) for the reception of dead bodies during the time required to conduct any post-mortem examination ordered by a coroner or other constituted authority, and may make regulations with respect to the management of such place; and where any such place has been provided, a coroner or other constituted authority may order the removal of the body to and from such place for carrying out such post-mortem examination, such costs of removal to be paid in the same manner and out of the same fund as the costs and fees for post-mortem examinations when ordered by the coroner (38 & 39 Vic. c. 55, s. 143)."

It will be observed that the above clause apparently forbids a post-mortem room being provided at the mortuary, although

this would appear to be the most appropriate situation for it, and indeed such a room is frequently provided at or near the mortuary. The reason for this prohibition, especially as it is associated with a workhouse, is evidently to overcome the prejudice which would exist in the minds of the ignorant that the fact of taking a body to a mortuary necessitated dissection: a practice which is looked upon with much disfavour by such persons.

Mortuaries in this country generally consist of one of the following descriptions:

(1.) Elaborate groups of buildings, comprising mortuary chapel, coroner's room, post-mortem room, dead house, waiting rooms, &c., and the necessary care-taker's rooms, and offices.

(2.) Mortuaries in connection with infectious hospitals.

(3.) Mortuaries in connection with general hospitals.

(4.) Mortuaries at cemeteries or licensed burial grounds.

(5.) Dead-houses provided by the sanitary authority.

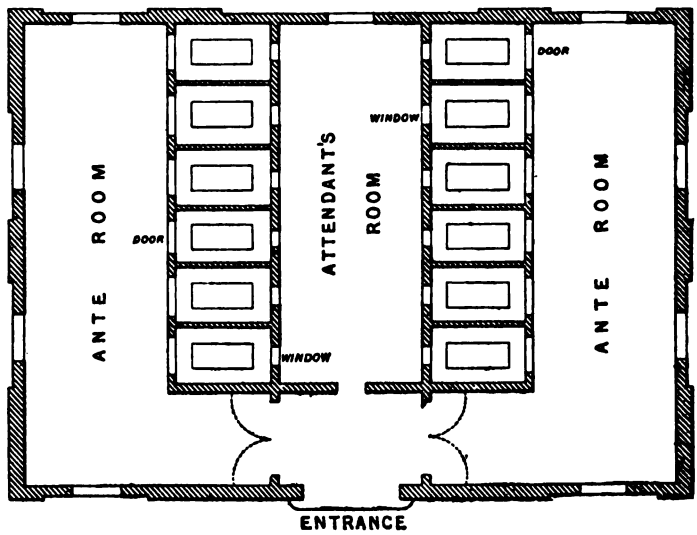
In arranging for the erection of a dead-house or mortuary in any town, the surveyor may find the following particulars and suggestions of some use to him:

A mortuary must be provided in the grounds or near all cemeteries that are in active operation, but in addition to these, others ought to be erected in central positions of the town, so that bodies can be easily conveyed there, not only with a view to meet the objections mentioned in the opening of this chapter, but also to avoid the unseemly practice at present so largely in vogue of taking any cases of sudden death, suicide, accidental drowning, violence or accident, &c., that may occur, to the nearest public house, there to await identification and the coroner's inquest.*

It has been computed that for every 50,000 of the population of any town, a mortuary should be provided.

* There is no law that can compel any one to receive a dead body into his house.

In Frankfort mortuaries have been for some years in existence; they are simple buildings, with a separate room for each corpse, intended not only to prevent bodies from being kept in private houses, but also to lessen the chance of any person being buried alive. The following is a plan of one of these institutions:



PLAN OF A GERMAN LEICHENHAUSER OR DEAD-HOUSE.

To prevent the chance of burying any person alive, each corpse as it is placed in its little dead-house has a ring placed upon its finger; this ring is attached to a string which is in communication with a bell which hangs in the attendant's room, who is there night and day, a window communicates with each dead-house, so that on the alarm being given he is at once ready to render assistance.

