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TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must, in all cases, be accompanied by a large envelope legibly directed by the writer to himself, and bearing a* 1d. *postage stamp, in order that answers received by us may be forwarded to their destination. No notice will be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* The Engineer, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

J. R.—*Chambers' Logarithms will probably best meet your requirements.*

An Old Subscriber.—*See the paper "On the Mersey Railway and Tunnel" in* The Engineer, *7th December*, 1883.

J. B. C. (Hull).—*There is no special book on marine laws affecting the interests of marine engineers. We can only refer you to the Merchant Shipping Acts.*

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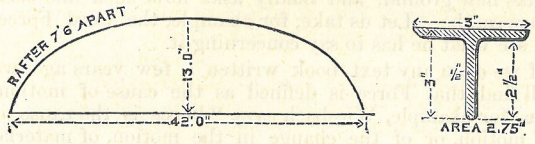
Draughtsman.—*There is no good book on prime cost. From time to time small works, prime cost sheets, and such like, are advertised, but we are not aware of the existence of any comprehensive treatise on the subject. Indeed, wide diversities of opinion and method exist, and in no two establishments, perhaps, is the same system adopted. The art of estimating never seems to be taught. It has to be picked up somehow, and this is no doubt the reason why so many firms find their way into bankruptcy.*

TIE-IRON RAFTERS.

(*To the Editor of The Engineer.*)

Sir,—Permit me to ask through your columns the following question:—What weight would a 3in. by 3in. by ½in. T-iron rafter sustain? Span, 42ft. between supports—distributed load—area of section, 2¾ square



inches; rise at centre, 13ft.; form, segment of circle, or elliptical, as per sketch; rafters, 7ft. 6in. apart; no principals.

A Subscriber.

Mold, April 14th.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. George Leopold Riche; all other letters to be addressed to the Editor of The Engineer, 163, *Strand.*

MEETINGS NEXT WEEK.

The Institution of Civil Engineers.—Tuesday, April 29th, at 8 p.m.: Paper to be discussed, "On the Comparative Merits of Vertical and Horizontal Engines, and on Rotative Beam Engines for Pumping," by Mr. Wm. E. Rich, M. Inst. C.E.

Iron and Steel Institute.—Annual meeting at 25, Great George-street, London, S.W., Wednesday, the 30th of April, Thursday, the 1st, and Friday, the 2nd of May, commencing each day at 10.30 a.m.

Institution of Mechanical Engineers.—Thursday, May 1st, at 7.30 p.m.: The following papers will be read and discussed as far as time will admit:—"On the Consumption of Fuel in Locomotives," by M. Georges Marié, of Paris. "On Portable Railways," by M. Paul Decauville, of Petit-Bourg, Paris. "On the Moscrop Engine Recorder, and the Knowles Supplementary Governor," by Mr. Michael Longridge, of Manchester. Friday, May 2nd, at 7.30 p.m.: "Description of the Automatic and Exhaust Steam Injector," by Mr. A. Slater Savill, of Manchester. "Description of the Apparatus used for Testing Current Meters at the Admiralty Works at Torquay for Experimenting on Models of Ships," by Mr. Robert Gordon, of Burmah. "Description of the Francke 'Tina' or Vat Process for the Amalgamation of Silver Ores," by Mr. Edgar P. Rathbone, of London.

Chemical Society.—Thursday, May 1st, at 8 p.m.: "On Benzozlactic Acid and some of its Derivatives," Part I., by Mr. W. H. Perkin, jun., Ph.D. "On Fluorene," by Mr. W. R. E. Hodgkinson.

Society of Arts.—Monday, April 28th, at 8 p.m.: Cantor Lectures.—"Some New Optical Instruments and Arrangements," Lecture I., by Mr. J. Norman Lockyer, F.R.S., F.R.A.S. Tuesday, April 29th, at 8 p.m.: Foreign and Colonial Section.—"The Transvaal Gold Fields; their Past, Present, and Future," by Mr. W. Henry Penning. Mr. F. W. Rudler, F.G.S., Curator of the Museum of Practical Geology, will preside. Wednesday, April 30th, at 8 p.m.: Nineteenth ordinary meeting.—"The New Legislation as to Freshwater Fisheries," by Mr. J. W. Willis-Bund. Mr. Edward Birkbeck, M.P., will preside.

MARRIAGE.

On the 17th April, at All Saints' Church, Blackheath, by the Rev. E. J. Willcocks, M.A., Head Master of the Grammar School, Warrington, brother of the bridegroom, assisted by the Rev. C. A. Stevens, Vicar of Portslade, near Brighton, and the Rev. E. Foyle Randolph, Vicar of the parish, George Waller Willcocks, M. Inst. C.E., second son of the late Roger Willcocks, of Teignmouth, to Mary, eldest daughter of Rowland Escombe, of Lindsay House, Blackheath.

THE ENGINEER.

APRIL 25, 1884.

THE EARTHQUAKE.

Our eastern counties have experienced a rude reminder that there are some terrestrial facts to which it is not pleasant to have attention drawn by practical illustration. Earthquake within short ranges is not a cheerful subject for contemplation, and on the principle that other folks' aches are not so bad as our own, earthquakes are to us much more interesting if less exciting at, say, Casamicciola or Cachar than in Essex or Suffolk.

