per inch, the gauge may work within these limits, but when exceeded, an additional hand would show by inspection whether, and by how much the pressure had been exceeded. A correct gauge with such an appliance kept under lock and key, under the charge of a mine inspector would make the enactment alluded to of real practical benefit, at present it is of little use. If an engineman put an extra weight upon his safety valve he would by this means be sure of detection.

I have to apologise for the length of this communication, but the subject is one which deserves every consideration.

I remain, Sir,
Your's truly,
MECHANIST.

UCHATIUS' STEEL PROCESS.

SIR,—It is a subject for much congratulation to the railway and engineering interests generally that this important discovery has been taken up so promptly, as appears by the newspapers, and is already in the hands of an influential firm, like the Ebbw Vale Iron Company, for it is a warrant that there is no room for doubt as to the perfect practicability of the new system and, what is still more valuable, a proof that *English* pig iron of moderately low price is available for steel making, so that in lieu of the thirty thousand tons of Swedish and Russian bar iron we are importing annually at a loss to our manufactures of half a million of money, that much will be nearly saved us. It is difficult to realise the immense importance of this new process to the country, especially if the manufacture of the atomic steel is at once prosecuted and perfected with the spirit common to English works, for they will immediately reach a point as to quality far above foreign competition, as they always do. It is asserted that the Ebbw Vale Company have satisfied themselves by very extensive experiments that the Uchatius cast steel, unlike the ordinary cheap (puddled) steels, is suitable for boring and turning tools, springs, files, saws, wire, and every purpose to which best steels are applied, indeed it is stated that it cannot be distinguished from the best description of Sheffield steel, either by analysis, or when under the hammer, or in the smith's hands, if this is true, and now there is no reason to doubt it, there is no invention of modern times of greater importance to English industry, for as lightness and strength combined, is desirable in nearly every description of machinery, cast steel will be turned to purposes hitherto never surmised, being prohibited by its costliness, under these circumstances a bright future may be safely prophesied for the steel trade, which must, without doubt, be immensely extended. We must not lose sight of the most important of all the points in the invention of M. Uchatius, namely, what he says in his patent about *modifying the quality of his steel exactly according to his pleasure* by simply varying his mixture. Could this be done by any previously invented process? ENGINEER.

WESTMINSTER IMPROVEMENTS IN CONNEXION WITH THE GOVERNMENT OFFICES COMPETITION.—Definite areas of accommodation for the several offices being given, competitors should have been allowed to make their own suggestions both as to the general site, and the mode of dividing and utilitising it. Probably, excellent suggestions might have been received for the conversion of ground including the south side of Great George-street. Suggestions have appeared in several quarters for the opening up of the end of St. James's-park, and its extension to the river. Is not something of the sort desirable, at least? and would it not have been well to allow the suggestion to appear on paper? Yet, for any such plan, the site, as at present marked out, allows no chance. The site of Richmond-terrace, and the ground along the east of Whitehall, might be admirably well appropriated. Yet no competitor can offer a design making any use of that ground, and receive a premium, unless through an act of injustice to the other competitors. Sir C. E. Trevelyan, in his evidence, even suggested a plan for the concentration of the offices, in which he comprehended the full use of the Whitehall site, and new buildings for the Admiralty and Horse Guards. We should not have approved of his scheme in so far as it included a building, following Inigo Jones's design for Whitehall Palace– because, with a full sense of the loss of art which there often is from the modification or abandonment of well-considered plans—we doubt whether it is generally advisable to go so far back for designs, and whether existing architectural talent could not produce something equally good in art, original, and more appropriate. But the main idea deserved to be left for the consideration of architects. We are tempted to ask whether any supporters of the Government dwell in Richmond-terrace? The Duke of Buccleuch, hard by, it was said, got his lease renewed, to the disadvantage of any project such as the present, during the time of the Derby-Disraeli Administration. Are there any supporters of the Government farther north with whom it is not thought desirable to interfere?—*The Builder*.

EDUCATION AMONGST THE COLLIERS.—Symptoms of a desire for self-improvement has been recently manifested by the colliers of Lancashire and Yorkshire, who have for some time been endeavouring to promote the education of their children, by seeking the aid of the law in their behalf, in the same way as has already been done for factory children—little time being, under present arrangements, permitted for their education. Influential parties have entered into the movement, and it is expected that a bill may be brought before Parliament, next session, making it compulsory for every boy to have attended school a certain length of time before being employed in a colliery; and also, that when so employed, he should be sent to school half his time.