In Paris, as is well known, all bodies that are found are placed in the "Morgue" behind "Notre Dame," where they are publicly exhibited, thus assisting identification,

although the exposure of bodies in this manner is not very attractive.

In preparing designs for a group of buildings such as are set forth in the first on the list which I have given, the following requirements should be considered:

The Mortuary Chapel should be of such dimensions as are suitable for the requirements of the district, bearing in mind that if an epidemic of a fatal character was to unfortunately break out, it could either provide accommodation for the extra strain upon it or be capable of being easily extended. It should be designed so as to combine the characteristics of a chapel with the most perfect sanitary arrangements.* The walls should be of stone and are better lined with cement or glazed tiles, and everything should be kept as flush as possible so as to avoid projections on which dust could accumulate, the whole being easily and readily cleansed and disinfected. The floor may be of asphalte or other impervious material, and be well drained, great care being of course taken to exclude rats.

The ventilation must be perfect, the building should always be of low temperature even in the hottest days of summer. All the group of buildings should, if possible, be surrounded by a free belt of air. Their position should be isolated with respect to other buildings, and of course it is highly necessary that they should be as far away as possible from any dwelling-houses, a disused burial ground being sometimes selected as a convenient site. The furniture of a mortuary chapel should consist only of trestles or of brackets against the walls upon which to rest the shells containing the corpses.

The Dead-house should be a room smaller than the mortuary chapel, but its construction may be the same. It is

* It is important to remove the idea of a "parish dead-house," otherwise its object will be defeated, as persons will object to allow the bodies of their deceased friends to be taken to it.

here that all bodies should be brought uncoffined for the purpose of awaiting identification, or preparatory to post-mortem examination, or of bodies of those who have died from dangerous contagious maladies, and rendering immediate removal necessary; these are placed upon slabs provided for the purpose, which may be of slate, zinc, or other suitable material. In conjunction with the dead-house should be

The Post-Mortem Room, which requires plenty of light; it must also, like the mortuary chapel and dead-house, be thoroughly ventilated and drained and be easily cleansed. Its furniture must consist of the necessary post-mortem table of slate, zinc, or wood covered entirely with lead: this table must slightly dish towards the centre and be drained into a pail or on to a grating. Plenty of water is essential, conveniently laid on, and the room must be fitted with good arrangements for gas or other means of artificial lighting. Some method is also necessary for the purpose of heating water whenever it is required.

The Coroner's Court may be simply a large room with convenient seatings and tables for the coroner and his jury, accommodation being also provided for the press, witnesses, &c. with the necessary retiring rooms and offices.

In addition to the above requirements the following accommodation should also be provided:

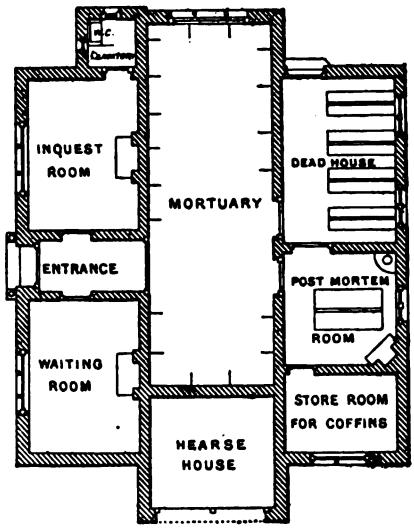
A caretaker or *resident attendant* should have accommodation at or near the main group of buildings.

A Laboratory and Weighing Room should also be provided in connection with the post-mortem room; and a *Store Room* for spare shells and disinfectants, &c.

If possible also it is well to provide a *Hearse House*; and in connection with the mortuary establishment, the disinfecting of bedding, clothing, &c., which have become infected, should also if possible be carried on.

Before, however, proceeding to discuss the question of

disinfection I will give the following drawing of a mortuary chapel, &c., as proposed by the late Dr. W. Hardwicke, the well-known Coroner, in a valuable paper upon the subject of Public Mortuaries which he read before the Royal Institute of British Architects in the year 1869:



I am, however, not aware that any public mortuary even of this size has yet been actually carried out in this country, greatly as they are needed.

