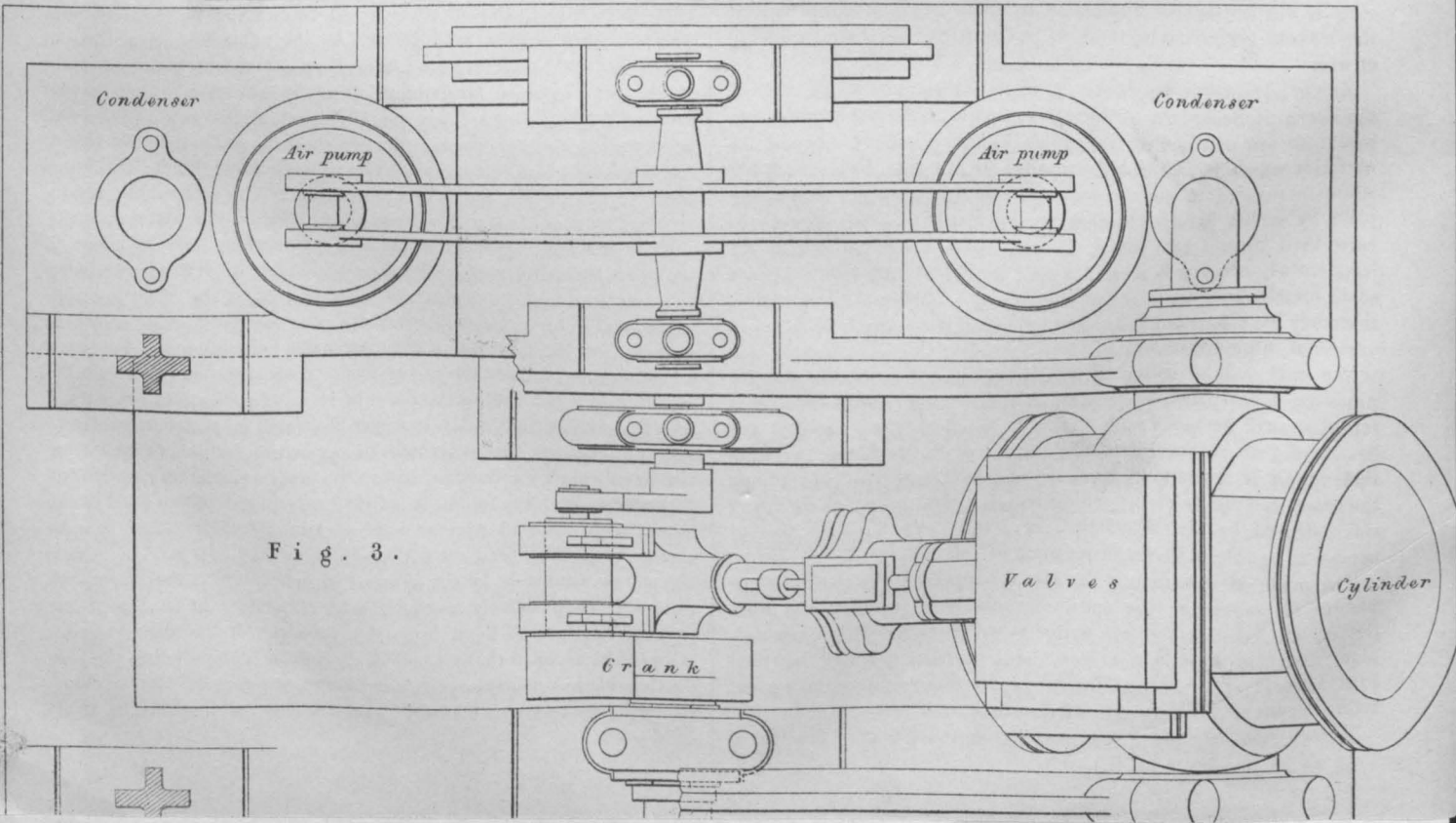
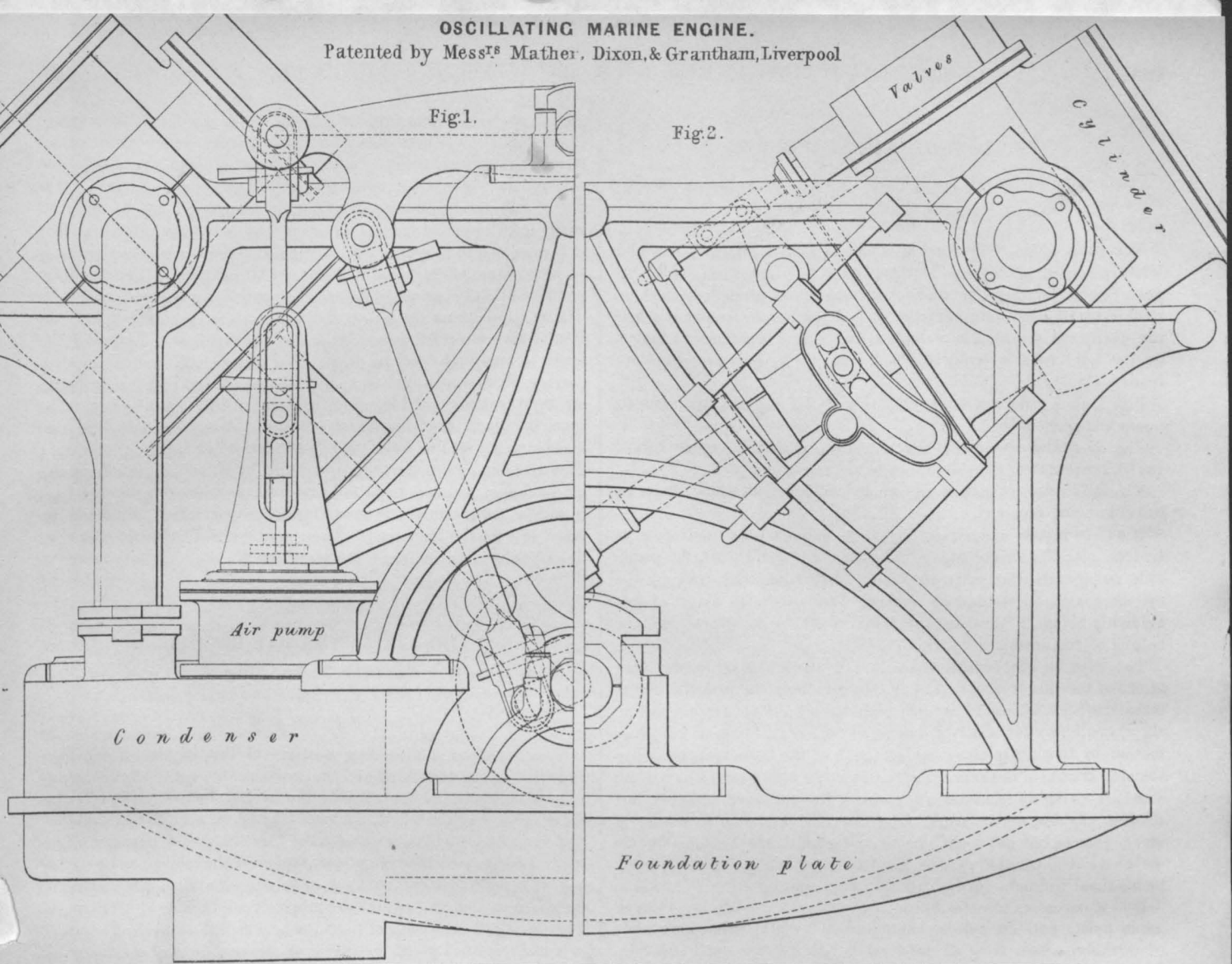


OSCILLATING MARINE ENGINE.  
Patented by Mess<sup>rs</sup> Mather, Dixon, & Grantham, Liverpool



## OSCILLATING MARINE ENGINE.

Patented by Messrs. MATHER, DIXON & GRANTHAM, of Liverpool.

(With an Engraving, Plate IX.)

WE have given a drawing of a pair of marine engines, on a plan lately patented by Messrs. Mather, Dixon and Grantham, of Liverpool, for an improved method of driving screw propellers; and we shall endeavour in a future number to add another arrangement showing nearly the same form of engine, but suited to vessels having a deeper hold than is required for the engines we now present to our readers.

Fig. 1, shows the half-side elevation of the engines, with one air pump and condenser.

Fig. 2, shows the other half elevation, with the engine turned round, representing the side opposite to the air pumps.

Fig. 3, is a ground plan of the whole arrangement, the cylinder on one side being removed.

It will be readily understood that these engines have oscillating cylinders, placed at right angles and opposite to each other, the piston rods being each attached to one crank. In the annexed drawings the cylinders are represented as working downwards, the object of this evidently being to allow the propelled shaft to be placed near the bottom of the vessel.

The engines are constructed with a foundation plate to which are attached the side frames that carry the cylinders; the pedestal of the main shaft is attached to the bed plate having the condensers cast on it; a small counter shaft is employed to work a beam which gives motion to two air pumps; one gudgeon of the beam rests on one of the side frames of the cylinders, and the other is supported by a small standard rising up from the condensers. It is intended to have short stroked engines, and to work them faster than is usual in sea-going steam vessels, but not faster than is now usual on the Thames; by this means we shall presently endeavour to show that high velocities may be obtained without employing multiplying gearing.

It is unnecessary to enter into a more detailed description, as in all minor points nothing new is contemplated, the proportions and mode of working, which is found favourable with engines driving paddle wheels, will be equally applicable to these engines, excepting that the makers prefer having two air pumps with a short stroke instead of one.

As the advantages which may be expected from the employment of the screw propeller are of very great importance, and as the plans, which we are now considering, seem likely to remove many of the obstacles which have hitherto impeded its progress, we shall not hesitate to present to our readers some additional particulars of the plans by which Messrs. Mather, Dixon and Grantham propose to carry their project into effect, as well as an account of what they have already effected in a small vessel built by them, which has for some months been at work on the Mersey. It is from these results that they have founded their calculations of what may be effected in vessels of large dimensions.

We gave a brief notice of this vessel in our last number, and are promised the particulars of some accurate experiments which it is intended shall be made with her. We need only now say that she has more than realised the expectations of the builders, and from their report it appears to be the most satisfactory trial yet made on the screw as a means of propelling vessels. The propeller employed was patented by Mr. Woodcroft, in 1830. We hope in another number to be able to give a description of this also.

The mode of constructing the screw, supporting the shaft, the apparatus for regulating the endward pressure of the shaft, and other details, will come under our notice as we proceed. All, in our opinion, being matters of deep interest and importance to those concerned in steam navigation, when on the eve, as we firmly believe, of a great improvement to this truly national question.

We will now only add a few remarks on the principal features of

the improvements here proposed, to show that it will not be necessary to introduce any system of working that has not under other circumstances been advantageously applied before, although not in the same combination. From the results given by the "Liverpool screw," it is stated that the advantage over paddle wheels, is fully 25 per cent, when under the most favourable circumstances for the latter, but that in towing and in rough weather, the gain by the screw when applied, as now proposed, is found to be nearly 50 per cent. It is therefore presumed that for general purposes two-thirds the engine power only will be requisite for the screw, that is necessary in paddle-wheel vessels, to give a certain speed. It is also found that if the pitch of the screw is made  $2\frac{1}{2}$  times its diameter, a very reduced amount of slip varying from 5 to 10 per cent, will take place, and that it is probable for light vessels and high velocities the pitch may be made three times the diameter of the screw. It is also clearly established that no disadvantage results from placing the screw one-third out of water. The steering is not perceptibly injured by it, and the loss from slip not increased, and it is expected that instead of its being an objection, it will be found more convenient for ordinary practice than when the screw is entirely immersed. This point we shall discuss when we describe the construction of the screw itself.

## THE AERIAL TRANSIT MACHINE.

*Analysis of the projected Aerial Transit Machine, and of the principles involved in its construction and employment.*

(Concluded from page 191.)

THROUGHOUT the preceding portions of this inquiry, which have appeared in succession in our last two numbers, our purpose having been to illustrate the operation of the parts, rather than to determine the efficiency of the whole, we have taken a view of the case simplified in a manner which, if it were the true one would, however apparently exaggerated the obligations, represent the object as nevertheless within the reach of art to accomplish, even with the means, be they ever so moderate, which the projector might have at his disposal. The unlimited declension of the force by which the machine, regarded as a mathematical plane (incapable of generating any resistance but that which belongs to it *as such*) would be opposed in its horizontal progress, in a degree proportioned to the angle of its inclination, would, however remote, still indicate a point at which this obstacle would have been so far reduced that any power, however feeble, would be adequate to the accomplishment of the *rate* necessary to produce the desired result. In theory it is perfectly true that a *mathematical plane* of any proportion of weight and dimensions hypothetically assignable, could, by the exercise of *any* amount of propulsive energy (sufficient to overcome the *friction* of the parts) be made capable of sustaining itself in the air; a rate of motion equivalent to the production of a vertical resistance adequate to its support being as surely attainable at some angle of inclination, as any effect is surely consequent upon its cause where there is no force in operation to prevent it. But the difficulty of the matter lies here—the machine is not a *mathematical plane*, nor by any mode of construction could ever be rendered so; and the interference of its *solid parts*, in the resistance they experience in the air, however restricted by the contrivances of art, introduces a new ingredient of opposition, which, not following the same rule of reduction, but on the contrary, increasing with the process by which the former is nullified or avoided, puts a limit to the extent to which that process with its attending advantages may be carried, and thus removes the case out of the category of results *necessarily* attainable by the exercise of art. Before, therefore, anything can be positively concluded with respect to the success of any particular scheme of flight upon the principle of the plan before us, we must be satisfied that a *power* is at command competent to the production of a velocity equivalent to the support of the machine, restricted by this new element of resistance—the interference of its solid parts.

IV. And this brings us to the consideration of the *fourth* subject of our inquiry; namely, the *power of steam* which Mr. Henson purposes to employ for the occasion. It is not our intention in this analysis to enter into any examination of the particular construction of machinery by means of which Mr. Henson has sought to apply this power to his present object. This has been sufficiently largely done in other publications, as well as, more particularly, in the specification of his plans drawn up under his own authority. Upon this point we would merely observe that the main difficulty, to the removal of which Mr. Henson's efforts have been principally directed, is the reduction of the weight of the engine in relation to its effective force. In all modes of developing *power*, the nature of the process imposes upon the machinery by which it is elicited a certain degree of weight proportioned to the force produced. Wherever there is a tension or pressure, there must be of necessity a counter-pressure or resistance in the parts of the generating apparatus; resistance cannot be experienced without strength of material, and strength of material cannot be had indefinitely without weight; and it is in the relative reduction of this weight that Mr. Henson's ingenuity is presumed chiefly to display itself.<sup>1</sup> Whether this has been done successfully, that is to the extent claimed, consistently with the retention of the necessary degree of strength, it is impossible for any one to determine apart from actual experiment. According to the published accounts, Mr. Henson's engine has been constructed to produce a resistance equal to the power of ten (some say twenty) horses, within the limits of 600 lb. weight. If this be true, he has certainly accomplished a very considerable abatement of that which has hitherto constituted a main obstacle to the establishment of a successful aerial navigation; and taking it for granted that such is the case, our intention here is to deal with the question upon these premises, and endeavour to test the applicability of the *power* so claimed to the purpose for which it has been designed.

We have said that a solid body cannot be moved through the air without experiencing a certain amount of resistance. Now this resistance has been determined to follow the ratio of the squares of the velocities under which it is generated; and a table has been constructed upon experimental data, in which the effects of this force upon a given extent of plane surface perpendicularly impinged upon, are set forth in terms corresponding to different assigned rates of motion, varying from one to one hundred miles an hour, with, of course, a power of extending the scale indefinitely, subject, however, to a consideration which we shall disregard at present, but which if taken into account would only magnify the exigencies of the case which we are endeavouring to define; namely, that at high rates of motion, this resistance increases even more rapidly than the ratio of the squares of the velocities otherwise assignable. Without regard to this qualification, however, we are enabled to ascertain that, at the rate of 240 miles an hour, prescribed to the machine as necessary to its support at an angle of  $3^{\circ}$  of inclination in the suspending plane, every square foot of plane surface perpendicularly directed, or *equivalent* amount of *oblique* surface, would experience an opposition equal to a force of 288 lb. avoirdupois; so that if we can conceive such a machine constructed so as to present to the impact of the air no larger extent of surface than what would be equal to 10 square feet perpendicularly exposed, the aggregate resistance it would experience to its progress at the rate in question, would amount to 2880 lb.—the horizontal resistance belonging to the plane *as such*, and which we have stated in round numbers to be, for that rate and degree of obliquity, about 150 lb.<sup>2</sup> Unless therefore the *power* at

<sup>1</sup> The improvement of the machine in this particular does not merely regard the reduction of the weight of the engine itself, but also of the means whereby its energy is maintained—the water and fuel necessary for its use. In the modifications by which a saving of these may be effected, a further step is gained in the same direction, which, however, more properly concerns the question of the *duration* of the flight when it shall have been accomplished, than its abstract *possibility*.

<sup>2</sup> These numbers are not strictly correct. They should have been stated at 223 miles an hour for the rate, with an horizontal resistance equal to 157 lb., as subsequently represented in table. The difference arises, partly from the omission of the cosine of the lesser angle in determining its pro-

command be adequate to the development of a reaction equal to this resistance, the machine could not be impelled at the rate with the angle prescribed; and we should be driven to adopt either a *slower* rate of motion at the expense of an increased angle of inclination, and of the increased horizontal resistance by which the plane itself, at that increased angle would be encountered, or else a more *rapid* rate of motion due to a reduced angle of inclination, at the cost of the increased resistance due to the solid proportions of the machine with this additional impulse—which ever should be found to be productive of the least amount, in the aggregate of this resistance.

To apply this with mathematical accuracy to the illustration of the case before us, is clearly impossible, because we are entirely unprovided with anything like a proximate definition of the main force to be overcome; namely, the capacity of the solid parts of the machine for effecting resistance. In assigning 10 square feet we have no doubt that we are keeping far within the limits of the truth; and were we to assign a higher figure we might be met by a denial of our premises which no reasoning, apart from actual admeasurement, and that of the most complicated description, could enable us to dispose of. Fortunately, however, for the purpose of our investigations, we are not put to such an alternative, as we shall readily see that the exigencies of the case, even upon the mildest hypothesis, are so far beyond the means appointed to satisfy them, that there will be no occasion to suspend our reasoning upon so disputable a point as the correct estimate of the resisting surface of the machine.