SAPPERS AND MINERS.—The suppression of the Sappers and Miners as a separate corps, and their incorporation with the Royal Engineers, of which announcement has already been made, is an event of interest beyond mere professional circles. In the history of science, as well as in the military annals of England for nearly a century past, the corps of Royal Sappers and Miners has occupied a conspicuous place. From the siege of Gibraltar, when the corps was first organised, in 1772, down to the siege of Sebastopol, the services of these military artificers have been of the utmost importance in time of war, and not less valuable in peaceful operations conducive to the national honour and welfare. Detachments of the corps placed at the disposal of the Astronomer Royal and other men of science, have furnished observations and conducted researches of the most difficult nature. In the Survey of Great Britain under the Board of Ordnance, and in similar operations in the colonies, the labours of the Sappers and Miners are well-known and appreciated. The records of geographical exploration in all parts of the world also attest their services, whether in the frozen regions of the Pole or in the torrid zone of Africa. It is almost with regret that one reads of the suppression of such a corps, even though only in name. But their incorporation with another corps whose duties and training are similar seems a natural step in the efficient organisation of the army, especially as the Sappers and Miners have always been officered by the Royal Engineers.

THE UCHATIUS STEEL PROCESS.—We are glad to learn that this patent, for the manufacture of steel direct from pig-iron, which was fully described in last week's journal, has passed into the hands of the Ebbw Vale Iron Company, well known as the largest iron manufacturers in England: this firm having discovered that their iron fields contain unlimited quantities of materials suitable for making the finest steel, by employing the new process; and we must congratulate the railway and engineering interests upon the prospect of the rapid realisation of their most sanguine hopes as to the production of a steel suitable for their purposes at the price hitherto paid for good iron, as, of course, the immediate result of this extraordinary discovery will be the manufacture of steel upon a gigantic scale.

METROPOLITAN BOARD OF WORKS.

ON Friday the ordinary weekly meeting of the Metropolitan Board of Works was held at Guildhall, Mr. John Thwaites in the chair.

PROPOSED PARK FOR BERMONDSEY AND ROTHERHITHE.

Mr. Miskin introduced a deputation, who presented a memorial from the vestry of Rotherhithe, relative to the formation of a park there. If the park were formed at Rotherhithe, the old mill stream, and the many stagnant ditches in the locality could be filled in; while the sewerage of the district could be improved during the construction of the park; and if a lake was formed the water could be used in flushing the sewers proposed to be made. The park could be easily approached from the north side of the Thames by means of the Thames Tunnel, and would be a general benefit to at least a quarter of a million of people. The park would cover 86 acres, the principal portion of which was garden ground, 32 acres being in Bermondsey and 54 in Rotherhithe. The probable cost would be about £40,000, of which £32,000 would be for the land. To keep up the parks and pay wages of keepers, &c., about £400 a-year would be required. The proposed park could be easily approached by the railway at each end.

After some conversation the memorial was ordered to be received.

IMPROVEMENTS IN SOUTHWARK.

A report from the Committee of Works and Improvements, recommending that necessary surveys be forthwith made for widening Union-street, Southwark, in conformity with the recommendation of Mr. Irvine, in his suggestions for improvements in the Borough of Southwark, was received.

THE METROPOLITAN DRAINAGE SCHEME.

Mr. Deputy Harrison moved that the Chairman, accompanied by the engineer and clerk, wait upon Sir Benjamin Hall with the plan for draining the metropolis.

Mr. Carpmael seconded the motion.

A long dissussion ensued, during which several hon. members objected to a deputation of the Board taking up the plan, suggesting that the plan should be forwarded to Sir Benjamin Hall, under the seal of the Board. Ultimately, the motion that the chairman, engineer, and clerk take up the plan, was carried by eighteen against eight.

THE WESTMINSTER CLOCK.

THE history of the Great Clock intended to be fixed in the clock-tower of the New Houses of Parliament, dates as far back as the year 1844, for it was in the month of March, in that year, that Mr., now Sir Charles, Barry, first wrote to Mr. Vulliamy to furnish him with a plan for the clock, at the same time inquiring upon what terms he would furnish such plan, first, in the event of his being employed to make the clock, and secondly, in the event of his not being employed. In reply, Mr. Vulliamy named 100 guineas for the specification, calculations, working, and other drawings, if he were employed, and an additional 100 guineas if he were not employed.