With reference to the question of disinfection, which as I stated can be conveniently taken in connection with that of mortuaries, the following is the clause of the Public Health Act 1875 which deals with it:

"Any local authority may provide a proper place, with all necessary apparatus and attendance, for the disinfection of bedding, clothing or other articles which have become infected, and may cause any articles brought for disinfection to be disinfected free of charge (38 & 39 Vic. c. 55, s. 122). See also 38 & 39 Vic. c. 55, ss. 120 and 121.

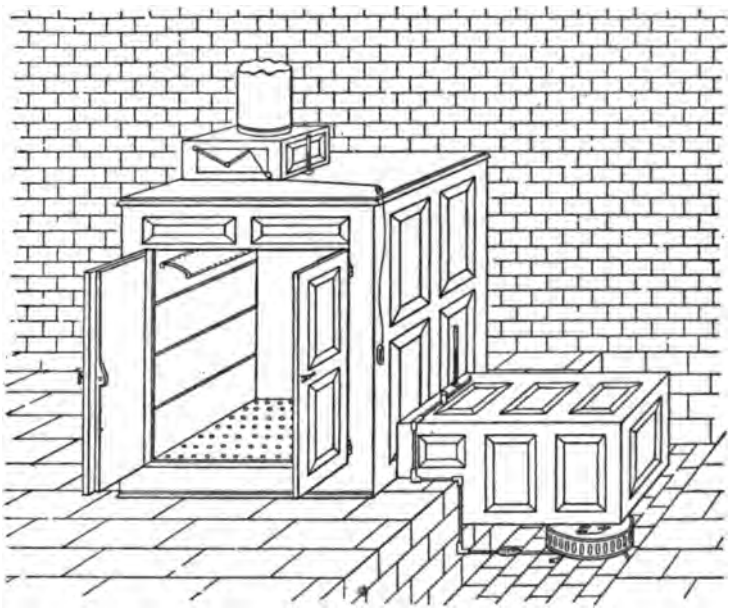
The first duty here involved is to provide a proper place for this purpose, and this place cannot be better than that of the mortuary, so as to centralize as much as possible the spots to which infection has to be carried, and the necessary attendant can also here be found, as well as convenient places to put the hand carts, &c., presently described.

The next duty is to provide the necessary apparatus, which is now done almost exclusively by the action of heat. This is sometimes effected by building brick-work chambers which can be heated up to about 350° Fahr. after the doors are closed, by means of coal or coke furnaces. Within these chambers are moveable horses on which are placed the articles to be disinfected: these are exposed to the necessary heat for varying times according to the nature of the articles, the horse is then drawn out, when the articles should be thoroughly washed with a disinfecting soap and returned to their owners. Great care is necessary in this operation to ensure evenness of heat, as otherwise the clothes, bedding, &c., may be scorched and injured, and the local authority will then have to make compensation.

A more convenient form of disinfecting machine, and one that is less costly to work and more even in its temperature, is one that can be heated by gas, this is sometimes effected by the use of an iron box with counter-balanced lid into which the articles are put, heat being applied by means of gas jets burning underneath. A more elaborate and effective method has however been patented, and is now manufactured by Messrs. Goddard and Massey of Nottingham, which is known as Dr. Ranson's system. The following drawing shows the arrangement of this machine, and some of the advantages claimed for it are as follows:

Its heat is maintained automatically within certain limits in all parts of the chamber, and has great drying power, which is important, as securing from the long period of time at which

this steady heat can be maintained, that penetration into bedding and other bad conductors which is so desirable to secure the necessary destruction of all disease germs or chances of after inoculation:



There can be no doubt that where a machine is not required to be constantly at work gas is the cheapest and most convenient heat-producer that we have.