In order, however, to be able more satisfactorily to elucidate this position, it will be necessary to take into account the elements of the force we are considering in relation to the process by which it is purposed to be developed. In estimating the actual amount of any force generated or required, it is well-known that, equally with the weight to be moved or the resistance to be overcome,<sup>3</sup> is comprised in the constitution of the force the *velocity* at or under which this result is to be accomplished. Without regard to this condition it is as impossible to give an intelligible definition of any force as it is for the force itself to exist or be exercised. A body cannot be moved unless it is moved through some space; and as every operation occupies some time, the time in which through a given space, or the space through which in a given time, the body is to be moved, are as essential ingredients in the constitution and definition of the force employed as the weight or resistance of the body which is the object of its application. Thus it is clear that before anything can be predicted with distinctness as to the actual value of any force in action, or the adequacy of any contemplated power, the rate under which it will have to be exercised must be included in the terms of the proposition. In taking therefore the resistance which a given plane is calculated to develop in opposition to its course at a given rate, as the measure of the force which is required to produce it, the rate must be specified, not of the body so moved, but of the instruments of its propulsion, by the operation of which that resistance is to be called forth; and the reduction of this *rate* becomes exactly as important an object in the economy of the forces employed, as the reduction of the actual *resistance*, to the constitution of which it contributes. Now the minimum rate of action that could be assignable to the *instruments* of a progressive motion is obviously that required to be conferred upon the machine itself, as the ultimate result of their operation; for, it is clear, by no appointment of surface, or other expedient, could the machine be propelled at a greater speed than that at which the agents of its propulsion were themselves accomplishing their reaction. Whether the conditions of surface, by which alone this conclusion

portion of vertical resistance, and partly from the adoption of a rate in round numbers, 12 miles an hour, as that at which a plane surface generates a resistance by perpendicular impact equal to two-thirds of a pound to the square foot, instead of 11.666, which is its true denomination. The results in the table further on are all based upon the actual quantities, and are mathematically exact.

<sup>3</sup> It seems scarcely necessary to observe that in mechanical operations a *resistance* to be encountered is the same thing with a *weight* to be raised; the rate of development in the one case being exactly analogous to the rate of elevation in the other.

would be rendered attainable, have been observed in the appointment of the propelling apparatus in Mr. Henson's machine, we shall not stop to inquire, (though from a consideration of their apparent dimensions and the angle of their impact, we should conclude most assuredly otherwise;) but, giving them full credit for their competency to that effect, proceed to show that even so, with a measure of resistance the least assignable, and a rate of impact the least under which it could be developed, the power in question would be utterly incompetent to enable the machine to maintain its elevation or continue its course, even for a single moment, at any angle of inclination at which it might be disposed. This we shall do by means of a table calculated for several angles of inclination, exhibiting at a view the several rates at which a machine of the proportions of weight and surface assigned to Mr. Henson's, would have to proceed at the corresponding angles of inclination, in order to generate a resistance opposed to gravity equal to the support of its weight, and the amount of horizontal resistance it would experience (considered as a mere plane) at each degree of the scale so impelled, expressed in pounds avoirdupois. In another column is shown the resistance which the solid parts of the machine would develop at the corresponding rates, supposing them to be so contrived as to expose an extent of surface not more than equivalent to a plane of one square foot perpendicularly impinged upon. In the next column are given the products of these last two quantities multiplied by the velocity assigned, in miles per hour, representing the actual forces developed, reduced to the same standard, and consequently, the proper measure of the power commensurate with such results. The last column contains the expression of this force in horse-power, or the number of horses which it would take to answer this demand, according to the conventional mode of calculating the force of steam; that is, reckoning the power of a horse to be equal to a resistance of 32000 lb. at the rate of one foot in a minute, or 363 lb. at the rate of one mile per hour.

with the least expenditure of power, are those which attach to an inclination of about 10 degrees; and for this a force would be requisite, equal to the power of above 100 horses. At any other angle of inclination, a greater amount of horizontal resistance in the aggregate would be experienced, and the requirements of power be proportionately enhanced.<sup>5</sup>

V. Now it is to be observed that the opposition which is here set forth as the measure of the propulsive power of the machine, is not a force only concerned in the initiation of its motion, which might be expected to vanish or become less influential after its first efforts had been subdued, like the passive resistance of mere weight, the *vis inertiae*, or the resistance of adhesion, which when once suspended or overcome ceases to affect, but a force always in operation, always the same under the same conditions, and requiring always the same amount of power to compete with while it endures. And with this observation we might have been content to let the matter rest, as incontrovertibly determined, were it not that a principle has been set up, implied in the proposition of a certain contrivance, which strikes at the very root of our conclusions, and, were it correctly conceived, would equally invalidate any inference that might be deduced in derogation of the scheme, from the consideration of any deficiency of power, however extravagant, that might be alleged against it. Sensible of the inadequacy of their means, in the abstract, to the whole effect which it is intended to produce, and under the impression that this deficiency might be supplied by the intervention of a force not inherent in the means themselves, a part of their plan, upon which the greatest reliance has been placed, which has been put forward with the greatest pretensions, and which has elicited the greatest share of the public admiration and approval, is to invest the machine at its first starting with a certain amount of velocity or momentum, by means of a preliminary descent down an inclined plane, which, however unable to originate, its inherent power, it is expected, will be sufficient to maintain. And this obliges us to devote a few lines to the consideration of the principle involved in this contrivance, which is the  *fifth*  and last point to which in the outset we proposed to direct our inquiries.

Obliquity of plane.	Velocity in miles per hour.	Horizontal resistance to plane.	Ditto extra for one square ft.	Total ditto reduced to a common standard.	Equivalent horse power
0	40103 000	872	7912592 00	317318716357 000	874156243 00
1	668 600	52 357	2199 36	1505497 986	4147 37
2	334 432	104 707	550 27	219045 268	603 43
3	223 089	157 210	244 76	89675 085	247 03
4	167 463	209 769	137 97	58233 416	160 42
5	134 121	262 461	88 50	47071 240	129 66
10	67 700	528 936	22 54	37335 125	102 81
15	45 892	804 812	10 36	37409 863	103 06
20	35 187	1091 932	6 09	38636 100	106 43
25	28 996	1398 845	4 13	40680 663	112 06
30	25 071	1731 924	3 18	43500 792	119 53
35	22 473	2100 658	2 48	47263 820	130 20
40	20 736	2517 180	2 11	52239 997	143 91
45	19 621	3000 266	1 89	58905 302	162 27
50	18 996	3575 592	1 77	67955 568	187 20
54	18 804	4247 429	1 73	79901 185	220 11
60	19 050	5195 784	1 78	99013 594	272 76
70	21 223	8238 362	2 21	174889 659	481 79
80	28 431	17017 921	3 97	483949 383	1333 19
85	39 679	34310 433	7 74	1361710 786	3751 27
89	59 684 000	10313149 000	2301 85	7055768381 000	19437378 00

Upon reference to this table it will be seen that the conditions of flight which, under the circumstances prescribed, would be attainable

<sup>4</sup> Supposing the propelling agents to be able by their rotation at a given rate to generate a given amount of resistance, the machine being at rest; when motion is conferred upon it, the condition of the medium, as far as the instruments of its propulsion are concerned, being altered by the consequent abstraction of the air, they would no longer operate with the same effect at the same rate of impact, but must either be worked with additional speed to enable them to overtake the retiring particles, or else proportionably increased in magnitude to enable them to take in a larger quantity of them. It is to this relation between the superficial dimensions of the propelling agents and that of the effective opposing front of the machine, that we refer as governing the relation of their respective resistances to their respective rates of motion, and by the due appointment of which, (regard being had to their form and direction of impact,) an equality of resistance becomes assignable to an equality of rate when the machine is in actual progression.

<sup>5</sup> This table may be made available to determine the conditions of flight assignable to any machine upon the same principle, whatever the proportion of its weight to the dimensions of its suspending plane, subject to the following considerations. In the first place, the velocity necessary to effectuate its support depending upon the *relative* and not the *actual* quantities, any weight may be assumed as a standard, and the modification necessary to maintain the proportion, referred to the size of the suspending plane. Let the case, therefore, be reduced to the standard of weight ascribed to Mr. Henson's plane, namely 3000 lb., and the surface determined accordingly. Now as the resistance, *ceteris paribus*, varies in the simple ratio of the areas of the impinging surfaces, and the squares of the rates of impact, the rates, *ceteris paribus*, must vary inversely as the square roots of the areas. If, therefore, the velocity assigned to any angle in the table above be multiplied by the square root of the area of Mr. Henson's plane, the product divided by the square root of the newly assigned surface, will give the rate at which it must be propelled in order to effectuate its support, as by a common rule of three. The horizontal resistances, depending upon the *real* quantities, may be deduced in like manner from those ascribed to Mr. Henson's plane at the same angles, by simply substituting the new rate assigned, in the ratio of the squares of the velocities, and the true surface, in the simple ratio of the dimensions; and thus all the conditions of flight depending upon these data may be ascertained. For example, if we suppose the suspending plane to be magnified to 10 times that of Mr. Henson's, affording an area of 45,000 instead of 4500 square feet within the limits of the same weight, the velocity

necessary to its support at an angle of 10° would be  $\frac{67.7 \times \sqrt{4500}}{\sqrt{45000}}$

$\frac{67.7 \times 67.082}{212.132} = 21.408$  miles an hour. The horizontal resistance in this

case, the weight being the same, would stand as in the table, at the same angle of inclination; the rate of development diminishing exactly as the surface is increased. If to this quantity be added the perpendicular resistance due to one square foot at the newly assigned rate = 2.254 lb., and the sum be multiplied by the rate in question, we shall have 11371.715 lb. as the representative of the whole resistance to be encountered; which, divided by 363, the power of a horse in steam at the same rate, gives upwards of 31 as the number of horses, or the measure of horse-power, which would be requisite to enable it to accomplish or maintain its elevation in the air.

Were it not that this principle and the mode by which it is intended to be applied, had got hold of the public mind by some of those fatalities, by which the most preposterous opinions occasionally get disseminated and established, we should not have held ourselves justified in administering a formal refutation to a position so exceedingly absurd, that a reference to the first rudiments of the physical sciences is more than sufficient to overset. For what, after all, is the principle which this position is calculated to uphold? Simply, that a body can be sustained in motion against a *given* amount of opposition by a less degree of force than what is actually required to establish it. That this is a true statement of the principle which is involved in this hypothesis, and that it is utterly fallacious and inane, we trust we shall not be at much pains to demonstrate; and the mode we purpose to adopt with this view, is to examine the forces which are inherently concerned in the establishment of a given motion, and those concerned in its continuance, to show that a perfect equality exists between them, and consequently that nothing less than what is required for the former would satisfy the exigencies of the latter. These forces, by which the induction or continuance of motion in any degree or direction, are solely affected, are reducible to four heads; the attraction of gravitation—the *vis inertiae* of matter—the friction of the parts in contact—and the resistance of the medium in which it is moved.

1. Of these forces, the first, assuredly, opposes no impediment to the induction of motion which it does not equally oppose to its continuation. Acting in one direction only, and (appreciably at least) with equal force in that direction at any elevation attainable by man, it is clear that whenever it interferes at all, it can never operate with less force in one than in another stage of the same proceeding. To initiate, therefore, or establish a given motion even in direct opposition to gravity, not a particle more force is exerted than is required for its continuance. In an *horizontal* direction, however, with which we are here more immediately concerned, the attraction of gravitation literally interposes no obstacle whatever either to the induction or perpetuation of motion to any extent in any body, however ponderous and inert. This might, indeed, have been concluded, without reference to principles, from a simple consideration of its effects; as in a vertical or upright direction gravity *opposes* the induction of motion with its *whole* power, and in a contrary or descending direction it *favours* the same in exactly the *same* degree, so in a direction which partakes of neither, but is intermediate between both, it follows as a matter of course, it can really exercise no influence at all. The weight of a body has in fact nothing to do with the difficulty of imparting to it an horizontal motion, except in so far as it increases the friction, in regard to the medium of its support; a property which, as the weight is not altered by its translation, it must exert with equal efficacy in the ultimate as in the preliminary stages of its progression. So far, therefore, as the attraction of gravitation is concerned, it is certain that the exigencies of the aerial machine in respect of power, are not a whit less for the *maintenance* than the *establishment* of the motion which is sought to be conferred upon it.

2. With regard to the second of the forces enumerated, the *vis inertiae* literally opposes, of itself, no *definite* obstacle to the induction or continuation of motion in any direction whatsoever, and literally requires no *definite* amount of power to overcome. Every body which is pressed against by another must reciprocate the pressure, and, unless restrained by some extrinsic impediment, must participate in the motion which is the measure of the force applied; the only condition affecting the establishment of a *given* rate of motion, so far as this property is concerned, being that a certain *time* must elapse before the operation be completed. In all transitions from quiescence to motion, or from motion to repose, a certain *time* is due to the transaction in respect of and proportionate to the quantity of matter which is the subject of the change; and the only obligation which is imposed upon the force employed, so far as regards the *vis inertiae*, is that it be *continuously* applied. With this reservation, there is no limit to the effects which can be produced, however great the mass to be moved, or small the force employed to move it. A fly attached by a human

hair to a ton of marble, would not only invest it with motion in an horizontal direction, if it were possible to suspend it free from all friction, but, presuming the absence of atmospheric resistance, bring it up, by continuous effort, to any rate of motion at which it could itself proceed; nay, the mighty globe of the earth could be propelled round the universe by an infant as fast as its legs could carry it, if it could find a path to walk on, provided the pressure was continued a sufficient time to allow all the particles to be indued with motion at the rate required. These results in relation to the hypothesis involved in Mr. Henson's scheme, may be conveniently and familiarly illustrated by the case of a man towing a heavily laden barge in still water; where the counteracting forces, friction and the resistance of the medium, being indefinitely assignable, and the impulse in an horizontal direction, the *vis inertiae* is free to display its peculiarities without ambiguity or interference. Here is no question as to whether the strength of the individual be sufficient to enable him to set his load in motion, or bring it up to that rate in which his own powers shall be equal to the extrinsic forces developed in the operation. As soon as he begins to pull, the boat begins to move, slowly at first, and increasing gradually until it reaches that point at which the friction and resistance it develops is equal to the power he is able to employ; nor would he accomplish anything by obtaining additional assistance in the commencement, which he would not immediately forfeit by its discontinuance, except a *more speedy* attainment of the same result. No one, not even the most unintellectual of bargemen, ever dreamt of being able at any time to drag his boat at a greater rate than he could, by his own unaided efforts, have brought it up to; or with less difficulty at the same rate, because he happened to have had the assistance of a friend to enable him to begin. And yet these are only the conclusions which the adoption of Mr. Henson's hypothesis requires us to admit. All, in fact, that the mediation of any extrinsic temporary force can effect, is to dispense with a part of the *time* that would otherwise be required to produce the result due to the inferior power alone; and it is to the forced limitation of this element of invested motion that are to be ascribed those appearances in certain familiar cases which have been so triumphantly referred to as affording illustrations and attesting the correctness of the hypothesis upon which Mr. Henson's scheme and the hopes of his friends are founded. The circumstances of the horse straining to drag into motion a heavily laden cart, which he afterwards appears to draw with the utmost facility, of the railway train and steam vessel, with so much difficulty seemingly set agoing, and ultimately proceeding with so much apparent ease, together with others of the like description, are all owing to the neglect of this consideration in the attempt to invest large bodies with motion at a given rate, in less time than is due to the proportion between their masses and the forces employed to move them. The conclusions, therefore, which have been drawn from these premises are utterly fallacious. Not a particle, absolutely, more power is required to initiate or establish a given rate of motion in any body than is requisite to compete with the extrinsic forces, the friction and resistance, developed at the rate in question; neither in the beginning, nor subsequently at any stage of the proceeding, there being anything *over* to be accounted for on the score of, or by which to measure the effects of, the *vis inertiae* in respect of the motion so superinduced and established—a certain proof that, so far as this also of the forces enumerated is concerned, no more power would be required to produce, and, therefore, no less would suffice to maintain, the rate of motion assigned to the aerial machine as necessary to its support, than what is due to the *extrinsic* forces, the resistance and friction, developed at the rate required.

3. Now the friction, it is well known, is a force in no way affected by the rate under which it is developed; but is just as great in a state of quiescence, however strange this may appear, as under the extremest condition of velocity. So far, therefore, as regards the question before us, this may be considered as a neutral element; interposing no more obstruction to the establishment of a given motion than to its continuance, and requiring, therefore, exactly as much power to keep in subjection, if we may so speak, as originally to subdue.

4. But if friction be a force which does not regard the condition of motion, such is not the case with the resistance of the medium, which yet remains to be noticed. Unfortunately, however, for Mr. Henson's hypothesis, this force really pursues a directly opposite progression, being absolutely none or of no effect in the first induction of motion, and increasing in intensity and requirement of power in proportion as it is more fully developed. It needs no laboured comment, therefore, to point out how little colour the consideration of this force is calculated to give to the principle which Mr. Henson's contrivance is intended to set up. And this completes the list of all those elements of opposition which are called into play in the process of investing a body with a given rate of motion. There are, it is true, other forces, or as they may be more properly termed, accidental conditions, by which a body may be detained at rest against the exercise of a greater power than would be competent to continue it in motion after they had been overcome. If a cart heavily laden, for instance, be left standing for some time upon an imperfectly hard foundation, the wheels will create for themselves a *rut* out of which they will require to be extracted with a degree of force, the necessity for which is then immediately dispensed with; or if it has to be dragged over such a kind of road, the retardation of its course affected by the depression of its wheels, which is greater the slower the rate, indicates the necessity for an accession of force to bring it up to a rate of motion in which this condition is overcome, when it may, without prejudice, be discontinued. Again, an object may be so circumstanced as not to be able to exercise its means of propulsion to equal advantage in the beginning as in the subsequent stages of its progress, and may therefore require the employment of a greater degree of power to *acquire* than to *maintain* its destined condition of velocity; as exemplified in the case of the larger birds labouring to ascend from the ground, where the height of their bodies not permitting the full action of their wings, they are obliged to make up the deficiency by the more forcible and frequent repetition of the stroke, producing that appearance of disproportionate exertion which has contributed to maintain, if not to suggest, the delusion implied in Mr. Henson's expedient to supply the inherent deficiency of his moving power. These, however, are all obstructions of a kind which do not enter into the constitution of the forces with which the aerial machine upon Mr. Henson's principle has to contend. These forces, with which alone we have any concern, are simply those enumerated above, of which we have seen there is not one that offers any more opposition to the induction or establishment of a given rate of motion than it does to its continuance, and consequently imposes no obligation in respect of power to begin with, that it does not equally exact during the remainder of its career.

Had we had to deal with the *contrivance* proposed by Mr. Henson alone, we should not have had occasion for all this elaborate investigation in order to prove its insufficiency for the purpose ascribed to it. The force acquired by a descent, however accomplished or applied, must be assuredly inadequate to the production of any effects that could extend to a condition of elevation superior to that from which it had originated; as might be concluded at once from a consideration of the properties of the pendulum, which, in so far as regards the influence of gravity in communicating motion, is a parallel case with that which we are supposing before us. But here the parallelism ends; nor can any inference be drawn, as so confidently contended for (see *Mechanic's Magazine*, &c.) from the continuance of the motion in the one case to its continuance in the other by the instrumentality of a power inferior to what is required for its original establishment. The pendulum is not, in fact, kept in motion by a power at all less than that by which it has been started, as a little consideration will evince. The force which puts the pendulum in motion is that employed in raising it to a certain height, from which it is allowed to descend by its own gravity. In this descent it acquires a force which would be equal to the original, and by which it would be carried up to an equal height on the other side, and thus reciprocate the movement without extrinsic assistance, were it not for the resistance of the air it encounters, and the friction of the parts in contact by which a part of it becomes expended or consumed. This

portion is supplied by means of a spring. But it is not the spring that maintains the movement of the pendulum, but the attraction of gravitation conjointly with it, which together are exactly equal to the original impulse. Here, however, is nothing analogous to the case of Mr. Henson's machine, acquiring a momentum by means of a single descent down a plane, not to be repeated, and unprovided with a power equal to the counteracting forces, the friction and resistance of the air, with which it has to contend.