Shortly afterwards, Sir Charles Barry wrote to the Board of Woods and Forests, saying it was desirable to have the specifications and estimates prepared, forwarding copies of his communications with Mr. Vulliamy, and recommending the acceptance of his offer, which the Board subsequently agreed to. In January, 1845, Mr. Vulliamy, in a letter to Sir Charles, noticed a mistake he had just then observed, viz., that the Board had spoken in its letter of an estimate being prepared, which he (Mr. Vulliamy) had not contemplated making. This communication does not appear to have been answered by the Board or Sir Charles Barry, excepting so far as it was done by a letter, dated July, 1846.

In November, 1845, the late Mr. Dent wrote to the Board, desiring to be admitted as a candidate for supplying any clocks required for the New Houses of Parliament, including the large one, referring to the Exchange clock as a work of his, and suggesting, in the case of the large clock, that it should be subject to the approbation of the Astronomer Royal, with Sir Charles Barry, and Sir John, or Mr. George Rennie, as referees. To this request the Board replied, that when the drawings and specifications were completed as the basis upon which the tenders were to be founded, he should be included among the competitors. To this Mr. Dent objected, declining to follow the plans of another clock-maker, but stating his willingness to comply with any suggestions from the Astronomer Royal. In consequence of this objection, it appears that Lord Canning consulted Mr. Airy as to the best means of obtaining such a clock as should be "the very best that the science and skill of the country" could supply. In answer to this inquiry, Mr. Airy alluded to a similar one which had been made by the Gresham Committee, in 1843, with respect to the Exchange clock, and that the reply he then gave was that certain conditions should be laid down, which he himself proposed to furnish; and he further proposed to give a certificate of the work when completed. These suggestions being followed in the case of the Exchange clock, the result had been the production of a clock which was superior to most astronomical clocks, and possessing these advantages, that the first stroke of each hour is correct as to time within less than a second, and that a person standing on the pavement can take time from the face without an error of a second. He suggested the names of Mr. Vulliamy and Mr. Whitehurst as the best makers; but the work was placed in the hands of Mr. Dent, who carried out his views most completely, making some judicious alterations. In conclusion, he proposed that his conditions should be submitted to Mr. Dent, for the purpose of obtaining a tender. The Board did not, however, adopt the recommendation of Mr. Airy; but from Sir Charles Barry's letter to Mr. Vulliamy, dated July, 1846, it appears that Mr. Airy's conditions were submitted to both Mr. Vulliamy, Mr. Whitehurst, and Mr. Dent. It also appears that the tenders were to include the estimated cost of the clock complete. Mr. Airy laid down fifteen principal conditions which were to be followed, the chief of which were, that the frame was to be of cast-iron; the wheels of hard gun-metal, with steel spindles; the pallets were to be jewelled, and the escapement a dead-beat one. Further, the pendulum was to be compensated; the train to have what is called a remontoire action; the minute-hand to have a discernible motion at certain definite intervals; and the striking machinery to be arranged so that the first blow for each hour was to be accurate to within a second of time.

In April, 1847, Mr. Vulliamy transmitted to the Board, through Sir Charles Barry, his drawings and specifications, but without any estimate, having previously declined to become a competitor under Mr. Airy's conditions. The tenders of Mr. Dent and Mr. Whitehurst were about this time also forwarded to the Board, and were, together with Mr. Vulliamy's plans, submitted to Mr. Airy. In May, 1847, Mr. Airy reported to the Board to the effect that having examined their factories, either Mr. Dent or Mr. Whitehurst were capable of constructing the clock satisfactorily, noticing the great difference between the two estimates sent in, Mr. Whitehurst's being £3,373 and Mr. Dent's £1,600; but admitting that he could not account for it, unless on the supposition that Mr. Dent was disposed to construct the clock at a loss, for the sake of the reputation he hoped to acquire by making it; whereas he presumed Mr. Whitehurst's was a paying price. He finally declined to offer any suggestion as to which of the two candidates should be employed. In a separate letter to the Board, Mr. Airy remarks upon the plans, &c., of Mr. Vulliamy, which had been submitted to him, as wanting nothing in regard to provisions for strength, solidity, or size, but that they failed in delicacy of action; amounting simply to a large village clock, but of a very superior character.

From May, 1847, to January, 1850, nothing further was done in the matter of the Great Clock; and at that time Mr. Denison suggests a doubt in the preface to his book on clock making, whether the clock would really ever be made at all.

Shortly after this, however, this important and so much talked-of work was finally placed in Mr. Dent's hands, and, in 1854, we find it had already been at work for two years, in the very place where it at present stands, in Mr. Dent's factory.