It is of course necessary that the infected bedding and clothing should be fetched from the owners' houses in such a manner as will lessen the risk of spreading infection as much as possible, and for this purpose it is necessary for the local authority to keep a covered hand-cart which should be lined with tin and closed hermetically. It should be sufficiently large to take a mattrass, and be of light construction, so that one man can draw it when full.

Before concluding my remarks on disinfection, it is well to state that plenty of carbolic acid should be kept in a mortuary. Sheets saturated with carbolic acid are used to wrap around the dead bodies of infected persons, and sawdust saturated with carbolic acid is also freely used, besides large quantities of that excellent disinfectant, "Sanitas."

CHAPTER XXXII.

BORROWING UNDER THE LOCAL GOVERNMENT BOARD.

THERE are a number of clauses in the Public Health Act 1875, which empower a local authority to borrow money on the credit of the rates for the purpose of "defraying any costs, charges and expenses incurred or to be incurred by them in the execution of the Sanitary Acts." (*Vide* 38 & 39 Vic. c. 55, s. 233).

The exercise of these powers of borrowing are subject to the following regulations:

(1.) Money shall not be borrowed except for permanent works.*

(2.) The sum borrowed shall not exceed at any time, including all outstanding debts, the assessable value for two years of the district.

(3.) Where it exceeds the value of one year, the Local Government Board will not give their sanction until one of their inspectors has held a local enquiry.

(4.) The money cannot be borrowed for a longer time than 60 years, and it must be paid off within that time.

(5.) Certain regulations as to sinking funds, &c. (*Vide* 38 & 39 Vic. c. 55, s. 234 *et seq.*)

The power to borrow money thus granted to local authorities has undoubtedly given a considerable stimulus to the execution of important sanitary works which could not be carried out if they had to be paid for out of the current rates. It is also a fair and equitable arrangement that permanent works should be paid for by those that reap the benefit

* The Local Government Board have held a steam roller, a steam fire-engine, a disinfecting apparatus, and lamp columns to be permanent works.

of them, and it is now so arranged that the money borrowed is repaid within a certain specified time by equal annual payments, in order that the ratepayer of the present shall not be unduly taxed for the benefit of posterity.

No regular or fixed times have been settled by the Local Government Board over which they will allow the repayment of loans to be spread, but it appears that the duration of the proposed works somewhat guides the length of time allowed, as will appear from the following list which I have prepared from the eighth Annual Report of the Local Government Board:

Description of Work.	Number of Years.
Purchase of land	50 to 60
Sewage disposal	30 ,, 50
Sewerage works	30 ,, 50
Water supply	20 ,, 50
Fire brigade purposes	30 and 60
Market Purposes	30 ,, 60
Plan of district	20 ,, 30
Lamps for public lighting	10 ,, 20
Artizans and Labourers' Dwellings Act	50
Erection of hospital	30
,, ,, public baths	30
,, ,, slaughter-houses	30
,, ,, buildings at sewage farm	30
A public park	50
Cemeteries	30
Gas supply	30
Street improvements	15 to 30
Paving* and channelling	15 ,, 20
Stables, urinals, enginehouse	20
Construction of a new road	20
Disinfecting apparatus	20
Mortuary and weighing machine	15
Steam road roller	10

Whenever a local authority decide to make application to the Local Government Board for power to borrow money for any proposed improvements or works within their district, it is the duty of the town surveyor to prepare the necessary

* For asphalte pavements twelve years have been allowed.

drawings and obtain the required information in order to fill in the forms which are supplied from the Local Government Board office.

With reference to this important part of his duty, I cannot do better than give the following Suggestions as to the Preparation of Plans of Proposed Works, by Robert Rawlinson, C.B., C.E., &c. (Chief Engineering Inspector to the Local Government Board), prepared by him in 1878:

"It will in all cases be necessary, upon application being made for sanction to a loan, for the execution of works, that plans (or tracings of the plans), sections, estimates in detail and specifications be submitted with the application, accompanied by information as to the population at the two last periods of the taking of the census, the rateable value of the district, and the amount of outstanding loans."