On Tuesday morning, at about twenty minutes past nine, what was evidently a severe earthquake occurred along our eastern coast, extending considerable distances inland, and was most felt at Colchester, Langenhoe, and Wyvenhoe, many buildings being wrecked at the latter place, while part of the tower of a Congregational church was thrown down in Colchester, and numerous chimneys overthrown. Some evidence of the shock having been felt in London has been published; and generally there is no doubt that England has again experienced an earthquake which came very near in intensity or in velocity and amplitude of wave particle to being disastrously destructive. People were startled in many localities where the shock was insufficient to cause any damage; and at those places where bricks and mortar fell about freely and entered rooms through the roofs, alarm was naturally very great, and the accounts of the earthquake are as usual accompanied by the exaggerations which describe what people thought took place, or what they thought they felt rather than what actually took place—such, for instance, as in the story of a woman being thrown out of bed, and a man shaken off a standing locomotive owing to the violence with which it was supposed to rock about. The shock, however, was very severe, and very few have any idea of how narrow a margin during that momentary throb divided their fates between that safety at which many no doubt felt some surprise, and one of the most dreaded forms of death by burial, or burning alive, or by suffocation or slow death, half-crushed under masses of masonry. Comparatively speaking, slight as was the shock when we think of those which destroyed Casamicciola, Caracas, and many towns of South America, it needed but slightly greater velocity of wave particle not only to have laid low the towns in the Eastern Counties, but to have made mountainous heaps of brickbats and rubbish of London and many towns far away from it. The shock felt in those places where no appreciable damage has been done was, to give a familiar illustration, probably due to a velocity of earth wave particle not greater than the velocity which imparts the shock one may feel by dropping on the heels from and to a stone step 6in. in height; but had the velocity been as great as that acquired by dropping from the height of a chair seat, the ruin would have been as complete as that of Chios. A shock of no greater violence than those which frequently occur within the Mediterranean seismic bands—one, for instance, the velocity of whose wave particle is not more than 12ft. to 15ft. per second—would do all this, and we should be far worse off under such a visit than those in towns which have in earthquake countries been so destroyed, for our waterworks, sewers, and gas mains would add to the destroying agents, and produce a scene beyond imagination terrible.

Even within historic times there have been many earthquakes in Great Britain, some very destructive; and at the present time there are some proofs that about two earthquakes per week shake the soil of England, Scotland, or Ireland, and this not including the minute and continually repeated vibratory jars which have been long remarked at Comrie in Scotland, or the slower pulsations continually experienced by those using the very delicate instruments at Greenwich, and Cambridge, and Oxford. Now and then some of these British shocks are not quite to be despised; for example, on the 13th of August, 1816, an earthquake, that extended with violence over more than 100 square miles of Scotland, shook down part, and twisted upon its base the whole of the spire of the church of Aberdeen. On March 17th, 1843, an earthquake, great enough to damage buildings, occurred in the North of England, and reached from Northumberland down to Flintshire, and from the Isle of Man to beyond Cheshire; and no longer ago than on the 9th November, 1852, a shock which threw down strong walls at Shrewsbury, extended over the British Islands from Dumbarton nearly to Dartmoor, in Devon—and from Enniskillen in Ireland, to Gainsborough in Lincolnshire. The last shock which swept over a large part of England was in 1863, but it is an illustration of the happy side of forgetfulness, that because anything like a tangible shock is infrequent in this country, we forget that England has been much visited by the earthquake evidences that our world is still experiencing the effects of the mechanical equivalent of thermal decadence. We experience a shock and forget it, and do not find any necessity for following the example of the Chilian in keeping an earthquake coat. This, however, would soon be wanted if we had to pass much time without preparation in the streets; and the panic on Tuesday in Colchester and other parts of Essex reminds us that amongst the many natural gifts referable to geographical position and geological structure, none have been so important in permitting our natural development as our immunity from frequent or severe earthquakes.

At present we are not in possession of full particulars of the extent to which buildings have really been destroyed or shattered; but it seems clear that more destruction has been wrought than by any earthquake in this country since the latter end of the thirteenth century, even if the fall of the Glastonbury Church is rightly ascribed to earthquake in 1175, or since 1580, when part of the Temple Church was said to be thrown down by the same agency. It is said that on Tuesday the Langenhoe Church was destroyed; and there seems to be no doubt that over a large part of Essex structures such as chimneys, with high centres of gravity and small base, have been thrown down; while badly-built houses have suffered much damage, and the Abberton Church was also much damaged.

Against earthquakes we are powerless; we can but build so that these earth pulsations shall, in spite of their great velocity, have no material effect on the stability of our structures. This the late Robert Mallet, to whom seismology owes its existence as a science, has shown us how to do. He gave the world the knowledge it now possesses on the true nature of earthquakes, although he only offered suggestions as to their cause. It is not likely, however, that buildings in England will be designed with any reference to seismic disturbances, which have hitherto been so few. Neither is it likely that we shall take any heed of the probable dates of earthquake recurrence; although, from the statistics which Mallet collected and systematised, it is possible to arrive approximately at such dates. Seismic energy may be considered as constant during historic time, though viewed with reference to much larger periods, it is probably a decaying energy. It does not seem to be of the nature of a distinctly periodic force, and while the minimum paroxysmal interval may be a year or two, the average interval is from five to ten years, the shorter intervals being usually attended with shocks of lesser intensity. During the last three centuries two marked periods of extreme paroxysm are observable in each century, one greater than the other, that of the greater number and intensity occurring about the middle of each century and the other towards the end of each. There appear to be distinct indications of a maximum about the winter solstice, and minimum rather before the autumnal equinox. Speaking still of the earthquake-attended countries generally, it seems that one earthquake of some severity may be expected about every eight months. Respecting the laws to be observed in building so as to be unaffected by earthquakes, we may refer to our impression of the 24th August, 1883, when we dealt with this subject in connection with the Ischia disaster. But unless we in England are unfortunate enough to have our knowledge of earthquakes extended by frequent actual demonstration, we are not likely to look upon them as in any way entering into our architectural considerations.