Our illustration, fig. 1, is taken from a photograph, obtained with considerable care in the upper floor of the factory, the instrument being placed upon the top of a pair of steps mounted upon two lathes, in order to obtain the best plan view of the various parts. The large timber framework upon which the clock-frame rests was fitted up in a very substantial manner, in order to prevent vibration, the upright timbers being carried down through the lower shop, and well buried in the ground. The pendulum rod, which is several feet in length, works through an opening in the floor of the upper shop, the lower end of the bob being situated nearly on a level with the floor of the lower shop, and having a graduated arc, fixed at the front of the rod, for measuring any variation which may take place in the arc of vibration. The clock has now been going for upwards of four years in its present situation, its entire completion being delayed from the necessity of determining its exact position in the clock-tower before the spindles, &c., for communicating motion to the hands could be finished. It must be understood that the clock-frame and wheel-work may be placed at any part of the tower most convenient, the motion being carried up to the dial-plates by means of a vertical spindle, the lower end of which is shown in the illustration.

The merit of the design of the Westminster Clock is due to Edmund Beckett Denison, Esq., M.A., a gentleman who has devoted very considerable time to the study of clock and watch-making, and who has at various times introduced many important improvements in their construction. The dials of the clock are to be twenty-two feet in diameter, the largest in the world with a minute hand; the larger dials on the Continent having only hour hands. The minute hand, on account of its great weight, and the velocity at which it must travel, together with the action of the wind upon it, will require about twenty times as much force to drive it as the hour hand. Moreover, the clock going a week instead of a day, again very considerably increases the weight and strength required, especially in the striking parts. It is stated that with hands of the size intended, it would be impossible for the clock to go, even as well as an ordinary church clock, if there were no remontoire work, and this has therefore been adopted. It has, in fact, a train remontoire and a gravity escapement, this latter being shewn in our illustration, Fig 2. The train remontoire is for the purpose of giving a visible motion to the hands at every half minute, when the point of the minute hand will move nearly seven inches. The gravity escapement is adopted because it is more independent of these peculiar causes of vibration which are found to affect clocks in such a position as the Westminster Clock will occupy. The great wheel of the going part is twenty-seven inches in diameter; the pendulum is fifteen feet long, and weighs 682 lbs.; and the scape-wheel, which is driven by the musical-box spring on the third wheel, weighs half-an-ounce. All the wheels, except the scape-wheel, are of cast iron, but with the teeth cast, not cut, and all have five spokes.

The barrel is 23 inches diameter, but only 14 inches long, as this part will not require a rope above $\frac{1}{2}$ inch thick, and 55 turns in the $8\frac{1}{2}$ days, for which that part is to be capable of going, though the striking parts go only $7\frac{1}{2}$ days, so that in case of an accidental omission to wind it up on the proper day, the clock may not stop, but proclaim the neglect by silence. The second wheel is 12 inches in diameter, with a lantern pinion of 12, driven by 180 teeth on the great wheel; it has 120 teeth, and drives the pinion of the spring remontoire and the fly. This part has all the back pivots on the great clock-frame, and the front ones on an intermediate bar laid upon two cross ones, the width of the frame for the striking parts being very nearly 5 feet, whereas only 2 feet is required for that of the going part. The leading-off arbor, however, comes to the front of the great frame, and there are the snails for discharging the striking parts, and also the first pair of bevelled wheels, which are 16 inches in diameter. The winding arbor also comes through the front frame.