Having now conducted our readers through the mazes of this intricate, but we trust not uninteresting nor profitless inquiry, we would conclude with a few observations touching the prospects of that "consummation so devoutly to be wished for,"—the establishment of a successful mode of navigating the skies. One thing is clear; that, upon the principle of the plan we have been investigating, it is totally out of the question. The obligations imposed by the necessities of support, are of so exaggerated a character, that by no modification of construction, or application of new resources, can it ever rationally be expected to fulfil them. In an early part of this analysis we had occasion to point out the conditions in subservience to which these obligations are imposed. We there showed that the circumstance upon which the difficulties of the case really depended, was the relation of the weight of the machine to the superficial magnitude of the suspending plane, whereby alone the rate of progression was ascertained, to which all the requirements of power are ultimately referrible. By a reduction of the one or an enlargement of the other, therefore, is this principle solely improveable to the attainment of success; and that, to an extent which a retrospect of past experiments and a general consideration of the nature of the case alike evince to be far beyond the reach of art to accomplish. Referring to the process by which the calculations in the preceding table may be applied to determine the conditions of flight assignable to other machines of the like principle, as detailed in the note annexed, it will be seen that the *smallest sized surface* which could be made effectual to support the *weight* of Mr. Henson's machine, with the exercise of Mr. Henson's *power*, taking it at the greatest, would require to be upwards of 100,000 square feet in extent; or somewhat more than 22 times the area which Mr. Henson has provided for the purpose. Nor can any argument in contravention of this conclusion be drawn from the proportion between the weight and superficial magnitude of the wings of birds, upon which so much reliance is wont to be placed by those who have hitherto written upon the subject. There is, in truth, no analogy whatever between the cases; neither consequently can any inference be legitimately drawn from what is effected in the one to what is possible to be effected in the other. The weight of birds in proportion to the size of their wings, may or may not be as great or greater than that attainable by art as between the weight of the aerial machine and the superficial contents of the suspending plane. Their purposes are entirely distinct, and accomplished through the intervention of essentially distinct properties. The bird possesses a power of unlimitedly increasing the reaction of its wings by their voluntary impact, which the rigidly suspended plane is devoid of, and which, by affording a compensation for any deficiency of size, neutralises all arguments founded upon a consideration of the relative proportion of weight, and removes the case out of all analogy with the machine constructed upon the principle of the plan before us.

Disappointed, therefore, in our expectations of success in this quarter, it may be asked, whither are we to direct our attention in order to discover the means of solving this perplexing but still interesting problem? The answer will most naturally suggest itself from a consideration of the circumstances to which the failure of all the attempts to navigate the atmosphere by mere mechanical impulse, the present among the rest, is entirely to be ascribed. These circumstances we have already specified in the exaggerated nature and amount of the obligations of support, occasioned entirely by the tenuity of medium and the force of gravitation; in the teeth of which we feel no hesitation in declaring our opinion, no process founded upon simple mechanical reaction ever can succeed; for even

if it were possible to contrive and construct a system of machinery by which the force required could be accomplished and applied, the violence with which it would have to operate in order to effectuate its purpose, (admitting its practicability,) would be such as to preclude the possibility of its employment.

To the balloon then, as affording the legitimate and only probable means of grappling with these difficulties, are we naturally referred: and that, by its means, success could be attained to such an extent, as to satisfy the scruples of the most incredulous, we are fully prepared to prove; not by the proposal of any crude and complicated contrivance, the operations and effects of which are neither defined nor definable, neither adjusted by the strict laws of science, nor reconcilable with practice, but by a mode at once simple in the extreme, susceptible of an examination as critical and close as that with which we have been sifting the scheme before us, and above all, answering the obligations imposed upon it by means so far within the limit of its attainments, as to leave no doubt as to its ultimate success, in some degree corresponding with the purposes which it might be expected to subserve. This, should our readers still continue to feel an interest in the subject, we may take an opportunity of laying before them upon a future occasion.

A SIMPLE METHOD OF COMPUTING THE SPHERICAL EXCESS, WITHOUT THE AID OF LOGARITHMS.

By OLIVER BYRNE, late Professor of Mathematics at the College for Civil Engineers; author of "The new and improved System of Logarithms," "The Doctrine of Proportion," "The Practical, Complete and Correct Gauger," &c.

ALTHOUGH Professor Dalby's rule for calculating the spherical excess is simple, yet in many instances it is inconvenient, especially when logarithms are not at hand, or when the tables are limited; moreover, when the radius of curvature at the place of observation is greater or less than  $365154.6 \times 57.2957795$  feet, a more appropriate constant logarithm than that given by Dalby might be used. However, it will be found in practice, that the spherical excess can be determined in all cases, by the method here explained, in one half the time usually employed to find the number corresponding to the difference of the logarithms mentioned by Dalby, (of which we shall speak by-and-bye,) and therefore the trigonometrical surveyor will in this particular calculation economise one half his time, at least.

The following table will be sufficient from 90'' down to  $\frac{1}{10000}$  of a second, and can be increased or decreased at pleasure by multiplying or dividing by 10, if this range be not extensive enough; the change is easily effected by increasing the number of perpendicular lines to the right and left of those already drawn. Such an alteration may be necessary in speculative inquiries, but can never be required in practice. This method of calculating the spherical excess, which depends on the succeeding table, may be better explained by a few examples than by a written explanation.

EXAMPLES.

I. The area of a triangle is 1764724375 square feet; what is the spherical excess in seconds?

Area .. .. .	1764724375	
Nearest in the table ..	1697710640	.8· headed tenths.
Remainder .. .. .	67013735	
Next nearest in the table	63664149	.8· headed hundredths.
Remainder .. .. .	3349586	
Next from the table ..	2122138	.1 headed thousandths.
	&c.	.831

Therefore the spherical excess = 0''.831,

FOR	Tens of seconds.				
	Seconds.				
	Tenths of seconds.				
	Hundredths of "				
	Thousandths of "				
1	2122138	3	0	0	6
2	4244276	6	0	1	2
3	6366414	9	0	1	8
4	8488553	2	0	2	4
5	10610691	5	0	3	0
6	12732829	8	0	3	6
7	14854968	1	0	4	2
8	16977106	4	0	4	8
9	19099244	7	0	5	4

II. Suppose that in the trigonometrical survey of Ireland, under the superintendence of Colonel Colby, the county of Wicklow, which occupies 21986496588 square feet, to be taken up with one large triangle, what would be the spherical excess.

	21986496588	Area in square feet.
10-0000 ..	21221383006	which terminate in the column headed tens of seconds, opposite 1.
	765113582	
.3000 ..	636641490	which terminate in the column headed tenths of seconds, opposite 3.
	128472092	
.0600 ..	127328298	answering to six hundredths of a second.
	1143794	
.0005 ..	10610691	there are no thousandths of seconds, but 5 ten thousandths, found by curtailing another figure.
10''-3605 spl. excess. &c.		

III. The lengths of the chords of a spherical triangle on the surface of the earth are 13, 14, and 15 miles respectively; the area of the triangle formed by these chords is 2341785600 square feet, (which may be taken as the area of the corresponding spherical one, on account of the sides being very small compared with the radius of the earth.) The three angles of the plane triangle are 53° 7' 48''-358, 59° 29' 23''-136, and 67° 22' 48''-506, required the spherical angles.

		2341785600	
1-000 .. .. .		2122138300	.. for 1 second.
		219647300	
.100 .. .. .		212213830	.. for $\frac{1}{10}$ of a second.
		7433470	
.003 .. .. .		6366414	.. for $\frac{3}{1000}$ of a second

1-103 seconds the spherical excess.

One third of the spherical excess must be added to each of the plane triangles to obtain the spherical angles. Therefore 1''-103 divided by three = 0''-368 nearly, hence we have,

Plane angles	53° 7' 48''-358	59° 29' 23''-136	67° 22' 48''-506
Third of exs	.368	.368	.368
	53 7 48-726	59 29 23-504	67 22 48-874

In this example the excess is distributed equally among the angles, because there is no reason to believe one of them to be more erroneous than another. But if one of the angles be suspected to be less correct, or less to be depended on than the others, to this angle must be applied a greater or less portion of the whole correction, according as it is thought to be in excess or defect.

Dalby's Rule.—From the logarithm of the area of the triangle taken as a plane one, in feet, subtract the constant logarithm 9-3267737, and the remainder will be the logarithm of the excess above 180°, in seconds, nearly. By this rule let us work the second example just given:—

Logarithm of 21986496588	..	10-3421561
Constant logarithm	..	9-3267737
		1-0153824
Logarithm of 10''-3605	..	1-0153824

Dalby's rule, from the simplicity of the wording, and from the few figures exhibited in the operation, appears to be more convenient in practice than the one which we have given as an improvement, but this is not the case; for to find the logarithm of 21986496588, or the number corresponding to 1-0153824 from a table of logarithms, will employ more time than the complete working of the problem by the method here proposed, which may be thus investigated.

Let  $E$  be the area of a triangle in square feet;  $r$  = the radius of curvature at the place on the earth's surface where the triangle is situated, and  $A^\circ, B^\circ, C^\circ$ , be the angles of the triangle considered as spherical, reckoned in degrees and decimal parts of a degree. By the well-known theorem of Gerard,  $2E = 4\pi r^2 \left\{ \frac{A^\circ + B^\circ + C^\circ - 180^\circ}{360} \right\}$  (A)

Suppose the triangle to be one employed in the trigonometrical survey of England, then the length of a degree may be considered equal to  $60859 \cdot 1 \times 6$  feet, without involving much error. Therefore the circumference of the globe to which this triangle is supposed to belong =  $360 \times 6 \times 60859 \cdot 1$ , and  $r = \frac{360 \times 6 \times 60859 \cdot 1}{2\pi}$

$\therefore$  (A) becomes,  $2E = 4\pi \left( \frac{360 \times 6 \times 60859 \cdot 1}{2\pi} \right)^2 \left( \frac{A^\circ + B^\circ + C^\circ - 180^\circ}{360} \right)$

$$\therefore 2E = \frac{360 \times 6^2 \times (60859 \cdot 1)^2}{\pi} (A^\circ + B^\circ + C^\circ - 180^\circ)$$

$\frac{2\pi E}{360 \times 6^2 \times (60859 \cdot 1)^2} = A^\circ + B^\circ + C^\circ - 180^\circ$ , which we shall call  $e$ , or the spherical excess in degrees and decimal parts of a degree, which when reduced to seconds will stand thus:—

$$3600 e = \frac{3600 \times 2\pi E}{360 \times 6^2 \times (60859 \cdot 1)^2} = \frac{\pi E}{1 \cdot 8 \times (60859 \cdot 1)^2}$$

but  $\pi = 3 \cdot 1415926$  &c.

$$\therefore \frac{\pi E}{1 \cdot 8 \times (60859 \cdot 1)^2} = \frac{E}{1 \cdot 8 \times (60859 \cdot 1)^2} = \frac{E}{(182577 \cdot 3)^2} \quad (B)$$

but  $\frac{(182577 \cdot 3)^2}{15 \cdot 707963} = 2122138300 \cdot 6$ , from whence the rule is derived.

It is evident that Dalby's rule is in error when half the length of a degree is greater or less than 182577·3 English feet in the place where the triangle is measured; for by putting (B) into a logarithmic form we have Dalby's rule. But the constant divisor or its logarithm can be readily attained by substituting (B) for 182577·3 feet, half the length of any other degree in feet. However, the difference must be very great when the spherical excess is effected, of such triangles as occur in practice.

#### LIFE OF SIR DAVID WILKIE.

Poor Allan Cunningham! he had a poetical imagination and a grateful heart. He never forgot an obligation, and felt every kindness so warmly, that it was natural he should overestimate his friends who were interested in his welfare; he loved Sir Walter Scott, he adored Chantrey, and believed Wilkie (if the truth were confessed) to be greater than Raphael. The basis of biography is fact, bare, naked, disinterested, unqualified, undistorted, unpoetized, unexaggerated fact. Unless all the facts connected with the character described be correct, the conclusions must be false, and confidence destroyed. I fear the manufacturers of reminiscences, conversations, and biographies of late years have not been remarkable for adherence to this essential principle.

"When Foote tells me a story," said Johnson, "it makes me laugh, but it passes from my mind from its falsehood; when Reynolds tells

me anything, I have an idea the more, for I know it to be a true representation of nature." Let every biographer print these words in letters of gold over his study door, and let him read them with attention whenever he feels inclined to give his imagination the reins at the expence of his understanding.

It may be said of all Cunningham's lives of artists that there is scarcely an anecdote told of any of them which happened in my time, which is not so *poetically* treated as to amount to a misrepresentation, though nothing was further from his desire or his principle. In the very first volume he states Wilkie was refused admission into the Academy of Edinburgh by Mr. George Thompson, and I, as well as others, felt the injustice as well as ignorance of Mr. Thompson. Now Mr. Thompson is alive, and luckily he is so, and he has given, in the *Morning Chronicle*, a flat contradiction to the assertion, and says it is "not true." Sir George Beaumont told me Boswell would race the town for days to ascertain the correctness of *yes* or *no*; as Mr. Thompson was alive, it was Mr. Cunningham's duty to have ascertained the fact, before he made so unjust an attack on a very worthy person.

No. 8, Norton Street, says Cunningham, was Wilkie's first residence, then a coal shed; now it was not a coal shed at the time, 1806, but a little front parlour! Wilkie's bed-room, sitting-room, and painting-room, and there he painted the Village Politicians.

He says again: something of Wilkie's reputation preceded him to London, for Jackson wrote to Haydon, &c. then in Devonshire. We never heard a word of him till he came to the Academy, and when he came, Jackson wrote to me. "Touched with Jackson's letter, Haydon came to London and went to the Academy. Wilkie, the most punctual of mankind, was there *before him*," says the author. Now Wilkie *did not come the first day at all*, and the next day *not till near one*—one hour and a half after his time! Because he painted to get his living, always before he came to the Academy, and Jackson, whom Lord Mulgrave maintained, and my father maintaining me, enabled us to be much more punctual than Sir David.

"Haydon," says Cunningham, "is an admirer of the grand style; but Wilkie, with a wider reach of mind, used to argue, "that though the rose excelled in beauty all other flowers of the field, we were not to despise the daisy, which had a loveliness of its own." *Very* like Wilkie's conversation. I imagine my dear old friend at that time, pale, thin, shrewd, legal, unpoetical and cold, talking the purest Fifeshire, scarcely understood in Auld Reekie, alluding in a strain of poetical language to the comparative beauty of the rose and the daisy! A wider reach of mind, too! So that I, who was devoting myself to see nature in the abstract, to clear the essential from the superfluous, and restore man, woman, and animal, to the essential properties in form of their respective species, as their great Creator sent them forth in Paradise to increase and multiply; I—who was thus fitting myself first, to master them as a species, and second, to put them in actions and expressions, to convey high moral lessons, to inspire the youth or elevate the country—was not of so wide a reach of mind as David Wilkie, who took man, woman, and animal as accident, disease, or dress had distorted them, painted them as they were in their humblest moments, without reference to moral objects at all, without relation, without abstraction, without choice!

He talks, too, very much of the smart pert students of the Royal Academy of that time. Except one poor fellow who is now insane, there was not a pert or smart student there—and the most loquacious, the most whispering, the most disturbing arguing student that ever lived, to whom we were all obliged to cry "Silence" repeatedly, was Sir David Wilkie. Wilkie was remarkably fond of loud whispering arguments, touching away with his port-crayon as he talked. "In my mind's eye, Horatio, I see him now." As to pertness, who was pert? Were Collins, Jackson, Mulready, Hilton, Pickersgill, Etty, and myself, were we *pert*?—we were the students, and our present station is an answer to such absurdity.

Page 76, Vol. I., he says, "Haydon was invited to breakfast; he knocked—a voice said 'Come in'; and he found Wilkie partly



naked, drawing his left knee." The fact is, I found Sir David stark naked as ever he was born, sitting on the edge of his bed, with a glass, drawing. "Wilkie," said I, my heavens, where am I to breakfast?" Without making a reply, he put his port-crayon to his mouth to wet his chalk, and said without moving, "It's jist copital practice, let me tell ye." "I'll take a walk," said I; and after a walk I found the room aired and bed turned up, and a good breakfast. It is astonishing how remarkable men are for particulars to impress you with an idea they are exceedingly correct, when they are not sure of it. The left knee! why not the *right*, why not *both*—and half of the right ankle—and four of the toes?

So idle and loquacious was Wilkie sometimes, that one evening when there was nearly dead silence, Fuzeli reading and nothing heard but the scraping of charcoal, Wilkie sent over to me some verses on his friend Crockat, the whole gist of which was doggrel rhyme such as,

My dear Mr. Crockat,  
Your name I won't pock-at,

I added a couple, and it went nearly all round, and before it got half way, the students were choking with laughter. Fuzeli looked up two or three times with the light shining on his white lion head, in a suppressed fury. We went on drawing in an hysterical agony, to keep under which with our lips, and keep our faces sedate, I nearly bursted a blood-vessel. I believe I have the verses now. It is such nonsense, for biographers to talk as if their hero had none of the follies of life.

All the account of the journey to Devon, 1809, is a perfect absurdity. It seems Cunningham must have skimmed the journal in his usual careless manner. The facts of this journey are as follows. Whilst we were dining at the Admiralty, Lord Mulgrave, the first lord, asked us how we were going? I replied by sea. His Lordship said, Would you like to go in a man-of-war? We were delighted, and he told General Phipps at table, as he knew Curtis, the Port-Admiral at Portsmouth, to give us a letter to put us on board any man-of-war sailing to Plymouth! Away we went in high glee, to Portsmouth; we dined with Admiral Curtis, a fine old veteran, of the siege of Gibraltar; there we met our friend Colin Mackenzie, then agent for Russian prisoners. As the Walcheren Expedition was collecting at Portsmouth, the men-of-war were coming up, so there was no chance, and we took our passage in a coaster; but just as we were going, Admiral Curtis came to the inn, and said, "will ye put up with a cutter?" "Certainly; a cock-boat in her Majesty's service," said I and Wilkie. "A cutter is now under weigh," said the Admiral; "I'll telegraph her." In a few minutes, Moody, the commander, was in the Admiral's office, and Wilkie and I were put under his charge, as two very great men. Wilkie lay on his back in horror all the way, and so insensible at times, that a carronade was fired over his very face, and he never heard it.

We arrived at Plymouth, my native town, in great glory, from whence I had issued five years before, an obscure youth, and were landed by Moody, in full state, as if we were bullion for the treasury! Happy days! Moody was afterwards drowned, a gallant British seaman. I remember Sir David, hearing us all laughing, put up his head through the hatchway; he had a red nightcap, which with his pale face, was a picture; but before I could sketch him, he dropped, as if shot, below, nor did we see him after!

Cunningham says, he visited the Haydons, the Eastlakes, the Northeotes. Nonsense! He was my guest at my father's for a month; I introduced him to the Eastlakes. The author calls Sir William Elford, Sir Richard, but that is nothing. Wilkie made beautiful drawings of my father and my sister—Cunningham says, it was only of my sister, but that is nothing.