MARINE BOILERS.

It is not to be assumed that the existing type of cylindrical marine boiler finds favour with all engineers, or that no attempts have been made to supersede it. We have reason, however, to know that some persons hold that the retention of the existing type is due to nothing but dogged obstinacy on the part of those who make it. We are told that the cylindrical many-furnaced boiler is merely a development or modification of the old box boiler; that it has nothing specially to recommend it, and that its use is a direct bar to progress in marine engineering. Now, it is quite true that the cylindrical boiler is a species of survival of the box boiler modified to suit new conditions of pressure; but engineers as a rule are by no means blind to its defects. It would not be used if there was anything better available. The only substitute that can be suggested for it is the locomotive type of boiler. Accordingly, this boiler, modified in various ways to suit the conditions under which alone it can be used at sea, has been tried. Messrs. Holt have used one modification. Turner's boiler very closely conforms to that of a locomotive; so do those of the Polyphemus. The results hitherto obtained, however, have been, to say the least, not eminently satisfactory; and so the cylindrical return tube boiler represents about 95 per cent. of the generators found on board ship. The great objections to it are its great weight; the enormous quantity of water which it holds; the irregularity with which it is heated—cold water often being found under the flues until a ship has been rolling at sea for some time—its enormous thickness renders it difficult to rivet, and to make or keep tight. On the other hand, it fits its place in a ship very conveniently; it is not given to priming; is economical, and causes less trouble than any other type. Such advantages as these not only go a long way, but far enough to justify the favour which has been accorded to it.

It is not to be denied that there is something very tempting about the locomotive boiler—its small size and great power are powerful arguments in its favour. It is, too, at least, as economical as any other boiler in use on sea or land when properly worked. But it is to be feared that all the good it can confer is overbalanced by the objections which can be truthfully urged against it. Every boiler is a composite affair; it must be regarded not only as a steam generator but as a furnace; it is not only a vessel in which water may be boiled, but an apparatus in which fuel has to be burned to the best advantage. For the moment we may neglect the former question and confine our attention to the latter. The locomotive boiler is smaller and lighter than the marine boiler, because its capacity for holding either coal or water is less than that of its rival; but its heating surface is not necessarily less. Yet a heavy price has to be paid for equivalence in this matter. Tubes about half the size, and more than double the number of those found in cylindrical boilers must be used. There is no objection to their employment in the locomotive, which never steams continually for many hours; there is a great objection to their use at sea, because they have to be frequently swept unless the draught is to suffer. But the great objection to the locomotive boiler is the small size of grate that can be got in; thus a boiler with a shell 5ft. in diameter cannot well have more than 25 square feet of grate, unless the fire-box is splayed, which entails obvious disadvantages. Such a boiler would be expected to make as much steam as a three-furnaced marine boiler 13ft. in diameter—say enough to supply an engine of 600 indicated horse-power. The three furnaces of the cylindrical boiler would have a grate area of 54ft., or more than twice that of the locomotive boiler. The result is, that combustion must take place at twice the rate in the latter, with a proportionate augmentation in furnace temperature. At first sight there may apparently be no objection to this; nor is there, provided the period during which the boiler is continually worked is moderate. But at sea steam must be kept up for weeks

THE EARTHQUAKE IN ESSEX.

THE various reports which have been published in metropolitan and local journals give nothing like an accurate account of the earthquake which shook a large portion of the eastern counties of England last Tuesday week. Nor is this matter for wonder. Those on the spot, brought face to face with the possibilities of a tremendous catastrophe are not those most likely to write coolly on such a subject. It is impossible indeed for those who have not endured such an experience to form anything like an adequate conception of the terror which an earthquake can inspire. It is not so much what has occurred, as the uncertainty concerning what will happen next that produces this feeling of dread. The utmost difficulty is experienced in getting an accurate account of what really takes place. We might as well expect a sufferer in a railway collision to give a precise description of the events which resulted in maiming him, in their proper sequence. The tendency all round is to exaggerate, and we have felt that it would be desirable to place in our pages for future reference the result of our own personal observations. We were not on the spot at the time when the earthquake occurred, and our visit of inspection was paid last Saturday and Sunday, when the excitement had disappeared and the scattered thoughts of the inhabitants had been recalled.