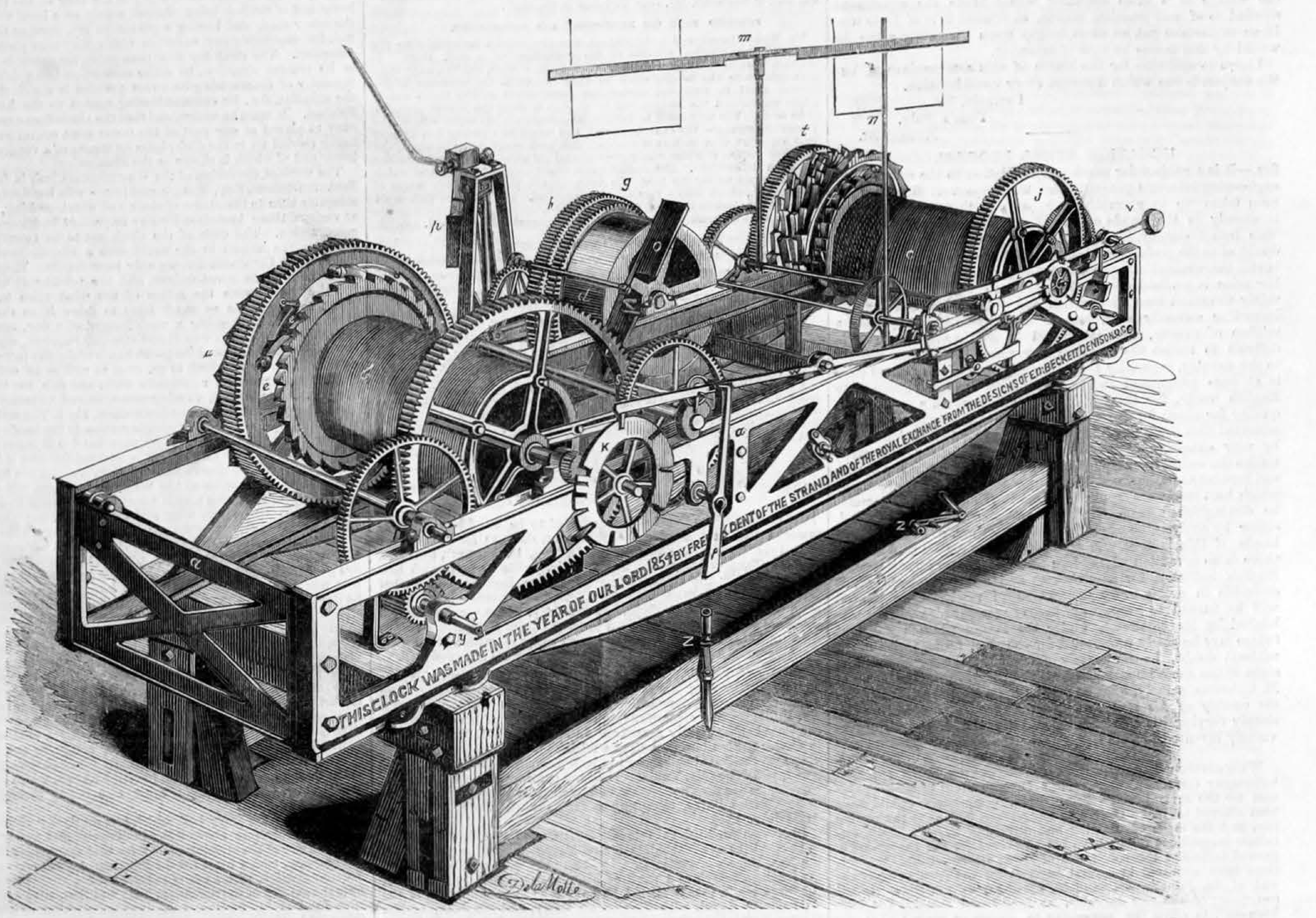
The size of the hour bell, which was originally given as 14 or 15 tons, and therefore above 9 feet in diameter and nearly 8 feet high, fixes the size of the striking parts; for that determines the weight of the hammer, which must not be less than 4 cwt., according to the usual proportion, with a rise of at least a foot; it will probably be cast from the pattern of the pendulum bob; and that, with a proper allowance for loss by friction, &c., fixes the striking weight at something more than a ton and a half; and that requires a wire rope of a certain thickness (6-10 in.); which must have a barrel of a certain length and diameter for such a number of coils as will give the most convenient arrangement of the striking cams, which are 18 in number, cast on a wheel of 37 inches in diameter; and that size again was necessary in order to keep all the wheels clear of the barrel. The cams are $2\frac{1}{4}$ inches thick, the same thickness as the great wheels; and the hammer lever is of corresponding size. The winding wheel on the end of the barrel, both of the hour and quarters is of the same size as the respective great wheels, and as a double multiplying power is required for winding up, the second winding wheel and its pinion are also the same as those of the train in each case; these winding wheels push out of gear with the great winding wheels, but not with their own winding pinions, which are made long for the purpose. There is a contrivance for stopping the winding when the clock is going to strike, as the winding of each of the striking parts will take two hours. The second wheels are a little more than 18 inches in diameter. The second train wheel in each striking part drives a bevelled wheel, which drives the fly above the clock on a vertical arbor, as in the Exchange clock, in order to keep it out of the way of people winding or examining the clock. The great wheels all have 180 teeth; the second wheel of the hour-striking part has 105 and a pinion of 15, so that it turns two thirds round at each blow, and the lifting cylinder upon its arbor has 3 segments cut out of it, and two of them are passed at each blow—probably a novel arrangement, but the most convenient here with reference to the numbers of the teeth. The size of the hour-bell also determines that of the quarters; the largest quarter bell will be about the same size as the great bell of St. Paul's, which weighs $5\frac{1}{2}$ tons. In the quarter part the arrangement is much the same as the hour. The eight cam wheels, which in fact form a chime barrel for the eight hammers of the four bells, have been mentioned already. The levers are 19 inches long from the arbor to the end which is pulled down by the cams, and the wire goes up from near the end, the wheel turning, so that the weight acts as directly as possible on the levers, with nothing but differential pressures either on their arbor or on that of the great wheel. The great wheels in this part are $38\frac{1}{2}$ inches in diameter, and the whole mass of the barrel, great wheels, and cam wheels weighs no less than 17 cwt. This clock may be said to be at least eight times as large as a full-sized cathedral clock, since the wheels are rather more than double the size in every dimension. The whole of the wheels, except the fly wheels and winding pinions, lie on the top of the great frame, which is a trussed girder frame 19 inches deep (like the girders of the Crystal Palace), resting on two walls 11 feet apart which come right up from the bottom of the tower. The frame is $15\frac{1}{2}$ feet long; and the striking pulleys about $2\frac{1}{2}$ feet in diameter, and pivotted in. To test the strength of cast-iron teeth, a segment of one of these great wheels was tried up to breaking point, and it bore a pressure of 6 tons, and then only broke from the pinion not bearing quite flat upon it: the heaviest weight which the teeth can have to bear in action will be about half a ton.