It is a curious instance of Wilkie's caution—I never knew he kept a journal, and he told my sister he did not. I have travelled with him, lived with him on the most intimate terms one man could live with another—he saw me at Paris put down my thoughts on art every night before going to rest. Wilkie told me he did not see its use, and after shaking hands and wishing me good night, must have gone

to his own bed room, and done what I did not do, put down his remarks on me, and kept his journal of what his friends said or did.

It is extraordinary, also, to see how completely he agreed with me on the nature and evil of modern colour. He sneers, in his letters, at the pink and raw reds and yellows of the season—he asks what colour is the go for the spring? Page 300, vol. II, when speaking of Titian's superb Pietro Martyre—"this being the day on which the exhibition opens, one can scarcely view this great work but in contrast, being almost an example of all that is the object of an artist to avoid when painting for that arena." 310—"One year is very like another at Somerset House! What Sir Joshua wrote and Sir George talked *was right*—and I am not now to be talked out of it." Again—"With us, you know, every young exhibitor, with pink, white, and blue, thinks himself a colourist like Titian." "I saw at Florence his Venus, his flesh (O! how my friends would stare) is a simple tint, completed while wet." 447—"Reynolds' portrait at Florence has never cracked, and has never been varnished." At vol. III, page 12—"I painted up at once, a custom quite denied in modern art." Would any believe that I have painted up at once all my life while wet—that I had preached this doctrine to Wilkie all my life—that he did it at first, gave it up, then went abroad, began it again, and talks of it as a discovery! Thus, after going to Italy, he comes to the same conclusions as Sir Joshua, Sir George, and Gainsborough, on the evil of want of tone.

To conclude as I began, on the exaggerations of this life; the author says, page 484, vol. III, the artists gave Wilkie a dinner in 1806, in honour of the Politicians—that one of the set made a speech, and said "let us do honour to genius, but before, we must honour justice; and can justice be honoured, while England groans from side to side? I give the toast which will set all right, 'a full, free reform of the House of Commons.' 'Ah, but very moderate,' said Wilkie, and emptied his glass. It was long remembered in Wilkie's protest." What are the facts? as follows: First, no dinner was given to Wilkie in honour of the Politicians' fame. It was in 1819 this was said, and not 1806, at my table, when John Scott, Mr. Otley, and Wilkie dined with me, and when all were in high glee; John Scott said, "let us drink Reform." Wilkie said, "No, no—I mustn't;" we appealed to his courtesy, and Otley filled Wilkie's glass; he drank his wine to the dregs, and "*success to Reform*;" but frightened out of his life, turned round, and in a subdued tone said, "Very moderate, remember." We plagued him the whole night; and Otley threatened to write to the ministers, which put him in perfect horror. It was all joyous fun, knowing the man. This is the way lives are written, and facts perverted—speeches invented, and absurdities told.

With all these careless inaccuracies, which could have been all remedied by proper inquiry and revision, and which the author would have done had his life been spared, it is a most interesting life and ought to sell well. It has occurred to me as a curious question, why Vasari's lives are sold throughout Europe better than any other painter's lives, and the reason is, they are not exclusively professional, though a whole code of technical practice can be ascertained from his occasional technical allusions, both on fresco and oil, execution and cartoons; but I will venture to say if these utilities had been their only merit, they would have lain unread, except by artists all over the world. Not so Vasari; he had more sense. Every man can read his lives and be amused, because he mixes up all the vices, virtues, follies, and tricks, characteristic of each artist. We know Michel Angelo, and Raphael, and Julio Romano, and Titian, as well as if we had lived with them; he tells us all sorts of anecdotes of their private lives. Fuzeli used to say to me, "What have we to do with their private lives?" I used to reply, "Every thing." It is these touches of human character in every painter, the humour of Buffalmacco—the violent temper of Michel Angelo—the sauity of Raphael—that interests the unprofessional man, the general reader, and have kept Vasari the very Bible of painting, and ever will. Whereas in the lives of Fuzeli, Laurence, Reynolds, and Wilkie, each in succession, is but a dry detail of professional correspondence, from which one retires harassed, disgusted, and sick; and after being published by a



bookseller at a great expence, lie on our shelves after the first excitement, and are never referred to either for instruction or entertainment. Every painter's life could be made as delightful as a novel.

In spite of all these defects, this life contains a great many useful things. Sir David Wilkie greatly overrated the value of going abroad—did serious injury to himself, and injured two of his friends, who got into a style, neither English or foreign, to the ruin of either style; he was apt to have serious hallucinations of mind, and whilst they lasted he was perfectly sincere, but if he seduced inferior minds to follow him for the time, it was likely, before the next season, he would startle them by running down with equal enthusiasm what the year before he had so earnestly worshipped! But he was a kind friend, a good brother, a dutiful son, and a high moral character. He founded our domestic school; and if ever man left this world fit to appear instantly before his Maker, it was DAVID WILKIE.

London, June 12, 1843.

B. R. HAYDON.

## LONDON AND BIRMINGHAM RAILWAY.

ROOF OVER THE LOCOMOTIVE ENGINE-HOUSE, AT BIRMINGHAM.

(With an engraving, Plate X, drawn to a scale of  $\frac{1}{8}$  of an inch to the foot, and the enlarged parts  $\frac{1}{2}$ -inch to the foot.)

THIS building was erected about five years ago; it is a polygon of 16 sides, and was originally covered by a roof having an open area in the centre: but this being found not to afford sufficient protection, from the inclemencies of the weather, to the men employed about the engines, the roof was removed during the autumn of last year, and replaced by another, the construction of which is shown in the accompanying engraving; it is simple, and at the same time an excellent combination of timber and iron.

The ring of columns and connecting girders, (shown in enlarged part C,) used in supporting the old roof, was retained for a similar purpose in the new one. On reference to the engraving, it will be seen that the roof is supported upon this ring, and upon the exterior walls of the building. The thrust upon the walls is neutralized by the tie rods *a*, which connect the head of each column fig. C, with the shoe of the opposite rafter fig. A. Upon the head of the column is fixed the stanchion *b*, which carries the curved brace *c*, these, together with the strut *d*, all of which are of cast iron, form the point of support for the rafter *e*.

The heads of the rafters meet in a cast iron curb *f*, shown in the enlargements E, upon which the lanthorn F, is erected; this curb is cast in eight portions, and firmly bolted together. The plan of soffit of the lanthorn is shown at G, and the junction of tie bars at the foot of the ring bolt at H.

The cost of the roof is as follows:—

	£.	s.	d.
1795 cubic feet of Memel fir, edges chamferred, at 4s. . .	359	0	0
110½ squares of 1-inch deal boarding, the edges shot, underside coloured in distemper, at 40s. . . . .	221	10	0
1094 feet run of hip roll, at 4d. . . . .	18	4	8
640 feet super. gutters and bearers, at 1s. . . . .	32	0	0
1248 feet super. 2-inch bevel bar skylights, glazed with British sheet glass in large squares, at 3s. . . . .	187	4	8
160 feet super. 2-inch wrought boards, at 1s. . . . .	8	0	0
134½ squares Duchess slating, copper nailed, at 30s. . . . .	201	15	0
9 tons of lead, at £28. . . . .	252	0	0
25 tons of cast iron, fixed, at £10. . . . .	250	0	0
4½ tons of wrought iron, at £22. . . . .	99	0	0
1163 super. yards painting four times in oil, at 1s. . . . .	58	3	0

## CANDIDUS'S NOTE-BOOK.

### FASCICULUS L.

"I must have liberty  
Withal, as large a charter as the winds,  
To blow on whom I please."

I. Our Note-Book is getting old—it has reached its Fiftieth Fasciculus; no matter—provided it has not actually fallen into its "ser and yellow leaf;" and does not begin to exhibit symptoms of dotage. No doubt there is a good deal of repetition in it—much that is nearly the same in substance has been touched upon again and again; yet not, I conceive, needlessly so, because it is only by their frequency that similar "morsels of criticism," can be expected to make such an impression as to be of real avail. It may, perhaps, be said that the criticism itself becomes in time a bore; and so, indeed, it would, were every one else also to deal in it after the same fashion, and just in the same strain. But people have no reason to complain as yet of being overdosed with architectural criticism, except of a respectably tame and stale kind.

II. What a sad pity it is that Klenze did not come over to this country and take a lesson from the Hanging Committee at our Royal Academy, before he fixed his plan for the arrangement of the busts in the Walhalla. They would have shown him how *fealty* he might have packed together as many thousands of them as there can now be hundreds, by having a row of them upon the floor, and piling up the rest upon shelves to the very ceiling. No matter whether seen or not, provided the things be but there. Our Academy seems to be of opinion that the nearer the ceiling the further out of harm's way, and out of the reach of criticism; and it would be well were some of them to exalt their own works so high aloft, that the most lynx-eyed critic could never make them out. Turner, for one, would show great judgment in doing so, because then we might fancy there was some meaning in his daubs and blotches. By the bye, what does Turner do with such things? he can hardly make use of them as waste paper yet some of them look very much like it.

III. Would that columns could be melted down as well as cannons, because were that possible, something might yet be made of the gigantic stone post, stuck up in Trafalgar Square, and which now seems to be sticking quite fast. The Athenæum tells us "it is still *insinuated* that it will one day be completed,"—perhaps at the Greek calends, for that day does not seem likely to come in a hurry. In the interim, therefore, the scaffolding might as well be taken down, instead of letting it rot to pieces, as it undoubtedly will do, if kept up until the work is completed, for by that time the column will probably have become a venerable piece of antiquity. In its present state, it is quite monument enough—a sufficiently significant one, and strikingly indicative of the sort of intelligence and taste which presided over the whole affair. If a column was deemed the most preferable form, upon the whole, for the monument, it should at least have been one of original and imposing character—a fine conception, treated in a noble style, whereas the thing now stuck up will inevitably have a puny look, and will be both lanky and top-heavy, the mass of the Corinthian capital being especially unsuitable for a detached column which has nothing to support—and considered with reference to the shaft and capital, the statue becomes tantamount to nothing, except there be some latent and malicious meaning in it, intended to make evident to us the littleness of the greatness that is stuck up above the heads of the rest of the world. If we had had nothing of the sort before, a column of the kind might have been welcome as a novelty—and for that very reason, perhaps, would have been protested against, as something remarkably fanciful and strange; but we have already so many examples of them stuck up all over the country, and all pretty much on a par as to insipidity, that it would be more desirable to get rid of some of them, than to add to their number. What all those bits of architectural trumpery may have cost it would be fearful to compute, but no doubt as much as would have sufficed to erect one or two edifices that would really have been genuine monuments of art—an honour to the nation and to the age.

IV. Who is this "Aunt Elinor," who has just started up as a female professor of architecture, in the hope, it would seem, of being able to lecture ladies into a love for the study of the art? The idea itself—which, by the bye, she seems to have borrowed, or rather stolen without acknowledgment, from Wightwick, is surely a most preposterous one, since what occasion can women possibly have for understanding aught of architecture? or are they even capable of attaining to any intelligent knowledge of it? Are all our studies to be invaded by the present Amazonian race of females? or is their ambition insatiable? Already have they mastered all our *ologies* and all our *nomies*, and now, forsooth, they must attack what we have considered an impregnable fort—architecture—though, to confess the truth, it is not every one who has displayed any particular *forte* in it. Surely the ladies might be content with the plunder they have got from us—among the rest, geology, a study remarkably amusing, and to them most particularly useful. But architecture!—oh no! we must not allow them to come poaching upon that preserve. What would become of us he-creatures—professors and all, should it be discovered that women could attain to any competent knowledge of architecture as a fine art—and perhaps be able to design a classical portico just as easily as they can hem a handkerchief? No, instead of admitting women, we rather want to get rid of some of the "old ladies" of the male sex, who are actually in the profession. Still it must be admitted that a very great deal may be said on the other side of the question; nor is Aunt Elinor's idea so very preposterous after all. Women, it may be presumed, are fully capable of appreciating what, in its quality of a fine art, apart from the science and mechanical skill required for the practice of it, addresses itself so much both to the eye and to the mind, and exercises the judgment as well as the fancy. They ought to be able to feel all its harmonies of proportions and combinations, and to note all those delicate minutiae and subtle coquetteries of the art, were they but sufficiently instructed to understand them, and know in what they consist. At present, indeed, such is not the case, because architecture has a language of its own, which must be studied before its productions can be read or relished. If there be such a thing at all as poetry in architecture, that surely can be felt, and not only felt but as distinctly and with as clear a perception of the immediate causes of it, by one sex as well as the other. For my own part I am inclined to think that were ladies but to apply themselves to the study, they would in general make far better critics in all matters of architectural taste, than men do. Hardly would they pardon those negligencies and that slovenliness which are now so frequently drawbacks on what are in other respects designs of considerable merit.

What an encouragement, too, it would be to architects themselves to know that their works could be intelligently appreciated by judges of the other sex—whose suffrages, as matters are now, they consider quite valueless, and their praises mere empty compliments, flattering to the ear, yet meaning nothing. Let the study of architecture be taken up by ladies, and by educated persons of the other sex, and instead of being as at present considered an exclusively professional one, it would acquire a degree of popularity that would have a most beneficial influence on the art itself. To say that because such persons can study it only partially—*only* as a fine art and for its history as such, that they therefore ought not to attempt to study it at all, lest they should be sneered at, perhaps, as mere dabblers and pretenders, is manifestly absurd; or at any rate it ought not to be expected by professional men, that non-professional people should encourage it at all, since what can it matter to them whether the taste shown in it be bad or good? Why, in the name of common sense, should people be reproached for not paying due regard to, and not encouraging what they themselves are discouraged from attempting to study and endeavouring to understand? Even the ignorance of the general public may, however, have its advantages, and one of them is that a "Pecksniff," or a ——— will do quite as well for such a public, as a Charles Barry.

#### GROSVENOR HOUSE.—THE NEW SCREEN.

THE most aristocratic streets at the west end of the town have very few attractions indeed for the admirers of architecture, being far more remarkable for the absence than for any display of taste. They have a certain air of opulence about them, not to be mistaken; but it is entirely in "undress;" so that nothing can be more homely and insipid than the "magnificent squares"—as they are often bouncingly termed—in that quarter of the metropolis. Grosvenor Square is no exception, for if it contains some mansions above the average in point of size, it also presents some that are of more than ordinary ugliness. In Grosvenor Street, however, there is now a rather striking and novel architectural display, which loses nothing of its effect by the contrast it forms to the insipid monotony of that fashionable district. We allude to the new screen erected in front of Grosvenor House, the residence of the Marquis of Westminster; which is designed, as we understand, by Mr. Cundy, and which, taken by itself, is very handsome both in its design and its effect, and is far more happily composed than what, by serving as a precedent for it, may seem to detract from its originality. Though we have not as yet heard this screen compared to that before Carlton House, we should not be very much surprised to find it described not only as a copy, but as a miniature copy of it. A decided improvement upon it, it may fairly enough be termed, for while it can be likened to that example only with respect to the general resemblance arising from the same general disposition, every point of similitude is also one of difference, and that difference is decidedly in favour of the present design, as would have been evident enough were the other still in existence. It is not, indeed, to be compared with it for extent, being, perhaps, only half its length, if quite so much—for we do not know what were the exact admeasurements of the screen at Carlton House, neither what are those of the one we are now speaking of. But this last is certainly treated in a nobler and *larger* manner, and is far more consistent and complete. Here the entrance gates are rendered important and beautiful features, that both give value to, and are aided in turn by, the open colonnade between them; which was certainly not the case in the other instance.

The composition consists of an open colonnade, of the Roman Doric order, placed upon a low stylobate, (about four feet and a half high,) and connecting the two gateways. These last form slightly projecting breaks at the ends, and have coupled columns of the same order, with the entablature breaking over them, in such manner that the cornices of the pediments project considerably; owing to which circumstances these parts of the design possess a certain degree of mass and energy; the archways do not look like mere shallow openings; but by acquiring some depth the roofs of the pediments show themselves boldly in perspective. The gates themselves are highly ornamented, being of rich open-work pattern in cast-iron in imitation of bronze, which colour and style of decoration is judiciously carried out by the candelabra or gas standards, one of which is placed in each of the seven intercolumns of the open screen.

Thus far, we can bestow almost unqualified praise, for the whole is well composed and well studied, most pleasing in its *coup d'œil*, and unites a happy mixture of airy playfulness and solidity. It has converted what was before a mere gap between the adjoining houses, into a most attractive piece of architectural decoration; yet though, as such, it does not seem too ostentatious or of too great pretension in itself, it certainly is so if considered as an appendage to the building before which it has been erected, or we should express ourselves better by saying that this last is utterly unworthy of what has thus been made to accompany it. In those who are not aware that the screen is a mere after addition, the first sight of it cannot fail to raise expectations of some corresponding if not exactly equal degree of architectural display in the mansion itself. Great, therefore, must be their disappointment, when on a nearer approach they discover behind this colonnade merely a plain-fronted house, which even as such has no beauty of proportions, nor any air of dignity. The contrast in this respect would be ludicrous, were it not also vexatious and annoying. Are we never to see anything carried out consistently and

perfected throughout?—must there almost always be something to operate as a drawback on our satisfaction, and to mar our enjoying what we might else admire? To mention economy in such cases by way of excuse, is no apology at all;—it is like buying a costly picture-frame and hanging it up empty, because you cannot afford or else begrudge the money to purchase a painting to put into it; and though it is done every day, it is a very strange kind of economy that induces people to spend their money merely, it would seem, to convince the world that they lack either the means or spirit to do handsomely what else there is no occasion to do at all.

Possibly, however—and we are willing to hope that such will be the case, it may still be intended to complete what is here begun, and that as a screen has been added to the house, a house will in due time be added to the screen—that is, a façade on this side, of corresponding character. If not, we can account for what has been done, only by supposing that the noble owner has built chiefly for the gratification of his own eyes—not so much with any idea of improving the appearance of his house—which now looks more insignificant than before, as for the purpose of providing a beautiful architectural object to be seen from his own windows, so that in fact he may be said to have followed Lord Chesterfield's advice, and erected a front "over the way" for himself to contemplate.

That the effect of the screen as beheld from the house must be very striking, and form quite an architectural picture, there can be no doubt, and not least so of all when lighted up by gas at night. But then, besides that such consideration does not reconcile us to so much being left undone, by carrying out the ideas suggested by the screen, the whole space between that and the house might have been rendered a highly ornamental, though rather small *cortile*, whereas at present, it has no architectural character, or no more than what amounts to a sort of apology for something of the kind. Indeed, if nothing further is now to be done, it becomes a question whether it would not have been better to make the screen more of a screen than it now is, by filling up the intercolumns, for about half their height, with metal work of the same pattern as the gates. In this there would have been novelty, and certainly no inconsistency. There were, besides, many other ways by which the same purpose could have been accomplished, and as one of them we may mention that of adopting for a design of the kind, an order of square pillars instead of columns, raised not on a stylobate but merely a socle, with inter-columnar screens of masonry between them carried up to the level of the impost of the archways: in which case the lamps would be placed on those screens, and these last might be embellished with bordered sunk panels (in the manner of those now over the two doors at the ends,) with reliefs, not in stone but *bronze*.