The facts which we can place at the disposal of the seismologist are, as usual in earthquake literature, very few—at least, those which are in any way likely to strengthen one theory or weaken another are very few. It may, however, be taken as certain that the nature of the motion is known. Very careful answers from intelligent eye-witnesses all lead to the same conclusion, and an examination, equally careful, of the ruins made by the earthquake strengthen that conclusion. There was a direct upheaval of the ground, which fell again immediately, the fall being accompanied by a violent vibration or shaking. If there was any lateral motion it must have been very small. The mere rising and falling of the ground did little harm; the subsequent shaking did a great deal. To make this matter quite clear, we may cite the experience of Mr. Clegg, C.E., municipal engineer, Colchester, to whom we are indebted for valuable information and assistance in pursuing our inquiry. Mr. Clegg was at breakfast when the shock took place. Workmen were employed in the upper part of the house. Mr. Clegg's first impression was that one of the men had fallen off a ladder, and he ran to the door of his room and called to the man. Immediately afterwards all the bells in the house began to ring. This ringing was apparently due to the shaking or vibration which followed the primary upheaval. Again, a great deal of damage has been done to tiled roofs, which abound in the district. When we have seen one house, we have seen all. The chimney was thrown down, and smashed through the roof. Apparently this happened first. Then all the tiles were shaken out of their places, some falling to the ground, but by far the greater number being packed on the roofs at a lower level. The accompanying sketch, Fig. 1, will give an idea of what we mean. The result is not only precisely what can be produced by a violent shaking, but it does not seem that it could have been produced in any other way. The position of the roofs has in no way affected the facts; whether the buildings which they covered faced north, west, east, or south, the result is the same. The position of the tiles on the roofs, however, materially affected the results. Thus the tiles near the walls have seldom been moved, while the ridges and upper portions have been stripped. In one instance, on a slightly raised portion of a house, the roof has been shattered, while on the rest of the house it has scarcely suffered at all. Fig. 2 will serve to illustrate what we mean. This shaking is a well recognised concomitant of earthquakes. Thus Mallet, the greatest authority on the subject, says in the *Nautical Almanac* under the title, "Seismology or Earthquake Phenomena":—"Before, during, or immediately after the passage of the great earth-wave or main undulation, a continuous violent tremor or short quick undulation—like a short chopping sea—is often felt. This may arise from secondary elastic waves accompanying the great earth-wave—like the small curling or capillary waves on the surface of the ocean swell—produced probably by comparatively minute or secondary impulses, due to the discontinuous and heterogeneous nature of the formations through which the normal wave has been propagated. Sometimes, however, a number of shocks occur so rapidly as to convey the impression of a continuous jar or tremor, and may be succeeded by one or more *great* shocks; this is probably the source of 'tremor observed before the shock,' as the subsequent arrival of the transversal waves is of the tremors after it. (For other complications of the phenomena see Mallet's 1st, 2nd, and 4th Reports, Brit. Ass.) It is very desirable that the interval in time between these minor oscillations should be observed by a seconds watch, and also the total duration at each epoch of motion and of rest between consecutive movements. Narrators often confound the whole of each epoch of such rapidly recurrent shocks, with one shock supposed to last a considerable time."