The pendulum of the clock is a compensation one, *i. e.*, it is so contrived that the centre of the bob is always kept at the same height. Various contrivances have been adopted from time to time for the purpose of compensating pendulums, the old form being known as the gridiron pendulum, which was composed of nine alternate bars of brass and iron. This was superseded by a pendulum of the same form, but composed of zinc and iron.

Fig. 2 is a section of the pendulum of the Westminster Clock. The iron rod which runs from top to bottom ends in a screw with a nut N for adjusting the length of the pendulum after it was made by calculation as near the right length as possible. On this nut rests a collar M, which can slide up the rod a little way, but is prevented from turning by a pin through the rod. On a groove or annular channel in the top of this collar stands a zinc tube 10 feet 6 inches long, and nearly half an inch thick, made of three tubes all drawn together, so as to become like one; for it should be observed that *cast* zinc cannot be depended on; it must be drawn. On the top of this tube or hollow column fits another collar with an annular groove much like the bottom one M. The object of these grooves is to keep the zinc column in its place, not touching the rod within it, as contact might produce friction, which would interfere with their relative motion under expansion and contraction. Round the collar C is screwed

THE GREAT WESTMINSTER CLOCK.

Fig. I.



a, *a*, Cast-iron Framing.
b, Hour-striking Barrel.
c, Quarter-Striking Barrel.
d, Going Barrel.
e, Ratchet and Clicks for Hour Barrel.
f, Ratchet and Clicks for Quarter Barrel.
g, Wheel for Winding Going Part.
h, Great Wheel for Going Part.
i, *i*, Gear for Winding Hour-striking Weight.
j, Gear for Winding Quarter-striking Weight.
k, Hour Locking Plate.
l, Quarter Locking Plate.
m, Quarter Fly (the Hour Fly is not shown, but is similar to the Quarter one).
n, Spindle for moving Hands; the Horizontal Bevel Wheel belonging to it is not shown, but the Vertical Bevel Wheel for driving it is seen behind the Spindle.
o, Remontoire Fly.
p, *p*, Temporary Suspension and Framework for Pendulum.
q, Locking and Warning Piece of the Hour-striking part.
r, Quarter Snail.
s, Fly Wheel for Striking part.
t, Cam Wheels for Raising Quarter Levers.
u, Cam Wheels for Hour-striking part.
v, Quarter Lever with Counterpoise at end.
w, Hour Lever.
x, Locking Arm for Quarter-striking part (the position of this lever is vertical when in action).
y, Square for Winding Weight.
z, *z*, Two Winders for Quarter and Hour parts.