We have said nothing as to the absurdity imputed to the idea of a row of pillars or columns employed merely as a wall—at least as a wall with openings in it. The objections urged against it as being such, appear to us pedantical and hypercritical. Columns, we grant, were not originally intended for such purpose, but it does not therefore follow that a different application from the one originally contemplated must necessarily be bad in itself. Were such the case, we must abandon much that is now considered perfectly legitimate, and is tolerated, if not always admired. If, too, absurdity there be in using columns that support nothing but their own entablature—which then becomes the top or coping of the perforated wall described by those columns;—how much more extravagant, and remote from the original purpose of columns must it be to employ them singly: and without their having anything at all to support, except it be a "black image" perched upon the top of the capital, yet not looking so much as if it had alighted from heaven, as if it had ascended from the infernal regions. If, therefore, we can endure absurdities of that kind, merely because antiquity has left us some precedent for them—of which, however, our modern copies fall very far short indeed—we may surely reconcile ourselves to what, while it is a degree or two less absurd and a less preposterous conceit, can hardly fail to produce a strikingly picturesque perspective effect, let the design itself, considered apart from such effect, be what it may.

## CONSTRUCTION OF A BÉTON BRIDGE.

*Description of a Bridge of Béton,<sup>1</sup> constructed at Grisoles, in the Department of Tarn-et-Garonne, in France. By M. LEBRUN, Architect of Montauban.*

Translated for the Journal of the Franklin Institute, from the "Bulletin de la Société d'Encouragement pour l'Industrie Nationale," for July, 1842. By ELLWOOD MORRIS, Civil Engineer.

Living in a region where suitable building stone is scarce and expensive, and where brick masonry alone is used, M. Lebrun, guided by the fine works of M. Vicat, on hydraulic limes, conceived the idea of substituting for this masonry the *béton*, which the Romans used with so much advantage.

In consequence, he submitted, in 1839, to the Minister of Public Works, the project of a bridge entirely of *béton*, which he offered to construct on the lateral canal of Garonne, to be traversed by many of the royal and departmental routes. This offer having been accepted, under certain conditions, M. Lebrun commenced his work in June, 1840.

The lime was of the hydraulic quality, burnt in perpetual kilns, by pit coal. The sand was clear of all earthy particles, of fine grain, and pretty uniform. The gravel stones, of the size of a hen's egg, came from the river Garonne. The lime was slaked alternately in two basins, joined together. For this purpose, we poured at first, in one of the basins, a quantity of water proportioned to that of the lime which we wished to slake; we then put in sufficient quicklime for the water to cover it; then we left the lime to slake freely without disturbance except by taking care to prick it, from time to time, with a stick, to introduce the water into those parts of the basin where the dissolved lime was dry. When the fermentation had ceased, we stirred up the lime in every direction with an iron hoe, in order to mix the paste and render it homogeneous; we left it then in this state, not to be used for twelve hours after slaking.

The proportions observed by M. Lebrun for *béton* destined for the construction either of walls or arches, were, in every ten parts, composed of two parts of lime in paste, three parts of sand, and five parts of gravel stones, or pebbles.

For making the mortars, we placed, on a paved surface, two measures of the slaked lime, which, after having been well beaten with pestles of cast iron, softened again by yielding up a part of the water with which it was charged; then we placed beside it three measures of sand, which we mixed, little by little, with the lime, always by the aid of the pestles, and stirring the whole with the shovel and in order that all the parts of the sand should be well incorporated. We observing not to put any water into the mortars, but, if the sand was too dry, we moistened it, a few moments before mixing. As soon as the mortars were sufficiently manipulated, we added five measures of gravel stones; the whole was then long and forcibly mixed and pounded, until each part of the gravel was sufficiently enveloped by mortar; then the *bétons* were taken in quantity, to wait for the moment of being used. We took care to make only what we could employ in a day's work, without which precaution it would have lost its cohesion.

The 15th of June, 1840, the excavation of the foundations of the two abutments being done, we commenced laying the *béton*, taking care, each time that a layer, or course, was finished, to cover it up immediately with wet mats of straw, to prevent a too rapid drying by the heat of the sun. By means of this precaution, the new course connected itself more intimately with the one below. We continued

<sup>1</sup> The French *béton* is nearly identical with the English concrete, the main difference being in the manipulation; thus *béton* is composed of lime, sand, and small pebbles, or broken stone, taken separately, and successively mixed together, the pebbles being added last; while concrete is usually formed of lime, mixed directly with gravel, containing naturally about the due proportion of pebbles and sand; proper quantities of water being used, and the factitious stone resulting, in both cases, being in effect the same.

*Béton*, or concrete, has before been used in retaining walls and other constructions, and, as is stated by General Pasley, of H. B. M. corps of Engineers, (in his admirable Treatise on Calcareous Cements,) it was also applied experimentally to build a military casement near Woolwich, of which the arch had 18 feet span, 5 feet rise, and 6 feet depth at the crown, and which, when subjected to the direct fire of 24 pounder guns, as well as the vertical plunge of 13 inch shells, loaded to weigh 200 lb. each, resisted both with success, and, contrary to expectation, was less injured by the latter, than by the former.

We must, however, here observe, that the failure of the concrete wharf walls, at Woolwich and Chatham, in consequence of tidal exposure, and the necessary protection of the concrete sea wall at Brighton, with woodwork, to shield it from the action of water in mass, (as mentioned by General Pasley,) points out the necessity of confining the application of concrete to constructions within reasonable and proper limits.

the masonry all of *béton*, (the backing of the arch and abutments keeping pace,) until reaching the height fixed. The exterior faces of the abutments, (not next the earth,) and of the walls, were formed by some planks strongly fixed, against which the *béton* rested. These planks were removed, two or three days after, and the faces of *béton* remained exposed, and were very well preserved. At the height of the springing of the arch, we laid five courses of bricks plumb on the faces of the abutments, to serve as perpendicular faces for the centre to fit up against, and enable it to detach itself easily.

Fifteen days after the laying of the last *béton*, we commenced the construction of the centre, composed of many courses of bricks, laid flat, in succession, (from the springing towards the crown,) following the curve of the arch at the intrados, built partly with plaster, and partly with cement, or hydraulic mortar, and supported at the springing by projecting masonry, or by a timber for that purpose. The centre was formed of four courses of bricks (in thickness, or depth, say nine inches); the three lower were laid with plaster, and the upper course with cement, to shelter the plaster from the dampness of the *béton*. The upper bricks of the centre were covered by a bed of mortar or clay, in order to model perfectly the intrados of the arch, and to hinder the *béton* from forming one body with the bricks.

The construction of the centre being finished on the 1st of August, we established, three days after, the masonry of the two heads of the arch of brick, (in lieu of stone,) which were completed on the 26th of the same month.

Immediately after the construction of the two heads, we wrought them into the general mass of *béton*, forming the arch; this operation was finished on the 5th of September, with the exception of the backing up, which was accomplished, on both sides, the 11th of the same month. The *béton* of the arch was composed in the same manner as those of the abutments, and manipulated by the same process; but we added to it  $2\frac{1}{7}$  cubic feet of cement for every  $35\frac{1}{2}$  cubic feet, or  $\frac{1}{17}$ th of the mass, to augment the strength of the mortars of the body of the arch. This construction was made without following

any regular order, and the *béton* was cast in masses, in the centre, to the thickness of two feet, which formed the first bed, or layer, on the development of the arch. This first being finished, we formed the second in order to reach the thickness of three feet at the key, the spandrel backing, and the abutments being levelled up. A coping of hydraulic mortar was then placed over the whole extent of the arch, and covered immediately with a layer of clay, strongly beaten.

All was left in this state until the 25th of January, 1841; we then proceeded to the operation of the striking of the centre of the arch. The 28th of January, the centre of bricks was taken away, and the intrados of the arch appeared very even in all its parts. After three months, it manifested not the smallest settlement in its masonry, and, since then, the bridge has stood through the summer, without incurring the least degradation capable of affecting its solidity. This bridge has a clear opening of  $39\frac{1}{2}$  feet between the abutments; the middle is placed in the axis of the canal, which has two towing paths; its breadth is

Fig. 1.—Elevation.

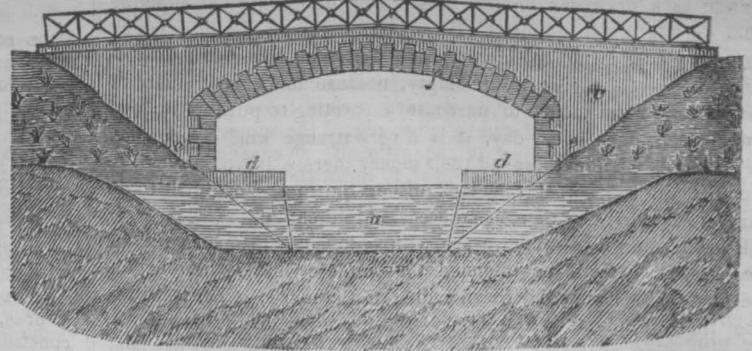
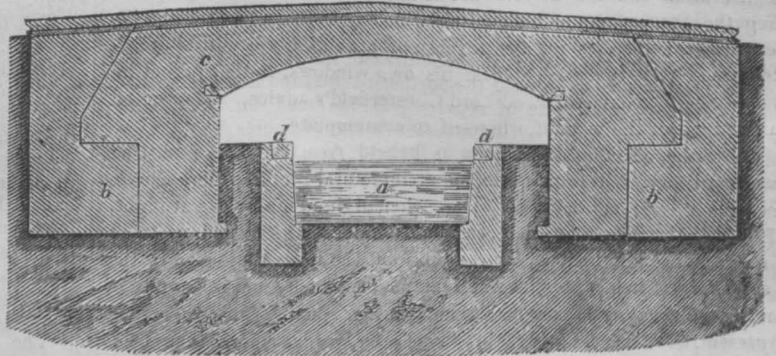


Fig. 2.—Section.



## EXPLANATION OF THE FIGURES.

a, canal; b, abutment of *béton*; c, mass of arch, also of *béton*; d d, towing paths; e, quoins of bridge upon the towing-paths, built of large stone, with the angles rounded; f, arrises of the soffit, or quoins of brick at each head of the arch, instead of the usual quoin-stone.

$19\frac{1}{2}$  feet between the heads, or faces, of the rings; and the arch is formed of a segment of a circle of  $39\frac{1}{2}$  feet chord, and  $5\frac{1}{2}$  feet rise, or versed sine.

The entire mass of the abutments is of *béton*, except the four angles on the sides of the towing paths, which are of large stone, rounded on the arris, on account of the rubbing of the towing lines. The arch is also of *béton*, as are the faces of the tympan, or spandrels, and the intrados with the exception of the arrises of the soffit, or quoin of the heads, which are of brick.

M. Lebrun has joined to his memoir, along with a plan of the bridge of Grisoles, many certificates, from the mayor of this commune, and from the engineer of the lateral canal of the Garonne, proving the complete success of the works, and the solidity of the construction, which has endured the proof of the passage of loaded carriages, the numerous influences of heat, and some very severe frosts, without having suffered the least degradation.

## OLD LONDON WALL.

A LETTER FROM MR. GEORGE GODWIN, F.R.S., &c.

"Some there are who cry down the study of antiquity with much contempt, as too curious a search after what is past; whose authority as I shall not altogether slight, so I shall not much regard their judgment."

CAMDEN.

On the west side of a vacant plot of ground in George Street, Tower Hill, and behind the houses in Trinity Square, stands one of the most considerable remaining portions of the wall which was anciently built for the protection of *Londinium*, (probably at the commencement of the fourth century,) and which for some time was considered of the utmost importance, and kept constantly repaired. As, however, the number and power of the citizens increased, they outgrew their shell, (it was but a small one,) and the irruptions of barbarians ceasing to be frequent, this protection was considered of less and less consequence; until at last, as Camden observes, the Londoners slighted fenced cities, as fit for nothing but women to live in, and looked upon

their own to be safe, not by the assistance of stones, but the courage of its inhabitants. Year after year has witnessed the gradual destruction of the remains of this ancient enclosure, until, with the exception of a bastion in Cripplegate Church-yard, the portion behind Trinity Square, of which I am about to speak, a continuation of it forming the back wall of Mr. Atkinson's hemp warehouse in Cooper's Row, and a few inconsiderable fragments to be found in the street to which it gives its name, it has been entirely swept away.<sup>1</sup>

The portion in question is also now threatened with destruction; and the object of this communication is in aid of other efforts which have been made, to induce those who have authority to re-consider the matter, with the view of avoiding this objectionable step if possible. It is intended to build a church on the vacant ground in George Street, with the special object of affording accommodation to the masters, officers, and seamen of the ships in the docks and the river; and it is considered that the site of the old wall "is essential

<sup>1</sup> For interesting particulars of the old wall, see Strype's edition of Stow's "Survey," chap. II. p. 7. Also Knight's "London," vol. I. p. 160.

for the satisfactory completion of the church." A memorial was presented to the Common Council from members of the Metropolitan Churches Fund, in February last, praying them to "grant permission for the removal of the materials of the wall, and to convey to Her Majesty's Commissioners, for building additional churches, the ground on which the wall now stands." This the Common Council granted; so that the fate of the wall is decided, unless those gentlemen in whose hands it is placed can be led to regard the subject in a fresh point of view. Their object is unquestionably an excellent one: far be it from me, even if I had the power, to throw the least impediment in the way of it. The gentlemen who are interesting themselves in effecting it are of undoubted character and worth, and I cannot help concluding that the proposal to destroy the wall was made in the first instance without serious consideration, and that now public opinion has been strongly expressed on the subject, other means will be taken to obtain sufficient ground for their purpose, or that the plan of the proposed church will be altered so as to adapt it to the land already in their possession.

The length of the wall is 48 feet, irrespective of a part of it which forms the end of some adjoining premises: the height next Trinity Square is from 20 to 25 feet, and the thickness, as nearly as can be estimated, about 6 feet. In times less eminent for the preservation of ancient monuments than the present day, it was coped with brickwork, and strengthened at the northern angle, and is consequently in a tolerably good state of repair. It is faced on both sides with masonry in courses, (the interior being of rubble work,) and shows occasional layers of Roman bricks. On the west side the facing consists in parts of alternate courses of square and flat stones, and the Roman bricks are few in number and very irregularly placed, so as to lead to the belief that it was reconstructed perhaps in the Norman period. On the other side, however, some vaults which adjoined the wall having been destroyed and the ground cleared away, a considerable portion is exposed to view—which is doubtless the original Roman wall, probably not less than fifteen hundred years old, yet still quite sound and perfect. The masonry is of broad squared stones, systematically bonded; and there are two or more continuous double layers of Roman bricks, agreeing precisely with other remnants of the original wall described by various writers. Dr. Woodward, who examined part of the old wall in 1707, when some houses were pulled down in Canonile Street, measured the bricks which were in it very accurately, and found them  $17\frac{4}{10}$  in. long,  $11\frac{6}{10}$  in. broad, and  $1\frac{3}{10}$  in. in thickness. The bricks in the wall now in question, measured without remembrance of Woodward's dimensions, I noted as 17 in. long, and  $1\frac{1}{2}$  in. thick. The double layer, including the mortar between the bricks, measures altogether  $4\frac{1}{2}$  in. From the top of the lowermost layer, or that next the ground, to the layer above it, the masonry measures 3 ft. 6 in.; from the top of this up to the next double layer, the masonry measures 2 ft. 7 in.

Of the value of this interesting relic of antiquity, the desirability of preserving it as a portion of the past for the service of the future, I would speak strongly. Monuments of this description become historical evidences, nationally important, and are continually found to be of the greatest service when tracing those changes in our state and manners which time is constantly effecting. They are links in a chain which connects the present with the past—awakeners of sentiment, silent teachers—and have never been destroyed without much after regret and condemnation.

"Past and future are the wings.  
On whose support, harmoniously conjoined,  
Moves the great spirit of human knowledge."

The importance of the study of antiquity, notwithstanding some few apparent proofs to the contrary, is now very universally admitted. "It was at one time the custom, amongst the people generally, (as the writer has elsewhere ventured to remark,) to reward the labours of the antiquary with ridicule and contempt—to consider the investigation of a ruined building, the preservation of a piece of pottery, or the noting down of the manners and customs of past ages, as the mere idlings of weak minds; and that he, who so employed himself, was not merely unworthy of praise, but deserving of censure for misapplying time. The value of the works of this class of men, is now, however, better understood, and therefore more duly appreciated. Through the exertions of these "musty" antiquaries, the civilized world is able (if we may so speak) to look back upon itself, and contemplate, in a great degree, its actual state, so far as regards the arts which flourished, the sciences which were understood, and the consequent position of the people, at various periods of its age; and that, too, not merely in the accounts of contemporary and succeeding writers, but in the very results of these arts so practised—in the coins used; the dresses worn; the furniture employed in their houses; and

the buildings raised for ecclesiastical, for warlike, or for domestic purposes."<sup>2</sup>

The architecture of a people especially, offers important evidence, in the absence of written records, towards the elucidation of their history; perhaps we may say the most important—for it speaks plainly of the state of society at each particular period, and hints at the degree of knowledge possessed by individuals, or by the people at large. As the comparative anatomist can from one bone determine the size, the shape, and the habits of an animal, which he has neither seen nor heard of, so may we almost discover, from the ruined buildings of a people, their prevailing habits, their religion, their government, and the state of civilization to which they had arrived.

Not to digress, however, from the immediate subject of this communication. The proposed demolition of the remaining portion of London Wall affords another instance of the advantage that might result from the establishment of a public board for the preservation of our ancient monuments similar to the *Comité Historique des Arts et Monumens*, of Paris, who when local requirements threatened the destruction of what in reality belongs to the whole nation, might interpose their authority, and prevent the contemplated injury. In the present case it is to be hoped that the Society of Antiquaries will not fail as a body to use their influence for the protection of the wall. At a recent meeting of the Royal Institute of Architects, the writer, at the request of a large number of gentlemen, brought the matter under their notice. The Marquis of Northampton, who was in the chair, expressed a hope that the wall might be saved, and suggested that the Council of the Institute should communicate with the Society of Antiquaries, with a view to the presentation of a joint memorial on the subject. The council of the Institute adopted the suggestion, and it is to be hoped that such a representation will consequently be made to the excellent gentlemen with whom the fate of the wall now rests, as to lead to its preservation whole and uninjured. Whether so or not, the writer feels he has but performed a duty in raising his feeble protest against the destruction of a most valuable and interesting memorial of the early history of the city.

GEORGE GODWIN.

#### ARCHITECTURAL DRAWINGS, ROYAL ACADEMY.

(Concluded from page 195.)

By the same architect, are one or two other designs of great merit; No. 1168, "Forest Cottage, the shooting residence of the Marquis of Breadalbane," answers perfectly both to its title and its purpose, having a look of most comfortable homeliness, and an air of genuine rustic picturesqueness in its ensemble, without any of that "make-believe" and affectation which frequently cause "genteel cottages" to appear strangely finical, and to remind us of the "tea garden." No. 1384, by the same, "Model of Wadhurst Castle, showing the alterations now nearly completed," also shows what a hideous piece of ugliness the house was, as first erected, and how happily it has since been metamorphosed, so as to be now a very pleasing and well combined design, marked by a good deal of expression in its details; whereas originally there was nothing whatever of the latter, while taken as a whole, the house was a mere insulated lump, unvarying in appearance, in whatever direction it may have been viewed. Such is by no means the case now, there being a very great deal of perspective play—of movement, fore-shortening, contrast;—a merit that confers varied interest on a building, and which renders the design we are speaking of, a very suitable subject for a model. Architectural models, however, do not seem to be in much favour with the Royal Academy, for instead of making suitable preparation for them, it seems to treat them as little better than lumber, that may be huddled together any how. Whether it ever turns away any things of the kind, we know not, but we certainly have seen many that have never been exhibited there, probably because it is pretty well known to architects that they would be considered unwelcome guests. But we must not say too much, or next year we shall have the Academy provide accommodation for models, by fixing up a shelf for them, on each of the rooms, at about a foot from the ceiling.