"Such plans or tracings may be used for showing lines of main sewers, drains, water-pipes and gas-mains. The lines of main sewers and drains should have the cross sectional dimensions of the sewers and their gradients distinctly marked (written and figured) upon them. The dimensions of water and gas pipes should also be shown in figures or by writing."

"N.B.—No general map should be submitted which is drawn to a scale of less than 6 inches to a mile, except when the inch ordnance map is used."

"Maps upon which sewerage works or water works are to be shown, or for street improvements, should be not less than the ordnance scale of $\frac{1}{2500}$th."

"The sections should be drawn to the same horizontal scale, and to a vertical scale of 20 feet to 1 inch."

Any detailed plan for the purposes of house drainage, paving, the purchase of land &c., should be "constructed to a scale of not less than 10 feet to a mile, and upon this plan should be exhibited all houses and other buildings, bench marks, the levels of streets and roads, of cellars, of the sea at

high and low tide level, and the summer and flood levels of rivers. 3 feet by 2 feet will be a convenient size for the sheets of this plan."

"Enlarged detail plans and sections of sewers, side entrances, man-holes, sewer sluices, sluice valves, water-pipe joints, and similar details, should be to a scale not less than 8 feet to 1 inch, and for some details 4 feet to 1 inch."*

"As it may occasionally be desired to carry out works piecemeal, with a view to save the time which would be occupied in the preparation of a complete plan from actual survey, it will be sufficient in the first instance to furnish any available general plan of streets and roads, with the surface levels and those of the deepest cellars figured in feet and inches, and the proposed scheme of works shown (or sketched) thereon, after which the works can proceed in sections. It should be understood, however, that a complete plan of the entire district must be proceeded with, so that when the works are finished, the sanitary authority and this Board may possess a proper record of them."

And again, Mr. Rawlinson in the same year, at a meeting of the Association of Municipal and Sanitary Engineers, writes as follows:

"Plans should be neatly and clearly drawn, the cross sectional dimensions and the gradient being written on the *plan* of sewers; there should be a title and scale on each plan, as also on each sheet, and the date with the name of the engineer or surveyor clearly written so as easily to be read; this as a rule should be in the right-hand corner. Many names are so written that experts cannot read them, and

* "Details may be drawn to any scale larger than the dimensions named. Engraved or lithographed diagrams, if clear and distinct, will be accepted. A new plan of any town or district cannot be used for main sewering, water supply, gas supply, pavements, footwalks, and other purposes without spoiling it; consequently it had better be retained as a standard and be zincographed, there may then be copies for all local purposes. The zinc plates to be the property of the local authority."

plans are frequently sent out having no title, nor any scale, nor any name.

"Plans of details, such as side entrances, man-holes, flushing chambers, and sewer ventilating arrangements, should be at 4 feet to an inch, larger works may be at 4, 10 to 20 feet to an inch. Clear understandable and measurable details are desirable . . . I have much trouble in looking over defectively prepared plans and crude ill-understood and ill-digested schemes as they are submitted to the Local Government Board, for approval and sanction to a proposed loan. One great fact connected with the Board must not, however, be overlooked. It is not an office of works, it does not undertake to devise neither does it make itself responsible in any degree for the plans or for the estimates which may have been sanctioned. Each engineer and each local authority must both devise and execute the local works, and the district must alone be responsible for the local expenditure. The Board neither dictates as to works, nor superintends works, but reserves the power of refusing sanction to a proposed loan, and of requiring full explanations as to failures in the works, or as to expenses over estimates before sanctioning a supplemental loan. The reason that the Board declines responsibility ought to be clearly manifest; plans and details may be the best possible, but the ultimate result depends on daily local supervision, and this the Board does not give; neither local action nor local responsibility is superseded."