FIG. 1

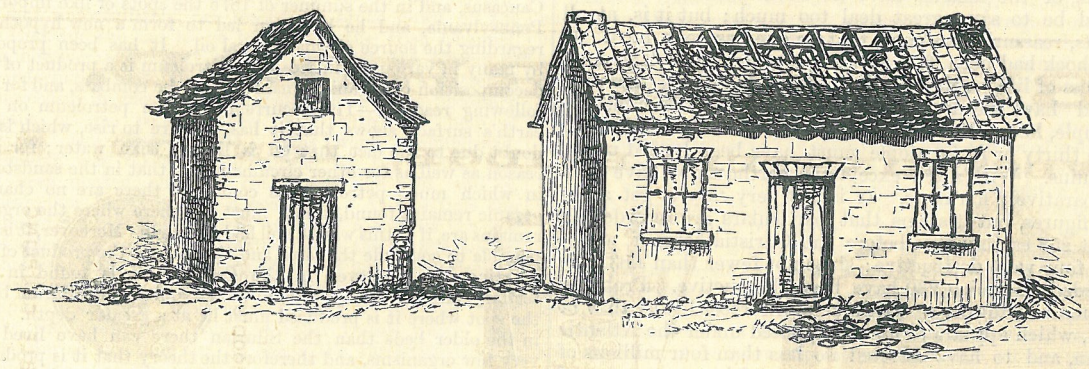
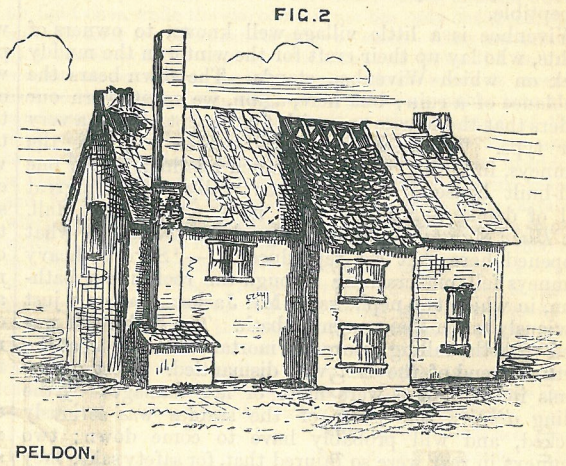
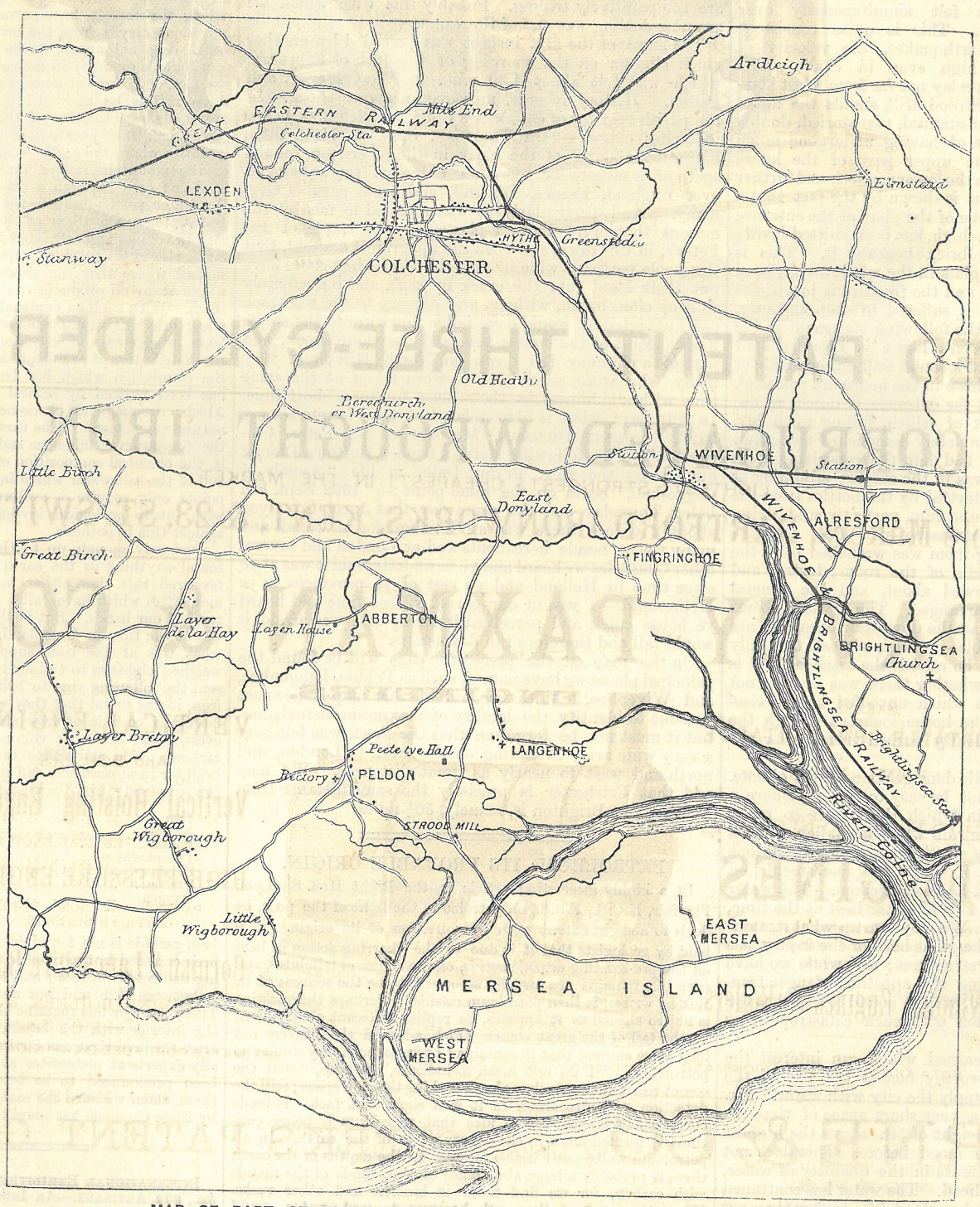


FIG. 2



EFFECT OF THE EARTHQUAKE ON HOUSES IN ABBERTON AND PELDON.



MAP OF PART OF ESSEX, AFFECTED BY THE EARTHQUAKE OF 22nd APRIL.

The accompanying map shows that portion of the district most severely affected. The nearer the sea level the worse the shock. Possibly some deductions of importance may be drawn from this. It is proper to state here, that only in a very few instances have really substantial buildings suffered at all. We read in the local press that Langenhoe Church has been completely destroyed. Those not living on the spot will naturally conclude that a church is a large and substantial edifice, and the circumstance that a church has been ruined will appear very alarming. As a matter of fact, however, Langenhoe Church was a small building crumbling to ruin, and we should say unfit for use. It possesses a large Norman tower, built, so far as can be gathered, at least 800 years ago. At some very remote period this tower leaned to the south-east, and was buttressed up by a huge rough mass of masonry. The tower has been cracked from top to bottom time out of mind; and it can be seen now that the mortar used in its construction was not very good. It is not remarkable, therefore, that the battlements on this tower were shaken off, and falling through the roof, of which the timbers were rotten, has involved the whole in destruction. The wonder is that Langenhoe Church did not fall down bodily of itself long since. The only specially interesting point about its destruction is that the ground at the south side of the church seems to have sunk. The stones in the floor of the little chancel have at one side perceptibly gone down. When it is borne in mind that the church tower had evidently needed propping up centuries ago, to keep it from sinking in the same direction, it is possible that the earthquake only developed and strengthened some original tendency to subsidence. Most of the strata here are brick earth on chalk; rather a treacherous foundation. Peldon Church is a much larger structure and in better preservation than Langenhoe Church. It, too, has a tower dating from the reign of the Conquerer. This also has a crack in it, but the crack has not been opened. The battlements have been shaken down on the roof of the church, and the lead flushing still stands up all round

where the battlements have left it. The tiled roof has been shaken off in great part, as in Fig. 1. Going into the church, it is seen that scarcely a portion has escaped. The whole structure shows the result of a violent shaking. The plaster has disappeared off the walls in all directions, and small cracks have been opened, which follow no particular direction. The chancel has been recently restored with flint facing and sandstone dressings. All this new work has been shaken ; that is the only word for it. The ancient buttresses of the church are cracked and split. An oak timber chancel arch, apparently new, has had all its joints opened. No disturbance of the floor is perceptible.