We have already observed that there are this season fewer subjects than usual which afford us any information as to public works or improvements actually in progress—with the exception of churches, almshouses, and union workhouses. Two drawings, however, there are which show us the additions now making to the buildings of two of the inns of court; viz., No. 1252, "South-east view of the hall

<sup>2</sup> "The Churches of London," vol. II.

and library, Lincoln's Inn," P. Hardwick, R. A.; and 1262, "View of chambers now erecting in the south court of Staple Inn," Wigg and Pownall. The first of these will be a handsome structure, somewhat similar in style and character to Middle Temple hall, and will, like that, be of red brick and stone. The building at Staple Inn, which is now considerably advanced, is also of the same materials, but there the colour of the brick is white, owing to which there is certain flatness and want of relief, the difference as to colour being just enough to disturb uniformity without producing decided and intentional contrast. The style itself is Elizabethan, of a sober cast—perhaps somewhat too much so, and so as to lose some of that character which is what chiefly recommends that style for imitation at the present day. In this instance we think it would have been an improvement had the lower windows been made slightly projecting bays, since that would have thrown a little more variety into the composition, and would have produced a sort of balance as well as contrast with the circular bow-windows over the doorways.

No. 1332, "The Amicable Life Assurance Office, about to be erected in Fleet Street," S. Beazley, makes us acquainted with another improvement, but one on so small a scale that it is not likely to produce so much show in reality as it here does upon paper—and even so seen, it is what would be passed without notice, but for the information relative to it contained in the catalogue. The new building at the corner of Water Lane, on the same side of Fleet Street, is a very much better piece of design, yet even that is so mere a piece in itself, that it looks no better than the commencement of a façade intended to have been carried on as far as Bouverie Street—had which been done, it would have formed a striking architectural object. As an improvement in general street architecture, may be mentioned No. 1233, "The intended new frontage of Freeman's Court, City," J. Anson, which, however, except as such, is not at all remarkable, since it consists merely of a uniform range of buildings in red brick, with stone dressings to the windows, somewhat similar to the front of the new office of the *Morning Post*, in Wellington Street North. Of "street architecture," much more dignified in character than anything we are accustomed to, or dare even look forward to, we meet with an ideal specimen in No. 1259, which is so massive and *grandiose* in style, that its author (A. Batson) will be considered quite a visionary. Regent's Park palaces and the architectural grandeurs of Pimlico, must hide their diminished heads, and shrink into utter insignificance, if in the course of the extensive improvements we are promised in the city, we are to have any streets—or even a single street of such exuberant pomp and stateliness. This drawing is also a very remarkable one in itself, energetic, but exceedingly vague and sketchy—more like the first conception of a painter than the distinctly defined idea of an architect, on which account it may perhaps strike the imagination all the more, by leaving a very great deal for the imagination to work upon.

On turning from this subject—whose title in the catalogue would never have led us to search for it—to some of the designs which we did look out for as promising something by their names, we feel rather chilled. While not a few of them disappointed us when discovered, others are put where, when found, so little can be seen of them, that it would be hazardous to attempt to pass any opinion on them, because they may be either very much better or considerably poorer than they look at a distance. Such is the case with No. 1217, "Design for the proposed Exchange, Manchester," of which we can only say that if it is shown to advantage by being placed where it is, nothing will be lost should it never be seen any nearer, and should it never be beheld in any other shape than that of a drawing. We may, however, have missed several things of merit, more or less, which may deserve to have been placed in situations now occupied by very inferior productions. We have, in fact, neglected to mention several drawings—not because they are unworthy of notice in themselves, but because some of them do not offer much for remark of any kind, and of others our recollection is now not sufficiently distinct. One rather striking architectural subject—how far it is portraiture or original composition, we do not know—is No. 1222, "Stone church in the palmy days of the 14th century," A. Smith; a splendid interior, well calculated to find favour in the eyes of those who hope that the devotional pomp of those same "palmy days" may yet be revived among us. In the meanwhile it is consoling to find that even should we not recover Popish puppet-show again, we are beginning to pay due attention to architectural decorum and character in our Protestant churches. Of such being the case we meet with a proof in No. 1260, "Interior of the new church of St. Mary, Herne Hill, Dulwich," G. Alexander, which though by no means showily, is consistently decorated, and the style, good in itself, is well kept up in every respect. There are some good designs for almshouses, and though not the very best of them, nor equal to Nos. 1265 and 1279, No. 1223, "Asylum for jour-

ney-men tailors, part of which has been lately erected at Haverstock Hill, Hampstead," is better than usual.

It is looking at this year's architectural collection as a whole, that we are dissatisfied with it, and not least of all so because it manifests an indifference on the part of the profession which contrasts strangely with the increased attention now given to the subject of architecture by the public—if not as yet by the public generally, by a very much larger class of it than formerly. If we ought to be satisfied with as many productions of interest and merit as we now actually find here, and consider them as forming of themselves a very creditable exhibition, we could also be satisfied with them alone, at any rate could very well dispense with a great many which only add to the numbers in the catalogue, without contributing at all to the character of the architectural part of the exhibition.

#### THE SELF-REGULATING EXPANSION SLIDE VALVE.

SIR—In the description of my self-regulating expansion slide valve, inserted in the *Journal* for February last, I inadvertently committed an error, which your Glasgow correspondent has very properly pointed out: this circumstance having given rise to a mistaken notion as to the efficacy of the principle on which this valve is constructed, you will, I hope, permit me to correct my former mistake, and to make a few observations through the medium of the *Journal*.

The erroneous statement was this: "*When the points of the tappets are approached so as to hold the plate I, the slide valve H, alone will move,*" &c. The tappets, properly speaking, should never hold the plate, although their doing so would lead to little or no inconvenience, if the plate I, is properly proportioned, because then even admitting the tappets to hold the plate I, as stated, the steam would be cut off so very soon, (at about  $\frac{1}{10}$  of the stroke of the piston,) that the engine would immediately lose her speed, the governor balls by closing would separate the cams or tappets, and the inconvenience would not be felt. The drawing, Fig. 3, being incorrect, the error in the description becomes important, for if, as improperly represented in Fig. 3, the plate I, is only just made long enough to cover the space existing between the passages on the back of the valve, and if the tappets are made so as to prevent that plate from moving with the valve, the steam would be cut off, it is true, at  $\frac{1}{10}$  of the stroke of the piston, but it would also be re-admitted into the cylinder, when the piston had got within  $\frac{1}{2}$  of the end of the stroke, and this imperfection would continue to a lesser extent during every other degree of expansion. The plate I, should be sufficiently long to cover half of both passages on the back of the valve.

The following example of a valve as made will fully explain my meaning.

The orifice of the steam part on the face of the cylinder, is three inches, the passage through the valve  $1\frac{1}{2}$  inches, and the moveable plate I, made so long, that when placed on the middle of the valve, it half covers the two passages; the cams or tappets are so regulated as never to approach within  $\frac{1}{4}$  of an inch of each end of the moveable plate, so that the valve will travel  $1\frac{1}{2}$  inch before the steam is cut off from the cylinder, and on its way back, the plate I, will cover the passage through the valve, until the valve itself covers the steam port in the face of the cylinder.

For the above valve the stroke must be six inches, and supposing the engine to be on her centre, the slide valve will be in the middle of its stroke.

As long as the tappets remain in the position assigned to them above, the plate I, will cover the passage when the valve has made one half of the remaining three inches of its stroke, which will be effected by the crank pin having described an arc of about  $29^{\circ} 30'$ , or nearly one-sixth of its half circumference, when the piston will have travelled through  $\frac{1}{10}$  of its stroke, *the motion of the valve being as the sine, and that of the piston as the versed sine, of the arc described by the crank pin.* Therefore, under the above circumstances, steam will be admitted during  $\frac{1}{10}$  of the stroke of the piston, and as the distance between the points of the tappets is increased by the action of the governor, so will the quantity of steam admitted to the cylinder be also augmented.

When, therefore, the plate I, is made of the length above-mentioned, the steam may be cut off at  $\frac{1}{10}$  of the stroke of the piston, but as it is seldom required to cut the steam off so soon, the portion of the length of the stroke during which the steam may be admitted, can be augmented by diminishing the length for the plate I—as for instance, if it is desired to cut the steam off at one-sixth of the stroke, it will suffice that the plate I, should be made long enough to



cover only one fourth of the passage at each end of the valve; and for any other portion between one-sixth and  $\frac{1}{12}$  of the stroke, during which it may be thought requisite to introduce the steam as a minimum, the plate I, must be made of a sufficient length to cover some intermediate portion of the passage, between one-fourth and one-half.

Under all circumstances, the distance between the points of the tappets at their nearest approach to each other, should be equal to the length from outside to outside of the two passages that run through the slide valve, and the governor should be so applied as to give to each tappet, a stroke equal to one-fourth of the total stroke of the slide valve.

Your Glasgow correspondent says that "a slight examination of the drawings will show that though the steam is cut off as soon as the port of the cylinder is half open, admitting steam during rather less than one-fourth of the stroke;" this is an oversight on his part, and a closer examination of the drawings, imperfect as they are, will convince him (every thing being as shown in the drawings,) that although the steam would be cut off as soon as the port of the cylinder is half open, it would only be admitted into the cylinder during about one-fifteenth of the stroke of the piston, instead of something less than one-fourth.

It remains for me to thank your correspondent for having called my attention to the error I committed in my former communication, and as I fear that I have already too much trespassed on your valuable space, I shall be happy to answer any questions, or give any information in my power, if your correspondent will send me his name and address. I was not in England when the *Journal* for May appeared, or I would have requested the favour of your inserting this in your last number.

I remain, Sir,

Your most obedient servant,

London, June 8th, 1843.

H. H. EDWARDS.

#### THE BUDE AND BOCCIUS LIGHTS.

During the last month two of the Wednesday Evening meetings of the Society of Arts, in the Adelphi, were occupied with the reading of interesting papers describing the Bude and Boccius lamps and their advantages. On the first evening the large room was splendidly lighted from one gas lamp, suspended from the centre of the room, on the Bude principle, when Mr. Bethel read a paper and described its principle. On the following Wednesday the room was lighted in a similar manner with the Boccius light, when a paper describing its advantages was read by Dr. Atkin. We have here given a full description of each light by the respective authors of the papers, and leave it to our readers to judge of their respective merits. They both appear to be deserving of encouragement and the patronage of the public.

##### THE BUDE LIGHT.

The Bude light is the invention of Goldsworthy Gurney, Esq., of Bude, in the county of Cornwall, and has been called *The Bude Light*, a name given to it at the Trinity House, to distinguish it from Mr. Gurney's former invention. Mr. Gurney has, for the last twenty years, been experimenting upon the best means of producing the most powerful and beautiful light. In 1822, he invented the light called the Oxy-hydrogen Light, which he fully explained in his lectures delivered in Cornwall in 1822, and published in his book on chemistry in 1823. This light was the result of his experiments with the oxy-hydrogen blow-pipe. The combustion of the two gases, oxygen and hydrogen, issuing from two distinct jets in certain proportions, produce no light, and only a small blue flame, giving off very great heat; but when a small cylinder of lime is placed behind the jets, the most intense and beautiful light is evolved. Some years afterwards Mr. Gurney invented another powerful light, produced by passing a stream of pure oxygen gas through the wick of an oil lamp, whereby a most intense and beautiful light was formed. This light was put up at the Trinity House, where it was seen by Mr. Hume, who was the chairman of the lighthouse committee; he introduced it to the notice of the House of Commons, and it was subsequently adopted for lighting that house. Difficulties occurred in the practical working of this light, and Mr. Gurney determined on still further prosecuting his experiments; and the result was, the production of what may be called *The Atmospheric Bude Light*.

The mechanical principle by which the light is produced, consists of a series of horizontal concentric rings of tubing perforated on the upper part for the escape of the gas placed at definite distances from each other, and so arranged as to regulate the quantity of atmospheric air, and to communicate by conduction and radiation sufficient heat to raise the temperature of the gas to a given point, so as to effect the separation of its carbon immediately as it leaves the burner, and then by an arrangement above to bring fresh atmospheric air to the proper points of the flame. A perfect lamp will

deposit the carbon in the flame the instant it passes the jet. If so imperfect as to deposit too soon, carbon will be found in the rings; if too late, then high up in the flame. There is a point of accuracy required, which practice has determined. This mechanical arrangement brings about a series of chemical changes involved in the evolution of light and heat, which are very interesting. The rapidity of chemical union governs the respective quantities of heat and light. We may by a too rapid combination produce heat alone, and no light. It has been found by careful measurement, that little or none of the light given off by the inner rings is lost, but that it all passes through the outer rings of flame. By the concentration of a mass of light, a powerful illuminating effect can be diffused over the whole apartment, and may be softened down by glass shades to any intensity, and tinted, if desired, with any colour. It has been found in the shops in London, where this light has been used, that its effect on coloured articles is very different to other artificial lights, as all colours—particularly blue and green—can be as distinctly seen by it as by daylight.

Its economy has been proved to be very great. The evidence given by the scientific gentlemen examined before the committee of the House of Commons, they proved that for the same quantity of light used in that house, the saving by using the Bude burner is equal to 50 per cent. Professor Wheatstone stated, that the Atmospheric Bude burner he used had 3 concentric rings, and was supplied with street gas. Its light was equal to 63 wax candles, and consumed 20 cubic feet of gas per hour. The Argand gas burner used by him was equal to ten wax candles, and consumed 5 cubic feet per hour. The Bude Light consumed not quite four times the quantity of gas which the common gas burner did, whilst the light given by it was  $6\frac{1}{2}$  times more intense, thus giving an economical advantage of the Bude Light over the gas light of very nearly double.

The committee in their report to the House, state that the saving effected upon the lighting of the house by the introduction of this light, was 484l. 9s. per session. The light has given the greatest satisfaction. Its intensity combined with its softness, has delighted all the members of that house. Its effect in the different churches where it has been placed is most excellent. Clapham church is lighted by one burner, which is composed of 5 concentric rings, the diameter of which is 11 inches; this lights the whole church very beautifully, and so perfectly, that the congregation is able to read in the shadow near the pillars supporting the galleries. In Christ church, Albany-street, a more perfect illumination has been produced by two burners than by the 72 Argand burners previously used there. But one of the most important advantages of this light is, that it proves a most perfect ventilator. It is always fixed high up in the room with a large escape pipe over it leading to the chimney, or externally entering, which carries off all the products of the combustion of the gas; without this pipe it is not considered that London gas can be pleasantly burnt.

##### THE BOCCIUS LIGHT.

The burner of the Boccius Light consists of one or several concentric rings; when more than one is employed, the inner ones rise to a higher level than the outer, as shown in the annexed engraving, B B, and are perforated with numerous minute holes, in about the proportion of 60 to a circle of an inch in diameter. The inner are supplied with gas from the outer, and to make up for the diminished supply, the holes in the inner are rather larger. Above the burner at a given distance, two concentric metallic chimneys (D), are placed, whose diameter is regulated, in great measure, by that of the outer ring. The chimneys are supported by three wires (C), upon the glass holders, and surrounding the whole, a glass funnel (F), proceeding from the level of the burners to the top of the metallic chimneys. The glass in the smaller burners is perfectly straight; in the larger ones, slightly bell shaped at the bottom. When the gas is turned on and lighted, the lower part of the burner—that is, the rings (BB), and crutch (A), become to some extent heated, and communicate a portion of their heat to the ascending gas; the amount of heat is from the construction (accuracy having been attained by experience) so nicely adjusted, that no carbon is deposited in the ring; but the warm gas escapes, ready to deposit its solid matter on a slight increase of temperature. The cold air, too, in rushing between the crutches and rings becomes warmed, and the burner is thus supplied with hot air, no air being admitted except from the bottom; it, of course, can produce but a very insignificant cooling effect on the flame. The chimneys, especially the inner one, robs the ascending current of a great portion of its heat, which it in turn communicates to the upper part of the flame, and carries the particles of carbon there to an intense temperature, and causes them ultimately to unite with oxygen. The quantity of air entering is so regulated by the size of the separate openings, that it produces nearly a perfectly cylindrical, instead of a conical flame. From some cause or other, the reason of which the inventor is unable satisfactorily to explain, the products of combustion are separated from one another, and appear at different positions. The ascending current of air between the glass and outer chimney supports combustion, as of a taper; when placed between the two chimneys the taper is extinguished, and re-lighted again when brought over the central aperture. The novelties in arrangement of this lamp are the rising concentric rings and the metallic chimneys. We have in the engraving represented a large double ring burner in the centre; the diameter of the outer ring is 5 inches; and of the inner, 3 inches. This size burner will consume about 55 feet per hour, and be equal to 22 Argand burners, consuming 5 feet per

hour, or 110 feet; the saving is, therefore, one half. These burners have been subjected to the most severe scrutiny; they have been examined and tested by some of the most expert experimentalists, and have passed the ordeal; and all who have had an opportunity of examining and proving them, concur in awarding to them the highest praise. The Boccicus light has been introduced in the Birmingham Gallery,<sup>1</sup> where both the features and statues were better seen by a clear than an obscured light. The students there (and, perhaps, on such a point their evidence is of value), state they can draw as well by the aid of the Boccicus light as with daylight, the shadows being as perfect as those produced by sunshine. Mr. Moxon's Hall of Commerce in Threadneedle-street, is illuminated with this light. It has also been erected at Charing Cross for some months, where it brilliantly illumines that great thoroughfare for a considerable distance. The advantages which the patentee proffers to the public, and proves his light to possess, are,

- 1st. Obtaining the greatest quantity of light from the least quantity of gas.
  - 2nd. From the small quantity of gas consumed, the trifling amount of deleterious gas produced.
  - 3rd. From the same cause the comparatively small amount of heat generated.
  - 4th. From the complete combustion, the impossibility of escape of the noxious inflammable gas into the air.
  - 5th. The complete absence of soot and smoke.
  - 6th. The durability of the apparatus, and the ease with which it is managed.
  - 7th. The possibility of applying with success, the principle to burners of all sizes, from one consuming 1 foot, to another consuming 100 per hour.
  - 8th. The easy mode of ventilation it affords, either by placing a ventilator in the roof immediately above the light if it communicate with the air.
- The light may be seen at any time at the office of the patentee, 14, Duke-street, Adelphi.

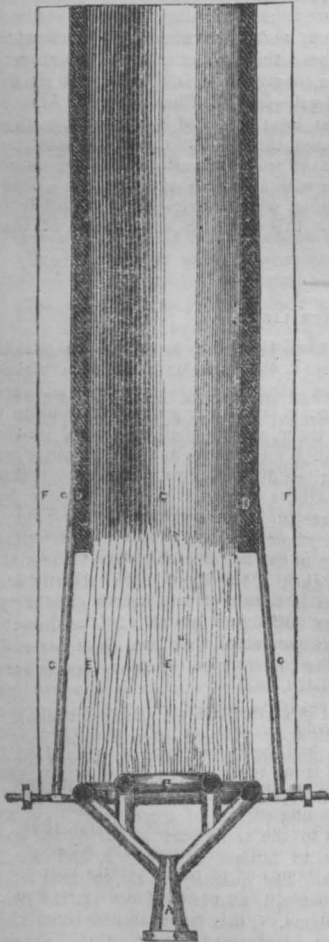


Fig. 1.—Section.