Speaking on this point at the first meeting of the Sanitary Institute of Great Britain held at Croydon in 1879, Captain Douglas Galton, C.B., says:*

"Where a loan is applied for, the plan upon which the money is to be spent is submitted for Government approval. The Government only lends the money after the approval of the proposed scheme of expenditure by one of their inspectors.

* *Vide* 'Transactions of the Sanitary Institute of Great Britain,' vol. i. p. 116.

"The Local Authorities of the towns to be drained cannot therefore be responsible for the plan selected, for the Local Authorities must alter their plans to suit the views of the inspector. The responsibility of the engineer is diminished, because he may be compelled to modify his plan in a manner in which he may not thoroughly approve, and the inspector has no responsibility in the matter, because, after having approved of the general scheme, he has no control over the details or the execution of the work, nor can he be in any way held responsible, if the result were a failure."

CHAPTER XXXIII.

CONTRACTS.

CONTRACTS being principally a legal question, it is not my intention to say much on the matter.

In the Public Health Act 1875 will be found the following clauses:

"Any Local Authority may enter into any contracts necessary for carrying this Act into execution (38 & 39 Vic. c. 55, s. 173).

"With respect to contracts made by an Urban Authority under this Act, the following regulations shall be observed (namely):

"(1.) Every contract made by an Urban Authority whereof the value or amount exceeds fifty pounds shall be in writing, and sealed with the common seal of such authority:

"(2.) Every such contract shall specify the work, materials, matters or things to be furnished, had or done, the price to be paid, and the time or times within which the contract is to be performed, and shall specify some pecuniary penalty to be paid in case the terms of the contract are not duly performed:

"(3.) Before contracting for the execution of any works under the provisions of this Act, an Urban Authority shall obtain from their surveyor an estimate in writing, as well of the probable expense of executing the work in a substantial manner as of the annual expense of repairing the same; also a report as to the most advantageous mode of contracting, that is to say, whether by contracting only for the execution of the work, or for executing and also maintaining the same in repair during a term of years or otherwise:

"(4.) Before any contract of the value or amount of one hundred pounds or upwards is entered into by an Urban Authority ten days' public notice at the least shall be given, expressing the nature and purpose thereof, and inviting tenders for the execution of the same; and such authority shall require and take sufficient security for the due performance of the same:

"(5.) Every contract entered into by an Urban Authority in conformity with the provisions of this section, and duly executed by the other parties thereto, shall be binding on the Authority by whom the same is executed and their successors, and on all other parties thereto and their executors, administrators, successors or assigns to all intents and purposes: Provided that an Urban Authority may compound with any contractor or other person in respect of any penalty incurred by reason of the non-performance of any contract entered into as aforesaid, whether such penalty is mentioned in any such contract, or in any bond or otherwise, for such sums of money or other recompense as to such Authority may seem proper" (38 & 39 Vic. c. 55, s. 174).

In reading the numerous foot-notes that follow the above clauses in Glen's 'Law of Public Health and Local Government,' it will be seen that contracts with corporations have been held to be very different from ordinary ones between individuals or companies. All contracts should be by deed under the seal of the corporation, or "there is no safety or security for anyone dealing with such a body on any other footing," and this applies also in "respect of any variation or alteration in a contract which has been made."

"A committee of the corporation has no power to enter into any contract" (38 & 39 Vic. c. 55, s. 200).

A member of a corporation may not be "concerned in any bargain or contract" entered into by the corporation, although this would not vitiate the contract (38 & 39 Vic. c. 55, sch. 11, clause 64), neither may an officer of the corpora-

tion be "concerned or interested in any bargain or contract" (38 & 39 Vic. c. 55, s. 193).

It is, of course, necessary before any contract can be entered into, that the town surveyor should prepare the specification, schedule of prices and drawings where necessary; this entails a considerable amount of work.

In addition to ordinary specifications for works, the town surveyor has often to prepare specifications and schedules for the supply of the following goods:

Ironmongery.	Fodder.
Paints, etc.	Road metal.
Disinfectants.	Paving.
Castings.	Clothing.
Coals.	Stationery.
Harness.	Horse hire.

and a host of other things too numerous to mention.