a large iron tube, also not touching the zinc, and its lower end fits loosely on the collar M; and round its outside it has another collar of its own, D, fixed to it, on which the bob rests. The iron tube has a number of large holes in it down each side, to let the air get to the zinc tube: before that was done it was found that the compensation lagged a day or two behind the changes of temperature, in consequence of the iron rod and tube being exposed while the zinc tube was inclosed without touching the iron. The bottom of the bob is 14 feet 11 inches from the top of the spring A, and the bob itself is 18 inches high with a dome-shaped top and 12 inches in diameter. As it is a 2-seconds pendulum, its centre of oscillation is 13 feet from the top A, which is very near the centre of gravity of the pendulum, and higher than usual above the centre of gravity of the bob, on account of the great weight of the compensation tubes. The whole weighs 682 lb., which is half as heavy again as the Post-office clock pendulum, which was before the heaviest probably in the world, it has a wooden rod with an iron bob. The same proportions hold for zinc compensation pendulums of smaller size, the zinc tube and the iron tube being always nearly two-thirds of the length of the main rod. The compensating action is this: the iron rod and tube both let the bob down as they expand, and the zinc column pushes it up: and as the ratio of expansion of iron to zinc is ·41, it will be found that by the above proportions the centre of oscillation will remain at the same height.

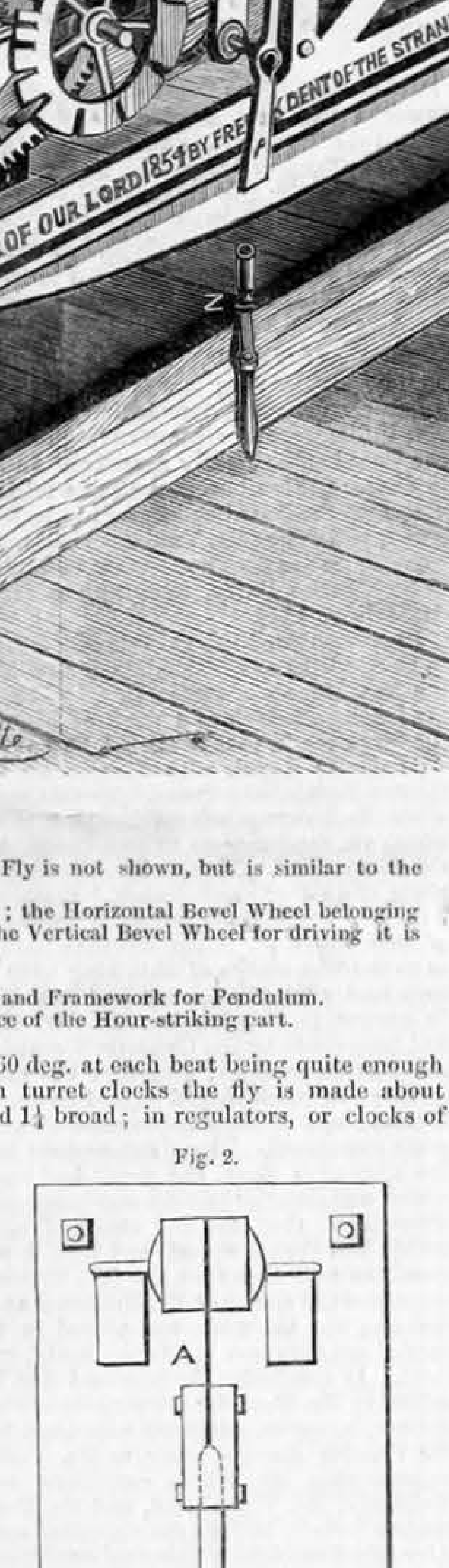
Two other kinds of compensation pendulums are in use, the one consisting of a wooden rod, with a long lead bob resting on a nut at the bottom; the other being the mercurial pendulum. The best form of the latter being those in which the mercury is enclosed in a cast iron jar, into the top of which a steel rod is screwed, with its end plunged into the mercury. By this arrangement all acquire the new temperature at any change more nearly together than when the mercury is in a glass jar, hung by a stirrup at the bottom of the rod.

The kind of escapement adopted by Mr. Denison for the Westminster Clock is a remontoire, or gravity escapement, which is illustrated in Fig. 3. The three teeth, or legs, are bent, so that the lifting-pins and the points of the teeth lie alternately on the radii of a hexagon. The pins are plain bits of brass wire rivetted into the scape-wheel, which is of steel.