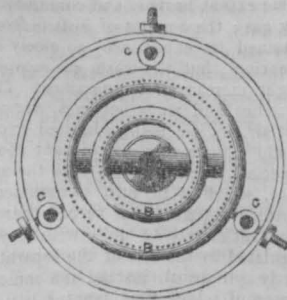


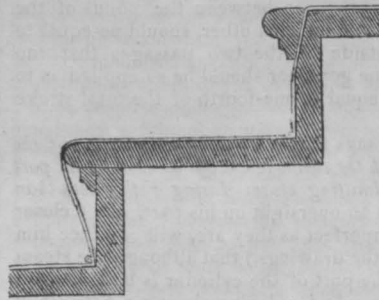
Fig. 2.—Plan.

<sup>1</sup> This picture gallery was illuminated with the Boccicus light for six weeks, and gave satisfaction; it was formerly lighted by 30 bats wings consuming 1,000 feet an hour; but with 3 Boccicus burners, consuming 225 feet an hour, double the amount of light was obtained; the statuary room was, also, lighted with one consuming 75 feet an hour instead of 22 bats wings, which used to consume 110 feet an hour.

PATENT SAOTAPE NOSING.

Patented by ARTHUR C. TUPPER.

Fig 1.



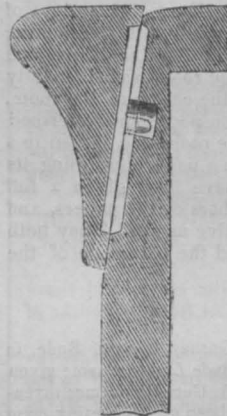
The improvements in laying down carpets, and other materials upon stairs and steps, and in the construction of stairs and steps, and for which Mr. Tupper has obtained a patent, may be arranged under two heads: the Nosing and Stair Rod. In staircases in present use, and where landlords will not go to the expense of having new nosings, Mr. Tupper proposes cutting through the tread obliquely close to the nosing, as shown in Fig 1., and in the slit so made the carpet passes through. To insure support, it is proposed that the stair-rods be made of an arch-like form, as shown in Fig 2., with the

Fig 2.



apex placed under the nosing, it will be the means, also, of preventing the stair rod from bulging and getting out of the "eyes;" these arch-stair rods are capable of being ornamented to any extent.

Fig 3.



The separate nosings can be made not only of wood, as wainscot, mahogany, &c., but also of or-molu, iron, brass, &c.; and these can be applied to stone and wooden stairs. As regards the fixing, Mr. Tupper proposes using a wrought iron stud and plate; but this can be effected, also, by screws, bayonet joints, rings, grooves, &c., so that the carpet, &c. can be either placed, and the nosing applied over it, or the nosing moving on hinge, can lift up and the carpet be placed as usual. The nosing so applied, not only preserves the carpet from the wear caused by the attrition of the feet, but also takes up less of the fabric used, as there is a saving of about 2 inches of carpet upon every stair; this method also prevents the carpet from "wabbling about," and here it is especially useful in winders and angular stairs. In these moveable nosings two or more pieces of metal can be attached, which can be ornamented to any extent, and fastened in such a manner, as, when the nosing is fixed

in its place, the carpet is firmly clamped by these "stays," doing away in this case with stair rods and eyes. It is presumed that the appearance of a staircase will be greatly improved by this method, as the nosings can be ornamented and decorated in various ways; for instance, if a mansion is of the Elizabethan age, the nosings, as well as the bannister and handrail, can be ornamented in the beautiful style of that period.

An enlarged model showing a variety of methods of forming the nosing, is exhibited at the Polytechnic Institution.

LAUNCH OF THE STEAM-FRIGATE "INFERNAL."—Woolwich, June 1.—This beautiful first class steam-frigate was built on the same slip in the dockyard as her sister, the *Devastation*, which has given such great satisfaction owing to her seaworthiness and other qualifications, and was launched on the 31st of May.

The following are the dimensions of the *Infernal* :—

	Feet.	Inches.
Length between the perpendiculars ..	180	0
Length of keel for tonnage .. ..	156	4½
Breadth, extreme .. ..	36	0
Breadth for tonnage .. ..	35	8
Breadth, moulded .. ..	35	0
Depth in engine room .. ..	1	0
Burden in tons, old plan, 1058.		
Burden in tons, new plan, 1027.		

## ON THE DECORATION OF THE NEW HOUSES OF PARLIAMENT.

[The following article is an abridgment of a paper which appeared in *Fraser's Magazine* for May last.]

THE destruction of the ancient edifice was felt to be a national calamity. The rebuilding another upon its ruins is the greatest architectural work of modern times; and now, that it advances towards completion, we naturally turn our thoughts on its embellishment.

With this design the House of Commons appointed a committee in 1841; and, on the 24th of November following, commissioners were nominated by Her Majesty, "For the purpose of inquiring whether advantage might not be taken of the rebuilding of the houses of parliament for promoting and encouraging the fine arts."

The commissioners have now published their first report. It is composed with care, and contains valuable information. Yet, in their projected plan of decoration I see, with regret, that the commissioners have stumbled over the very threshold of their duty.

Justice to those gentlemen demands, however, that their plan should be stated in their own words.

They say:—"We beg to report our opinion that it should be expedient that advantage should be taken of the rebuilding of the houses of parliament for the purpose of promoting and encouraging the fine arts of the United Kingdom.

"With this view we have, in the first place, directed our attention to the question, whether it would be expedient that *fresco-painting* should be employed in the decoration of the new houses of parliament; but we have not been able to satisfy ourselves that the art of *fresco-painting* has hitherto been sufficiently cultivated in this country to justify us in at once recommending that it should be employed. In order, however, to assist us in forming a judgment on this matter, we propose that artists should be invited to enter into competitions of *cartoons*.

"As *fresco-painting* has not hitherto been much practised in this country, and as, therefore, candidates for employment in that mode of painting, whatever their general skill may be, will probably find it necessary to make preparatory essays, her majesty's commissioners think it expedient that the plan which they have resolved to adopt in order to decide on the qualifications of such candidates should be announced forthwith.

"Three premiums of 300*l.* each, three premiums of 200*l.* each, and five premiums of 100*l.* each, will be given to the artists who will furnish cartoons which shall be respectively deemed worthy of one or other of such premiums, by judges to be appointed to decide on the relative merits of the works. The drawings to be executed in chalk or in charcoal, or in similar material, but without colours.

"The plan which may be adopted in order to decide on the merits of the candidates for employment as oil-painters, and as sculptors, will be announced at a future period."

Further, the commissioners determine that the subjects of these cartoons shall be chosen from English history, or from the works of Spencer, Shakspeare, or Milton.

In the consideration of this plan, I do not presume to instruct the architect, the sculptor, or the painter, but I address myself to the public's feeling, taste, and sense, by which this plan, with the works executed under its authority, must eventually be approved of or condemned.

The royal commissioners were nominated for two objects: first, to consider of the decoration of the houses of parliament; and, secondly, of the promotion of the fine arts of the United Kingdom.

Let us then examine how these objects are to be attained by the plan proposed.

The first and principal end is undoubtedly the adornment of the seat of the legislature by works worthy of the edifice, the nation, and the age. While instrumental and auxiliary to this, the fine arts of the country were to be employed, and by employment, to be encouraged.

Now the plan proposed inverts this design, for it forgets what is due to parliament in its eagerness to introduce a special branch of art. It gives "the first place" and consideration to painting in *fresco*, while it admits this art not to have been sufficiently cultivated to justify its immediate employment.

In the useful, no less than in the ornamental arts, we see by daily experience, that the less the practice, the more the risk of failure.

But in this mode of painting hitherto unpractised, where every part has yet to be learned, and can be learned in no other way than by long experience and repeated trials, failures in the beginning are not merely probable but unavoidable.

Are the walls of parliament a fit place for the trial of a new art?

Are the 'prentice hands of painters to be employed, where nothing

ought to be admitted but what is of the highest excellence our arts have attained to?

Is parliament, I demand, to be made the "*experimentum in corpore vili*?"

This were to sacrifice the end to the means—the embellishment of this national edifice to the patronage of a new art—certain to disgrace what it meant to adorn.

The second object of the commission was to promote the sculpture and painting of our country.

Consider, next, how this "Plan" can promote them. It attempts to introduce a branch of art practically unknown, or known only by some poor failures.

To this "the first consideration" has been given. To this are offered premiums and employment. Meanwhile, all other branches of art are to be postponed, and the "Plan" as to them is to be announced at a future period.

Now how can this unknown mode of painting promote those wherein our artists practically excel?

If the preference be given in the hope that, with the advancement of *fresco-painting*, historical painting will follow, then the plan overlooks an essential condition, namely, that such a result must be the work of time—probably of ages. Whereas, the commissioners were nominated for a special purpose—the decoration of the new houses of parliament, now in progress towards completion.

Is it wise, then, to postpone all those forms of art in which we actually excel for so distant and doubtful a result? Or do the commissioners expect artists of established reputation will take up a new branch of painting, beset with difficulties, even in the material on which they are to work?

What man of sense would risk a well-earned fame by a public exposure where failure is certain?

The preference, therefore, given by this plan to *fresco-painting*, will tend to exclude men of distinguished merit, and thus narrow competition to such as have yet a name to gain; possibly modest men of skill, more probably, bold adventurers ready for any job.

Or it may exclude entirely our native artists, to throw employment in the hands of foreigners, eagerly on the watch to grasp at the occasion.

Still the contradictions between this "Plan" and its professed purposes are forgotten in the absurdities that mark its manner of execution. The commissioners evidently mistrust their favourite project.

"They are not satisfied that *fresco-painting* has been sufficiently cultivated to justify them in recommending its employment.

"They admit that artists, whatever their general skill may be, will probably find it necessary to make preparatory essays."

Here is a difficulty, indeed, and how do the commissioners get over it?

They offer £2000 divided into eleven premiums, for the best cartoons or drawings "in chalk or in charcoal without colours." These drawings are to serve the double purpose of "preparatory essays," and to enable the commissioners, or those they shall nominate, "to judge of the qualifications of candidates."

Let us pause here for reflection. Have the commissioners ever seen or heard of any art, introduced and brought to such eminence as should fit it for a great national work by mere "preparatory essays?" Have they forgotten that this very art of painting in *fresco* attained its excellence in Italy by the genius and labours of successive generations? Do they not see that they are setting artists to work without masters to show them where they will encounter, and how they are to overcome, the endless difficulties that beset the *fresco-painter* at every step?

The commissioners strive at what is unattainable. For no branch of painting ever has attained excellence, without genius to invent, labour to execute, masters to teach, models for imitation, schools for the principles, and practice, and time, that in art extends through ages for the accomplishment.

In the place of all these stand "Preparatory Essays." What, then, are those preparatory essays that are to work such marvels, whereon £2000 are to be expended, at once designed to teach artists how to paint in *fresco*, and the commissioners to judge of their ability? Are they to be paintings in *fresco*? No. For this were impracticable, unless walls had first been built, and plastered to practice on. Are they to be paintings at all? No: they are to be merely "drawings in chalk or in charcoal without colours."

Now will the commissioners condescend to inform the public how drawings upon paper or canvass are to teach the art of painting on plaster? The drawings may possess every quality of design, yet their designers be utterly incapable to paint them in *fresco*. Suppose, for instance, that Raffaele's cartoon of the "Schools of Athens" were placed in the hands of an unpractised artist, is there any one so

simple as to believe that, presently, he would be invested with ability to paint the famed fresco on the Vatican? It is true the drawings will show the choice of subjects and manner of treating them, but they will show no more. They cannot prove the artist's power to transfer, embody, and permanently fix his colours into a material so untractable and capricious as a plastered wall.

Whoever, like myself, has watched the slow progress of a fresco-painting, from the "tracing" to the last touch, knows well that it is a process beset with difficulties at every step, unknown in other branches of the art, and to be learned and overcome by years of patient labour. Yet upon this false notion the commissioners have resolved to rest their judgment, and expend £2000.

What motives could have induced the Italian masters to have persisted in the use of a material so unmanageable, capricious, and perishable as stucco; at the best but a cheap and mean imitation of marble? To answer this question, we must consider the various materials used as grounds for painting. These have been vellum, paper, glass, ivory, marble, porcelain, copper, panel, canvass, and stucco. For works of magnitude, the three last, panel, canvass, and stucco, have superseded the rest. They were simultaneously used. But in the early times of oil-painting, panel was preferred, not only for its durability, but because it enabled the painter to enrich his figures with inlaid jewels, pearls, and gold, agreeable to a custom transmitted from remote antiquity. Though subject to rend, to warp, and to be worm-eaten, panel is the most durable of these three substances. The oldest works in the best preservation are those on panel. Many are yet extant, on which 300 years have wrought no visible decay.

Canvass possesses many peculiar qualities as a ground for painting. It may be woven of any size and texture; it is light, cheap, and easy of transport, for we must not forget that paintings form an article of commerce. It may be stretched if shrunk, and what is truly admirable, when rotten or worn out, it may be severed from the painting, and replaced by new: an invention that has bestowed upon canvass paintings the durability of those on panel, and has already saved from crumbling to dust many precious works. Light, then, as the fabric is, canvass paintings have lasted for centuries; and if frescos are older, it is not that stucco is fitter to preserve them, but because painting in oils was an art invented or recovered in later times. Having these substances in daily use, the question then returns, what motives could the Italian painters have had for persisting to paint on stuccoed walls, while some are said to have preferred them.

Let us next proceed to the inquiry, in what manner sculpture and painting may be most suitably employed in adorning the magnificent seat of our legislature, by works worthy of its destinies, of the empire, and the age.

Whoever will be at the pains to duly reflect upon this subject will find himself drawn to the conclusion, that these objects are not to be attained otherwise than by the employment of those branches of the arts wherein we have already attained to excellence. Now the sculptors and painters of our country possess unrivalled pre-eminence throughout Europe for statues and portraits. But here the question comes, are statues and portraits the most suitable decorations for the houses of parliament? We shall find the answer in the customs of mankind. No custom wherein the fine arts have borne a part has been more anciently or generally established, than for halls of council to be adorned with the effigies of illustrious men.

In the free states of Greece this custom served as the memorial, the reward, and the incentive to noble deeds.

In Rome it rose to the dignity of a political institution, placed under the jurisdiction of the senate. Whence it was copied by the municipal councils of that empire. The nations who formed kingdoms out of its conquered provinces preserved the usage where their arts would permit. The Italian republics gave the custom the sanction of law. Undoubtedly, then, such ornaments must have been in harmony with the feelings of free nations. Still more is required. The custom ought to be congenial to the habits of England. Let us recall what we possess in this sort. We see in Westminster, in the cathedrals, even in the parish churches, how rich England is in monumental statues, and how charmingly they harmonise with architecture.

In our ancient cities where is the council-chamber without portraits of honoured citizens? Where is the college-hall unadorned with the likenesses of its founders and benefactors? Where is the ancient mansion without its family gallery?

The custom, then, is truly English. Shall a usage so honoured, interwoven with all we hold dear, find no place in parliament, where are concentrated the ranks, intellects, and feelings of the country? Shall its adoption by the senates of antiquity, whose attainments in the fine arts we are now vying to emulate, be of no weight, not even to prefer the memorials of departed worth to the projects of unknown men?

In sculpture and painting it will be found that the likenesses of the renowned dead affect the feelings more deeply and lastingly than the loftiest creations of fancy, even when their subjects are chosen from actual events.

A comparison taken from the highest works of art will best explain this principle. Whoever has resided at Rome may have seen the frescos of Raffaele in the Vatican, and probably passed onward to the gallery of statuary where are arranged the sages and statesmen of Greece. In the frescos are seen the designs of the loftiest genius expressed with consummate art. In the statues are seen in the cold marble the features and expressions of those mighty men of old whose names have been familiar to us from boyhood, whose fame still fills the world, perchance whose intellect may have guided our own.

The paintings charm and excite, the statues calm the feelings, and lead the mind onward through grave trains of thought. Which of these conditions is most suitable in senates and courts of justice?

Nor is this difference due to the contrast of painting with sculpture, for substitute portraits for statues, and we may observe a similar effect. Both are triumphs of simple truths long treasured in our minds, over the utmost powers of invention.

And here I cannot let slip the occasion to remark, that France and Germany are now employed in reviving this wise and noble custom of antiquity, each applying it to their respective conditions. France has devoted the deserted palace of Versailles to place the statues and portraits of her illustrious men, and by this act the present generation have done their utmost to repair the ravages of the last.

The plan is admirable for comprehension and arrangement. There are seen the kings, warriors, statesmen, presidents of parliaments, and whoever was renowned in times authentic and known, all classed and arranged.

The Walhalla, erected by the king of Bavaria, is a similar design to commemorate the renowned men of Germany.

I do not cite these national works as models to be followed by England, but as proofs how the spirit of antiquity still lives in modern times.

These principles stated, I submit the following outline of a plan; for an outline is all that can be offered, yet distinct enough for precise ideas, which failing to satisfy the judgment may perhaps hereafter serve for some happier suggestion.

1. The subjects for sculpture and painting should be chosen from the constitution of parliament itself, and in a manner to illustrate its history.

By a gallery of the kings of England represented in statues of marble, arranged in the order of time.

For in all ages, in fact as in law, the sovereign has been the "*principium et finis*" of our parliaments.

The series should begin with Alfred, as founder of the English monarchy, by union of the Saxon states under his sole dominion; and as his memory is revered, for the wisest and best of that long illustrious line by his successors to the throne, who claim him as their common ancestor.

Of the later Danish and Saxon kings, most of whom are known only by name, a selection should be made; and Athelstan and Canute merit to be preferred. For the former, by arms and treaties, united Great Britain under one supreme sovereignty, leaving the more distant provinces under the immediate rule of their native princes and laws—an event that imperial Rome had contended for in vain during 300 years. And the latter was the most powerful monarch of his age: under him the rival races of Saxons and Danes were united by equal laws.

From the conquest until the reign of her present majesty, a statue should be erected to each sovereign.

2. I propose that an historic gallery be formed in portraits of the most distinguished members of the House of Peers, arranged in the order of time, less to commemorate individuals than to illustrate the institution—in former ages, the guardian of public and private rights against the usurpations of monarchy; in our own, against those of the populace; holding the balance between custom and change, principles that contend for the government of society.

3. I propose a similar gallery of portraits of those who have been the most distinguished members of the commons.

The series must begin with the reign of Elizabeth.

Lastly, adhering to the constitution of parliament, another gallery falls to be added of the most eminent judges of the land.

In fine, this plan consists of historic galleries to be formed from past and future times. And as the age is more distant from our own, the easier will the choice become, for then it will be guided by established renown.

THE FRENCH AND BELGIAN RAILWAYS.

WE are indebted for the following interesting and valuable paper to Mr. Flanagan, a young engineer of considerable talent, who has of late had much practice both in Belgium and France, in estimating and superintending engineering works; it is a document which shows with what minuteness the continental railway engineers prepare all their details, and likewise gives some idea of the cost of railway works on the continent. The scale of prices is low, as the tender which was accepted only allowed half per cent off the schedule.