A well-written, clear, and comprehensive specification is a most difficult thing to write, but it should be "common sense" from beginning to end, any legal phraseology being left to the town clerk to introduce in his "deed" as required by the Act.

For sewer and drain work lump sum contracts are often undesirable: it is better to work according to a schedule of prices, and periodical measurements.

It must not be forgotten that in all contracts the contractor seeks to make a profit out of the work; if there is no intermediate contractor this profit goes to the ratepayers. In most sanitary works also the men employed by the local authority are more skilled in that particular class of work than the chance men employed by a contractor, and for this and many other reasons, administration by the local authority is in most cases preferable to contracts.*

* Mr. Parry, C.E., Borough Surveyor of Reading, says, "My experience of such works is that town authorities can obtain both labour and materials cheaper than contractors, and with efficient supervision the work costs less money." (*Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. iv. p. 89.)

Where tenders have been invited by advertisement or otherwise, the successful person should be written to, apprising him of the fact, and requesting him to call, sign the necessary specification, deeds, and drawings; an intimation should also be made to the unsuccessful competitors that their tenders have not been accepted.

In conclusion, let me thank the authors of the following books for the useful information which I have gained in perusing them for the purposes of this work, and, let me add, they can be studied with advantage by every "Town Surveyor":

'American Sanitary Engineering,' by E. S. Philbrick.
'Annales des Ponts et Chaussées,' published in Paris.
'Annual Reports of the Local Government Board,' published in London.
'A Practical Guide for Inspectors of Nuisances,' by F. R. Wilson.
'A Treatise on Roads,' by Sir H. Parnell.
'Cremation of the Dead,' by W. Eassie.
'Experience sur le tirage des Voitures,' by M. Morin.
'Healthy Dwellings,' by D. Galton.
'Health of Towns Commission,' sundry reports.
'Law of Public Health and Local Government,' by W. C. and A. Glen.
'Local Board Manual,' by Owen Harris.
'New Mode of Constructing Streets,' by J. Edgworth.
'Plumbing and House Draining,' by W. P. Buchan.
'Practical Treatise on Roads,' by A. Penfold.
'Repair of Main Roads,' by W. H. Wheeler.
'Roads and Streets,' by D. Kinnear Clark.
'Roads, Streets, and Pavements,' by Q. A. Gillmore.
'Roads and Roadways,' by G. W. Willcocks.
'Remarks on the Present System of Road Making,' &c., by John Loudon McAdam.
'Sanitary Engineering,' by Baldwin Latham.
'Sanitary Engineering,' by Bailey Denton.
'Sanitary Work,' by Charles Slagg.
'Suggestions as to the Preparation of District Maps and of Plans for Main Sewerage, Drainage, and Water Supply,' by Robert Rawlinson, C.B., &c.
'Street Pavements,' by G. F. Crosby Dawson.
'Steam Road Rolling,' by Fred. A. Paget.
'The Parks, Promenades, and Gardens of Paris,' by W. Robinson.
'The Public Health and Local Government Act,' by J. Vesey Fitzgerald.
'The Interments Act 1879,' by T. Baker.
'The Plumber and Sanitary Houses,' by S. S. Hellyer.
'The Maintenance of Macadamised Roads,' by Thomas Codrington.
'The true system of Wood Pavement,' Anonymous.
'The Surveyor of Highways,' by Alex. Glen.

'Tree Pruning,' by A. des Cars.
Various papers in the Proceedings of the Institution of Civil Engineers.
Various papers in the Proceedings of the Sanitary Institute of Great Britain.
Various papers in the Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors.
Various papers from the Journal of the Royal Agricultural Society.
Various papers from the Reports on the Application of Science and Art to Street Paving.
Various reports by Mr. Haywood, Engineer to the Commissioners of Sewers of the City of London.
Various reports by Mr. Till, Surveyor of Birmingham.
Various reports of Commissions, etc.

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