Wivenhoe is a little village well known to owners of yachts, who lay up their craft for the winter in the muddy creek on which Wivenhoe stands. The town bears the semblance of a ruin; but here, again, we must warn our readers that the houses are, with few exceptions, of a very poor type. The tiles have been shaken off, and the chimneys, in falling, have done much mischief. Only one well-built house in the place has really suffered a great deal of damage—Mr. Jackson's house, Wivenhoe Hall. The *Essex Standard* contains so good an account of what happened here that we reproduce it:—"Several heavy chimneys fell, one crashing through the roof into a bath-room, in which two nephews of Mr. Jackson had only just previously taken their morning bath. The bath itself was filled with the falling bricks and mortar. The gable at the north-east end of the hall was dismantled. Most of the rooms in the house were more or less damaged by the falling *débris*; the tower of the stables was seriously cracked, and will probably have to come down; two chimneys in rear were so injured that, for safety sake, they were at once pulled down; the north-east part of the entrance lodge, where the keeper resides, was greatly damaged, the top end being carried away, as well as some of the chimneys."

There is no evidence whatever available to show that the shock was not felt simultaneously over the whole district affected. This is quite consistent with what is known of earthquakes, the velocity of wave transit being very high even in chalk. The centre of maximum disturbance lay not far from West Mersea. On the roadside, near Strood Mill, stands the house of Dr. Green. This was a substantial, two-storied, double villa, and it gives evidence of having undergone much more than a shaking. The upper part of the house seems to have moved bodily on the lower portion; and further evidence of this lateral action is shown by the fact that a heavy flat cut-stone cap on one of the piers at the entrance gate, which pier is about 5ft. high, has been shifted bodily a couple of inches on the brick beneath it. This is the only house in which the glass in the windows has been directly broken by the shock, and the fracture is just of the kind produced when a sash is suffered to drop violently. There is no exaggeration in the following statement in the *Essex Standard*:—"Mr. Green's house is literally split from end to end—there is not a sound wall either inside or outside standing, all the windows in the house are smashed, the cap stone to the porch at the entrance is down, as also are the chimneys, one stack of which, falling upon Mr. Green's consulting-room, completely demolished the latter. Mr. Green, who fortunately had left the consulting-room only a few minutes before, was in the surgery adjoining at the time, and here he was startled by the bottles from the shelves falling upon and around him, perfectly smothering him with their contents. A massive pier glass over the mantelpiece in the drawing-room was wrenched from the wall, and fell into the middle of the room; lustres and other ornaments were strewed about, and the general furniture of the room disarranged. The upstair rooms suffered as much or more than the downstair ones, and are now altogether uninhabitable—in fact, almost the only room in the house that can be used is the kitchen." It is not easy to say in this case whether there was or was not any vibration, such as that which unroofed houses elsewhere. As we have said, the house looks as though the bottom of it had been violently pushed from under the top of it.

In Colchester there was little damage done worthy of note. We suppose that it would not be easy to find anywhere a town of such importance in which there were so many ricketty old chimneys. The ruin which has fallen on them is widespread, but no injury worth naming has been done to any well-built structure, if we except one steeple, off the top of which about 16ft. has been shaken. The water tower, which had about 930 tons of water in it at the time, remains entirely uninjured. We may sum up what remains to be said by stating that the great bulk of the injury has fallen on weak and ill-built structures; and while we have no intention of understating the appalling danger from which so many have escaped, we are bound to add that the shock had little in common with such catastrophes as those of Ischia or Java.

There is little to be learned which can interest the geologist. The most noteworthy fact is the rise of the water in the wells which supply the city with water. Mr. Clegg found that within a very short space of time the level rose in them to a height of 5ft. above the highest point at which it had ever stood before. This does not seem to be due to any increase in the quantity of water, but to an augmentation of head. The water has continued to rise slowly, and on Sunday stood 8ft. higher than yet recorded. This is probably due to a shaking of the chalk, which has opened up fissures communicating with water holes in the rock standing at a higher level than any previously tapped.

The freaks played by the shock are, in a few cases, noteworthy. At the "Rose" Inn, Pelden, the roof has, as usual, been shaken off, and the house is a good deal racked At the back is a brick chimney, some 15ft. high and 2ft. square; about half-way up it was supported by a band of iron put round, and a horizontal stay fixed to the roof behind it. The chimney has parted at the iron band, and the upper portion has been twisted round a couple of inches on the bottom. Another somewhat similar chimney has had all the bricks below the band loosened and ready to fall apart, as shown in Fig. 2. The upper portion is quite sound and unharmed. The circular stone tower, of Strood windmill, has been shaken and split all over, evidently by the vibration of the vertical wooden post carrying the mill above. Steam is supplied in aid of wind, by a small horizontal boiler in a house close by. The chimney, a square shaft, nearly new, some 35ft. high, and very well built, has parted at about two-thirds of its height from the ground, and the upper portion has twisted slightly on the lower. There is no evidence that any decided vortex motion was manifested by the earthquake, though the results are supposed to indicate this.