The pins raise the pallets by the projecting faces A, B, and the long teeth rest on the stops D, E, which are bits of steel screwed on, and hardened after they are adjusted. The points of the teeth are about six times as far from the centre as the pins are, and consequently their pressure on the stops is not enough to hold the pallets up if they do by accident get thrown too high; and thus the effects of approximate tripping are prevented, for the pallet immediately falls down again, and rests against the pin which lifted it until the pendulum returns and carries it off; moreover the friction at unlocking is thus rendered insensible. The beat is adjusted by two thumb screws with broad and slightly convex steel heads set in the pendulum rod, which are embraced by brass fork pins from the bottom of the pallets. In turret clocks, where there is plenty of room, there are no beat screws, but the fork pins are made eccentric and so adjustable by the nuts which fix them to the pallets. In the finest clocks the lifting faces of the pallets are jewelled, so that no oil is required. In turret clocks, however, there has been a striking proof that the escapement is sufficiently independent of oil; for the first of these clocks was sent out to the cathedral at Fredericton, and the person who takes care of it reports that he could observe no variation of the arc during winter, even while the oil was frozen as hard as tallow. A very material feature in this escapement is the fly, which is set on the scape-wheel arbor, with a friction spring, just like a common striking fly. It is this which moderates the velocity and renders it safe against tripping, and against any damage to the teeth from an accidental run, the motion of 60 deg. at each beat being quite enough to render the fly effective. In turret clocks the fly is made about 5 inches long in each vane, and 1¼ broad; in regulators, or clocks of

Fig. 3.

Fig. 2.



astronomical size, about 1½ long and ¾ broad. The stop E, which is struck upwards, should be set a little higher than the scape-wheel centre; for if not, the blow has a tendency to throw the pallet out and make it trip, if the force is much increased; the other stop D may be about on a level with the centre, and the distance of the pins from the centre may be about 1-36th of the distance of that centre from the pallet arbors; the weight of the pallets should be such as to make the pendulum swing not less than 2deg., nor more than 2½deg. In regulators, the distance of centre has been generally made 6 inches (the scape-wheel being put near the bottom instead of the top of the frame), and in turret clocks 9 inches, except in the great Westminster Clock, where it is 12 inches, on account of the great size of the pendulum, which was made before this escapement was invented. Besides the other advantages, it supersedes the necessity for a long and heavy pendulum, which is generally wanted to resist the variations of force in the escapement; but here no such variations exist, at least none that reach the pendulum.

In working the Westminster Clock wire-rope has been used in preference to hempen, not only because it lasts longer, if kept greased, but because a sufficient number of coils will go on a barrel of less than half the length which would be required for hemp ropes of the same strength without overlapping, which it is as well to avoid if possible, though it is not so injurious to wire ropes as it is to hemp ones. By this means also the striking cams can always be put on the great wheel instead of the second wheel, which saves more in friction than could be imagined by any one who had not tried both. In the great Westminster Clock it was thought of so much consequence to get the striking from the great wheel, both in the hours and in the quarter chimes on four bells, that eight cam wheels are used for the quarters, as some of the blows are repeated on the same bell too closely to get sufficient drop for the hammer levers without using two alternate hammers to each bell. If it had been made on the plan first proposed of striking from the second wheel, and the friction aggravated by a number of pulleys and hemp ropes, which must have been an inch and a half thick, the striking weights would probably have been nearly four tons each, although they have the enormous fall of 170 feet; and the clock would have taken a whole day to wind up. As it is, they will be a ton and a half each, allowing a waste of about a quarter of the force, in friction, and in the interval between the fall of the hammer and its beginning to rise again.

In the case of the Westminster Clock, the annoyance of the clattering of the clicks, during the several hours it will take to wind up, is got rid of by stopping their drop on to the teeth by check springs, for which there is plenty of room.

We have thus given what we fear will be considered a somewhat imperfect description of the Great Westminster Clock, and have noticed some of the chief points of interest which render it different from any clock which has yet been constructed. For most of the facts given above we are indebted to the small treatise on Watch and Clock-work by Mr. Denison, as also to the article in the eighth edition of the Enclycopædia Britannica. We are also indebted to the present Mr. Dent, and his manager, Mr. Smith, for the assistance they have at all times rendered us in explaining many of the minute parts and most ingenious contrivances which characterise this beautiful piece of mechanism. Some of these parts, though exceedingly simple, both in their construction and action, nevertheless would be difficult to make easily understood. When the time arrives for fixing the clock in its place, we shall have another opportunity of referring to the subject, and probably illustrating the mode in which the motion is to be given to the hands on the several dials, as also the mode of illuminating them, with details of their construction. Until then, we trust that the sketch we have given will be interesting to our readers, many of whom, though well-skilled in mechanical science, will yet doubtless be interested in knowing the peculiar methods adopted in the construction of the largest and most beautiful piece of clock-work which has yet been produced.