When additional scientific evidence has been collected we shall, perhaps, return to this subject. To say that the people of the district have no further cause for alarm would be to say a great deal too much; but it is, at all events, reassuring to know that no one has been hurt. If the shock had been felt at 9.20 p.m. instead of 9.20 a.m., the loss of life would have been very great: and the same would have been the case if Langenhoe Church, for example, had fallen on Sunday, when it is possible that some thirty or forty people must have been buried under the ruins. With a few exceptions earthquakes have been comparatively harmless. It is not very easy to get accurate figures, but it seems that particulars are recorded of about 258 earthquakes before the Christian era, of which only four were destructive; since not fewer than 6831 are recorded, of which 230 have been destructive. Probably the most noteworthy earthquake on record was that of 1755, which appears to have originated under the Atlantic Ocean, and to have affected no less than four millions of square miles. Lisbon was destroyed by a succession of shocks, the first being felt about half-past nine a.m. At Madrid, Gibraltar, Algiers, Funchal, in Germany and Sweden, successions of fearful shocks were felt. Throughout almost the whole of Great Britain and Ireland they were felt with more or less severity. England is by no means outside the earthquake zone ; but the shocks recorded are comparatively trifling. Possibly this with which we are now dealing was one of the worst.

The shock of the 21st instant was preceded by another much slighter on the morning of the 18th of February, which was felt about 1.30 a.m., in West Mersea and Pelten. History records, moreover, a severe shock. In the parish register of St. Peter's Church, Colchester, is the following entry :—"On Thursday, Sept. 8, 1692, there happened about 2 of the clock in the afternoon, for the space of a minute or more, an universal earthquake all over England, France, Holland, and some parts of Germany. And particularly it was attested to me by the masons that were there a-plastering the steple of St. Peter's, in this town, and upon the uppermost scaffold, that the steple parted so wide in the midst that they could have put their hand into the crack or cleft, and immediately shut up close again, without any damage to the workmen (who expected all would have fallen down), or to the steple itself. Most of the houses here and elsewhere shook, and part of a chimney fell down on North Hill ; and very many who were sensible of it were taken at the same time with a giddiness in their head for some short time. In witness of what is here related, I have hereto set my hand. Robert Dickman, Minister of St. Peter, Colchester." The following extract from "Bufton's Diary," quoted by the Rev. Bryan Dale, in his "Annals of Coggeshall," bears on the same point :—"1692 Sept. 8th being Thursday and the same day that Jacob Cox dyed about 2 o'clock there was an Earthquake at Coxall and many towns beside hereabouts and at London and several other Countries we heard and ye news-letter said it was at ye same time in Holland and ye rest of ye provinces in ye Netherlands—I was in our garret at that time and heard ye house crack and perceived it shake and was afraid it would fall and therefore ran downstairs."

On the map on the preceding page will be found the principal places we have named, such as Peldon, Langenhoe, and Wivenhoe. With the aid of this map it becomes possible to identify the locality of maximum disturbance, but it must not be forgotten that the shock was felt over a very wide area, extending on the south to London, and north and west to nearly as great distances. We may add that Colchester is precisely the same distance from London that Brighton is, namely, 50¼ miles.

PETROLEUM: ITS PROBABLE ORIGIN.

In a highly interesting article by the Right Hon. Sir Lyon Playfair, K.C.B., F.R.S., on petroleum, the light of the poor, he deals to a slight extent with the question of its origin. It is held by geologists that it is due to the charring action of heat on the pre-existing organic *débris*, on the bodies of trilobites, and such like remains are usually supposed to be the sources of it. But he writes, is then petroleum cosmic? Perhaps the question is not so absurd as it appears, he replies. Recent observations on the tail of the great comet which adorned the heavens not long since showed that it contained hydrocarbons very similar to petroleum. "I do not mean to indicate," he adds, "that the comet was a huge petroleum lamp rushing through space ; still the detection of hydrocarbon in it is a significant fact. It lends considerable support to the idea that petroleum is being continually formed anew in the deeper parts of the earth. In all petroleum wells water is also found. In the depths of the earth there is probably a large abundance of compounds of the metals with carbon, for we find them in basaltic and other rocks. When the crust of the earth becomes fissured, water would reach them at a high temperature and be decomposed, its oxygen passing over to the metals, while the carbon and hydrogen would unite to produce hydrocarbon, the most common form of which is petroleum. The gaseous hydrocarbons, formed by the same action, are pent up in these cavities, and, when a boring is made for a well, force up the petroleum frequently as high fountains. Wells of this substance are generally found at the base of mountain ranges, as of the Alleghanies in America or of the Caucasus in Russia. These elevations indicate cavities, fissures, or crevices below, and into these, as into a receiver, the hydrocarbons may have been distilled and become condensed. This is only a theory, but it is the one which is the most satisfactory to my mind, and, if it be true, it is a comforting one ; for while we find forests disappearing from the earth, and coal being exhausted without being formed afresh, petroleum—which as fuel has about twice the value of coal—is being constantly formed and deposited in nature's reservoirs. I have admitted, he says, that this is nothing more than a theory, and as such the practical mind is accustomed to look upon it with contempt. But theories are the leaves of the tree of knowledge, nourishing it while they survive, and even when they fall they give new nutriment to the parent stem. We probably may soon have a better theory, and when it comes we will embrace it."

Thus writes Sir Lyon Playfair in 1884. Now let us see what a Russian chemist said on the same subject now several years ago. M. Dimitri Ivanovitch Mendelejeff, on whom in 1882 was conferred the Davy medal by our Royal Society, is principally known for the calculations by which he certainly has in one case foretold the atomic weight of a new element—the metal gallium which he made out to be ekaaluminium. He had at an earlier period visited the source of the petroleum in the Caucasus, and in the summer of 1876 the spots of like import in Pennsylvania, and he has been led to form a new hypothesis regarding the source of this mineral oil. It has been proposed by many in various countries that petroleum is a product of the decomposition of organic remains. This he combats, and for the following reasons:—The occurrence of the petroleum on the earth's surface shows that it has a desire to rise, which is no doubt due to the fact that oil is lighter than water; for this reason as well as for other circumstances, that in the sandstones in which much petroleum is contained there are no charred organic remains found, which must be there where the organic remains are, if in this way the oil had its origin. Moreover, it is impossible to conclude that this and this only is the product of the charring. As, however, in the Caucasus it is found in the tertiary, and in Pennsylvania in the Devonian and Silurian beds, the spot where it is produced must lie at a greater depth. But in the older beds than the Silurian there can have lived but very few organisms, and therefore the theory that it is produced by the charring of organic remains is a very improbable one. When we consider the hypothesis of Laplace regarding the development of the earth at the outset, the law of Dalton respecting the original condition of vapour, of the constituents of the globe, and the density of the globe, taking into consideration the density of the vapour of the elements, it appeared to Mendelejeff necessary to assume the existence of a collection of metals in the interior of our globe. If now we suppose that among the metals iron prevails—this view was propounded long since, chiefly from the increased density of the interior—which does not appear to be improbable, since it is found in considerable quantity in meteorites, and in the constitution of the sun, and the existence, moreover, of carbon compounds of these metals be allowed—it will serve not only to explain the mode of formation of the petroleum, but to make conceivable all those peculiarities under which it is found in certain localities where the earth-beds, in consequence of the upheaval of the mountain ranges, must have suffered a break on the interior face. Through a fracture produced in such a manner, the water passed down to the carbon compounds of the metals, and acting upon them at high temperatures and pressures, metallic oxides and saturated hydrocarbons are the result. The latter rise in the form of vapour to those layers of the earth's surface where they can condense, and the porous sandstones, where many oil products can be taken up, are saturated with them. With such an explanation of the genesis of petroleum, many other natural phenomena can be explained—the prevalence of elements of low atomic weight on the earth's surface; the distribution of petroleum in straight lines or in large circles; the connection which has been traced with vulcanism, which has been noticed by several scientific men, and especially by Abich; the magnetic phenomena of the globe, and many other natural phenomena. The further metamorphosis of petroleum, the formation of mine-gas and unsaturated hydrocarbons out of it, the chemical composition of petroleum from various regions, and of the salt water which invariably accompanies it—all these points only require a continuous study, which, in connection with future geological investigation of facts, will tell for or against this hypothesis.

Curiously enough, up to the year 1870 there had not been found anything in the earth's crust which by its composition favoured this view, either in the earth's crust or among the meteorites which have fallen on the earth's surface, and have reached our hands. But in that year Baron Nordenskjöld, who was at the time in Greenland, found some remarkable masses of what was at the time supposed to be meteoric iron. Some weighed eighteen to twenty tons, and a Swedish gun-boat was sent the following year to bring them home. Unlike meteoric iron, it was found that they were insoluble in acid ; they consist largely of carbide of iron and oxide of iron ; when heated it evolves 100 times its volume of gas, which chiefly consists of carbonic oxide and a little carbonic acid ; the iron now becomes brighter in appearance, and soluble in acid. The composition to the supposed "iron" was found by Wöhler to be:—

Iron	80·64
Nickel	1·19
Cobalt	0·49
Phosphorus	0·15
Sulphur	2·82
Carbon	3·69
Oxygen	11·09
	100·07

Iron carbide is not found in meteoric iron. These blocks had been enclosed in the basaltic cliffs of Ovifak, which by weathering had set them free ; and they fell down the face of the cliff to between high and low water mark, where they were found. These more or less metallic blocks must have been erupted from the interior with the basalt, in which they were inclosed, and after the investigations carried on by chemists, who are especially experts at meteorites at most centres of cultivation, have been pronounced to be terrestrial rather than meteoric. In them, then, we have the material which the theory propounded by these chemists has sought for.

International Exhibition of Engines, Machinery, Tools, &c., for Artisans.—An International Exhibition for Artisans—Internationale Ausstellung von Motoren und Werkzeugmaschinen fur das Kleingewerbe—under the protectorate of the Archduke Carl Ludwig, will be opened in Vienna on the 24th July and closed on the 12th October, 1884. It is instituted by the Austrian Society of Arts—Niederoesterreichischer Gewerbe Verein—in Vienna, and will comprise all articles of interest for artisans, such as motive power engines, machinery, tools, physical and chemical apparatus, and materials for industrial schools. The Exhibition will be held in the buildings of the Horticultural Society on the Park Ring, therefore in the centre of the town. Numerous applications for space have been made by manufacturers of small motive power engines, and of machinery and tools for carpenters, shoemakers, tailors, and other artisans. The intending exhibitors have been mostly Austrian and German firms, but it is expected that English and American firms will participate largely as soon as the Exhibition becomes more widely known. Applications for space are to be addressed to the Gewerbe Verein, Vienna, before the 15th May.