The method of proceeding with contracts for public works in France and likewise in Belgium, is in the following manner. The engineer of the line prepares his contract drawings, which are executed with great minuteness—he then prepares a schedule of prices in detail, and the quantities of the works necessary to be done on the line as per annexed list. Tenders are then advertised for. The parties tendering have to state what per centage he will take off from the schedule of prices, not upon any individual price but upon the whole; this method is analogous to the form of tendering for works to be done for the Ordnance and Government in this country. After the tenders are received they are immediately taken into consideration, and the party whose tender is accepted is called in and informed of the result; an appointment is then made with the engineer and contractor to go over the country of the proposed line of railway, which the engineer describes to the contractor, and at the same time furnishes the latter with a bill of quantities priced out according to the schedule of prices; after going over the line, the contractor is allowed from fourteen to twenty days to examine the quantities, and if no error greater than one-sixth can be discovered the contract is considered binding, but if any error is discovered an allowance is made; but after the contract is concluded, at the end of the fourteen or twenty days as the case may be, it is binding upon the contractor, notwithstanding any error may be found out afterwards. We should also state that the contract is subsequently sent to the minister of public works, who has the sole power of rescinding it if he thinks proper.

In this translation the French measures and currency have been retained. They may easily be reduced to their respective values in this country by taking in round numbers the cubic metre as equal to 1½ cubic yard and the franc as equal to 10d.; thus the first figure in the decimal part represents as many pence as it has digits. The lineal metre is nearly 3 ft. 3½ in.

BASIS OF THE PRICES.

WAGES PER DAY.

	Not including tools & profit of contractor.		Including tools & profit of contractor.	
	francs	cents	francs	cents
Navigator for getting and filling ..	2.95		3.25	
Navigator for wheeling ..	2.15		2.48	
Stone cutter and setter ..	4.00		4.62	
Assistant stone cutter and setter ..	3.00		3.47	
Ordinary mason ..	3.00		3.47	
Labourer ..	2.50		2.89	
Superintendent of mortars and betons ..	3.00		3.47	
Carpenter, sawyer, and joiner ..	4.00		4.62	
Pavioir ..	4.00		4.62	
Assistant pavioir ..	3.50		4.04	
Smith ..	4.50		5.20	
Assistant smith ..	4.00		4.62	
Painter ..	3.50		4.04	
Slater ..	4.00		4.62	
Assistant slater ..	2.75		3.18	
One horse and cart including driver ..	7.00		8.09	
Two horses ditto ..	12.00		13.86	
Three horses ditto ..	17.00		19.64	

1st Division.—EARTHWORK.

The earthwork to be measured in the cuttings per cubic metre.

No. 1.—Getting and Filling; or one spade's throw every kind of soil and every thing included, per c. m.

In transverse section, No. 1 to 44 ..	0.65
Ditto 44 to 108 ..	0.46
Ditto 108 to 356 ..	0.59
Ditto 356 to 470 ..	0.46
Ditto 470 to 581 ..	0.44

N.B. These prices for getting and filling will be applied without

- any exception, and without its being in the power of the contractor to demand any other classification than the above.
- No. 2.—Wheeling for each relay or run of 30 metres on a level, or of 20 metres on an incline of 1 in 10, per c. m. .. 0.12
- No. 3.—Carting for the 1st relay of 100 metres on a level, or of 75 metres on an incline of 1 in 20, per c. m. .. 0.42
- No. 4.—Carting every relay after the first, of a 100 metres on a level, or of 75 metres on an incline of 1 in 20, per c. m. .. 0.11

If the centre of gravity of the cutting is on the same level, or higher than that of the corresponding embankment, the distance between the centres of gravity will be taken for the distance of carriage; if the centre of gravity of the cutting is lower than that of the embankment, it will be considered that the difference of level has been surmounted in ascending inclines of 1 in 20 for carts, and of 1 in 10 for barrows, and that then the carriage has been completed on a horizontal plane. The length of lead is taken in the vertical plane passing through the two centres of gravity. It is only when the distance between the centres of gravity is such that it is necessary to divert in order to obtain inclines of 1 in 20 for carts and of 1 in 10 for barrows, that such diversions will be paid for.

The fractions of relays will be counted by ½.

No. 5. Carriage by Wagons.—The price will be determined by the following formula:

$$x \text{ equal to } 2.50L \times 3D + 3.75R + 2.50C + 300 + 0.0000355(L + 1.50D + C + 300) + 0.000389l + 0.122 \text{ divided by } m.$$

in which

L is the distance between the commencement of the cutting and the extremity of the embankment.

D, the length of the cutting.

R, the length of the embankment.

m, the cubic quantity of earthwork, measured at the cutting, to be tipped.

l, the horizontal distance between the centres of gravity of the cutting and embankment.

C, the length of sidings.

The value of the letters which enter into this formula will be fixed for each cutting.

No. 6.—Spreading of a cubic metre of embankment in beds of 0.15 m. to 0.20, including trimming and dressing of slopes .. 0.03

When wagons and temporary railways are used, no price will be allowed for spreading, as it is included in the price allowed for the embankments formed in this manner.

No. 7.—Ramming or Punning the embankments in beds of 0.15 m. to 0.20 m. thick, when the engineer considers it necessary, will be paid for per c. m. .. 14

Previous to ramming, the soil must be properly watered

The rammer must weigh 4 kilogrammes (9 lb.), and must strike at least four times the same spot.

The engineer reserves the right of having the ramming done at the direct expense of the administration, by day work.

No. 8.—Refilling, per c. m. .. 0.20

No. 9.—The picking out and laying aside the rubble and gravel found in the cuttings will be paid for per c. m. .. 0.25

2nd Division.—PAVING THE CROSSINGS AND THEIR APPROACHES.

No. 10.—Siliceous gravel for roads, and beton broken to the required dimensions.

Compensation for land ..	0.25
Picking and breaking the large stones ..	1.70
Filling ..	0.17
Carriage to the distance of 2000 metres ..	1.64
Laying aside in heaps ..	0.15

Tools, &c. ¼ .. 0.196

Profits of contractor, 1/10 .. 0.410

Price per cubic metre .. 4.516 4.52

No. 11.—Breaking stone, found in the gravel of cuttings, to the required dimensions of 0.06 m. in every direction .. 0.350

Tools, &c. 1/10 .. 0.017

Profit 1/10 .. 0.367

Per cubic metre .. 0.404 0.40

No. 12.—Making macadamised roads, including the dressing and ramming of the bed .. 0.40

No. 13.—Sand from the sand pits of Brenil le See and de l'Equippée, to be used between transverse sections, No. 1 and 230.

Price at the sand pits .. 0.50

	fr. c.	fr. c.
Filling, &c. .. .. .	0.30	
Carriage to the average distance of 4000 m. ..	2.245	
	3.045	
Tools, &c. $\frac{1}{20}$ .. .. .	0.152	
	3.197	
Profit $\frac{1}{10}$ .. .. .	0.320	
Per cubic metre .. .. .	3.517	3.52
No. 14.—From Erquimvillers, to be used between transverse sections 230 and 330		
Price at the pit, filling, &c., as in preceding ..	0.80	
Carriage to the average distance of 6 kilometres ..	4.04	
	4.84	
Tools, &c. $\frac{1}{20}$ .. .. .	0.24	
	5.08	
Profit $\frac{1}{10}$ .. .. .	0.51	5.59
No. 15.—Sand from the pits of Blin and St. Firmin, to be used between transverse sections 330 and 581		
Price at the pit, filling, &c., as in No. 13 ..	0.80	
Carriage to the average distance of 4500 metres ..	3.13	
	3.930	
Tools, &c. $\frac{1}{20}$ .. .. .	0.197	
	4.127	
Profit $\frac{1}{10}$ .. .. .	0.413	4.54
Price of a cubic metre .. .. .		4.54
No. 16.—Paving stones per thousand, from the quarries of Blaincourt, to be used between transverse sections No. 1 and 85.		
Price at the quarries .. .. .	152.	
Filling and laying the stones aside .. .. .	6.	
Carriage on average distance of 19 kilometres; (a cart drawn by 3 horses will make 13 trips in 15 days, carrying 84 paving stones per trip) .. .. .	233.52	
	391.59	
Tools, &c. $\frac{1}{15}$ .. .. .	26.10	
	417.62	
Profit $\frac{1}{10}$ .. .. .	41.76	459.38
Price per thousand .. .. .		459.38
No. 17.—Paving stones from the quarries of Gannes, to be used between transverse sections No. 85 and 581.		
Price at the quarries .. .. .	140.	
Loading and laying them aside .. .. .	6.	
Carriage to the average distance of 10 kilometres; a 3-horse cart loaded with 84 paving stones, will make 4 trips in 3 days .. .. .	151.78	
	297.78	
Tools, &c. $\frac{1}{15}$ .. .. .	19.85	
	317.63	
Profit of contractor $\frac{1}{10}$ .. .. .	31.76	349.39
Price of a thousand stones .. .. .		349.39
No. 18.—Paving between transverse sections 1 and 85.		
18 paving stones at 459.38 per thousand (see No. 16) ..	8.26	
0.25 m. of sand at 3.52 (see No. 13) .. .. .	0.88	
Labour, dressing and ramming the bed, tools, and profit of contractor .. .. .	0.35	
	9.49	
Price per superficial metre .. .. .		9.49
No. 19.—Paving between transverse section 85 and 230.		
18 paving stones at 349.39 per thousand (No. 17) ..	6.28	
Sand as in No. 18 .. .. .	0.88	
Labour, &c. as in No. 18 .. .. .	0.35	
	7.51	
Per superficial metre .. .. .		7.51
No. 20.—Paving between transverse sections 230 & 330.		
18 paving stones as in preceding .. .. .	6.28	
0.25 of sand at 5.59 per cubic metre (No. 14) ..	1.397	
Labour, &c. as in preceding .. .. .	0.35	
	8.027	8.03
Per superficial metre .. .. .		8.03
No. 21.—Paving between transverse sections 330 & 581.		
18 paving stones as in No. 19 .. .. .	6.28	
0.25 of sand at 4.54 per cubic metre (No. 15) ..	1.135	

	fr. c.	fr. c.
Labour, &c. as in preceding .. .. .	0.35	
Per superficial metre .. .. .	7.765	7.77
No. 22.—The taking up of a paved road, including the carriage of the old paving stones to the new road to be formed, and the picking and dressing of these stones will be paid for per superficial metre .. .. .		
		0.60
3rd Division.—WORKS OF ART.		
No. 23.—Oak, including carriage, dressing, waste tools, and profit of contractor per cubic metre .. .. .		
		85.
No. 24.—Cradle of oak planks of 0.15 by 0.03 to 0.05, dressed on the banks, and used in the platforms of bridges, exclusive of spikes, per cubic metre .. .. .		
		90.
No. 25.—Oak capping piece for cradle.		
Sawing oak .. .. .	0.60	
Loading, carriage, and unloading .. .. .	0.10	
Dressing and fixing under water .. .. .	1.20	
14 spikes, weighing together 0.90 kilogramme at 1.30 ..	1.17	
Tools, &c. $\frac{1}{10}$ .. .. .	0.307	
	3.377	
Profits $\frac{1}{10}$ .. .. .	0.338	
0.059 of oak (see No. 23) at 85 fr. .. .. .	5.015	
	8.740	8.74
No. 26.—Piles. Preparing the head, fixing the shoe, and cutting off the pile .. .. .		
	1.20	
Tools, &c. $\frac{1}{10}$ .. .. .	0.12	
	1.32	
Profit of contractor $\frac{1}{10}$ .. .. .	0.13	
	1.45	1.45
Each pile .. .. .		1.45
No. 27.—Oak waling-piece for the cradle.		
Sawing, sawyer 1 hour .. .. .	0.40	
Loading, carriage and unloading .. .. .	1.50	
Dressing it, and fixing it under water to the piles by bolts .. .. .	21.60	
	23.50	
Tools $\frac{1}{10}$ .. .. .	2.35	
	25.85	
Profits $\frac{1}{10}$ .. .. .	2.59	
	28.44	
1.10 of oak (see No. 23) at 85 fr. .. .. .	93.50	
		121.94
Price per cubic metre .. .. .		121.94
No. 28.—Iron formed into a chain for suspension bridges. Iron wire dipped twice in linseed oil including the making of the chain, and two coats of paint, the first to be of red lead, adjusting the chains, every thing included per kilogramme .. .. .		
		1.40
No. 29.—Oak sheet piling with herring bone joints, not including driving.		
Sawing oak .. .. .	0.40	
Loading, carriage, unloading, &c. .. .. .	0.18	
Preparing the head of the pile, and joints, fixing the shoe, and cutting off the pile .. .. .	2.12	
	2.70	
Tools, $\frac{1}{10}$ .. .. .	0.27	
	2.97	
Profit $\frac{1}{10}$ .. .. .	0.297	
	3.267	
0.12 oak at 85 fr. .. .. .	10.20	
	13.467	13.47
Price per square metre .. .. .		13.47
No. 30.—Centres of oak, including the fixing of the centres and all labour, the oak being returned to the contractor, per cubic metre .. .. .		
		55.
No. 31.—Every time after the first that the same timber is used, per cubic metre .. .. .		
		22.
No. 32.—Carpentry of oak fixed and dressed, per c. m. .. .. .		
		130.
No. 33.—Cast iron per kilogramme, (2.2 lb.) cast iron (No. 2) in bridges, &c. .. .. .		
		0.50
No. 34.—Pipes of grey cast iron No. 2, of the dimensions prescribed, including fixing, joints, &c. .. .. .		
		0.40
No. 35.—Iron for shoes of piles .. .. .		
		0.85
No. 36.—Wrought iron railing, &c. .. .. .		
		1.10

	fr. c.	fr. c.	fr. c.	fr. c.
No. 37.—Iron for bolts, spikes, nails, &c.	..	1.20		
No. 38.—LEAD used for leading, including charcoal, labour, &c., per kilogramme	..	1.20		
No. 39.—Solder per kilogramme	..	0.55		
No. 40.—Hydraulic lime per c. m.				
Quick lime at the works, per c. m.	..	50.		
Slacking, whatever be the method employed	..	1.60		
Price for 1.33 m. of slacked lime	..	51.60		
Or for one cubic metre	..	38.80		
No. 41.—A cubic metre of mortar between transverse sections 1 and 230.				
1 m. of sand at 3.52 (see No. 13.)	..	3.52		
0.35 of slacked hydraulic lime, at 38.80 (see 40.)	..	13.58		
Labour including tools, profit, &c.	..	2.00		
			19.10	
No. 42.—Mortar between transverse sections 230 & 330.				
1 m. of sand at 5.59 (see No. 14.)	..	5.59		
0.35 of slacked hydraulic lime (see No. 40.)	..	13.58		
Mixing, &c.	..	2.		
Per cubic metre	..		21.17	
No. 43.—Mortar between transverse section 330 & 581.				
1 m. of sand at 4.54 (No. 15.)	..	4.54		
0.35 of slacked lime	..	13.58		
Mixing and profits	..	2.00		
Per cubic metre	..		20.12	
No. 44.—Beton to be used between transverse section No. 1 and 230, per c. m.				
0.80 m. of broken stone, at 4.52 (No. 10.)	..	3.62		
0.50 of mortar, at 19.10 (No. 40.)	..	9.55		
Mixing, carriage, ramming, &c.	..	3.50		
Per cubic metre	..		16.67	
If it be found necessary to use beton between transverse sections 230 and 581, the above will be the price allowed, making the price of the mortar alone vary according to the place.				
No. 45.—"Sand beton" between transverse section No. 1 and 230.				
1 m. of sand at 3.52 (No. 13.)	..	3.52		
0.15 of hydraulic lime at 38.80 (No. 40.)	..	5.82		
Mixing, carriage, ramming, &c.	..	3.		
Per cubic metre	..		12.34	
This will be the price allowed on the whole length of the contract, changing only the price of the sand according to the place where the beton is wanting.				
STONE per cubic metre.				
No. 46.—Ashler for the two viaducts over No. 7 and No. 8, and the bridge No. 12 over the Breche.				
Stone at the quarry of St. Maximin, including the use of tools, and profit of contractor	..	33.		
Loading and carriage, average distance 21 kilometres	..	22.		
			55.	
No. 47.—Viaducts 27 and 28.				
Stone at the quarry of St. Maximin	..	33.		
Loading and carriage, average distance 37 kilometres	..	35.		
			68.	
No. 48.—To be used between transverse section No. 1 and 330				
Stone (Vergellé) at the quarry at Mello	..	10.		
Loading and carriage, average distance 24 kilometres	..	24.		
			34.	
No. 49.—To be used between 1 and 330.				
Stone at the quarry La Gache	..	30.		
Loading and carriage, average distance 10 kilometres	..	14.		
			44.	
No. 50.—Between 1 and 330 (Vergelé.)				
Stone at the quarry La Gache	..	12.		
Loading and carriage, as in preceding	..	14.		
			26.	
No. 51.—Same between 330 and 490.				
Stone at the quarry, as last	..	12.		
Carriage, &c., average distance 25 kilometres	..	25.		
			37.	
No. 52.—Between transverse sections 330 and 490.				
Stone at the quarry Blancfosse	..	30.		
Loading and carriage, average distance 12 kilometres	..	17.		
			47.	
No. 53.—Between transverse section 490 and 581.				
Stone at the quarry Faloise	..	30.		
Loading and carriage, average distance 10 kilometres	..	15.		
			45.	
No. 54.—Between transverse section 330 and 490.				
Large hard stone for foundations, at the quarry Blancfosse	..	30.		
Loading and carriage, as in No. 52	..	17.		
			7.	
No. 55.—Between transverse section 330 and 490.				
Stone for foundations at the quarry Gannes	..	20.		
Loading and carriage, average distance 14 kilometres	..	6.		
			26.	
No. 56.—Between transverse section 1 and 80.				
Hard rubble stone, at the quarry Bethenconstel	..	2.		
Loading and carriage, average distance of 3500 m. &c.	..	4.		
			6.	
No. 57.—Between transverse section 80 and 330.				
Hard rubble stone, at the quarry Agnetz	..	1.75		
Loading and carriage, average distance of 8 kilometres, &c.	..	6.		
			7.75	
No. 58.—Between transverse sections 330 and 490.				
Hard rubble stone, at the quarries Blancfosse	..	2.		
Carriage, average distance 12 kilometres, &c.	..	8.80		
			10.80	
No. 59.—Between transverse sections 490 and 581.				
Hard rubble stone, at the quarries Faloise	..	2.50		
Carriage, average distance 10 kilometres, &c.	..	7.50		
			10.	
No. 60.—Hard rubble stone, from between transverse section 245 and 390.				
Hard rubble stone, at the quarries St. Just	..	2.00		
Carriage, average distance 4 kilometres, &c.	..	4.50		
			6.50	
No. 61.—Between transverse sections 490 and 581.				
Hard rubble stone, at the quarries Bimont	..	2.00		
Carriage, average distance 10 kilometres	..	7.08		
			9.08	
MASONRY.				
The price of stone for ashler in the following items, No. 62 to 69 is calculated from the prices No. 46 to 51, with .16 or near $\frac{1}{4}$ added for waste.				
No. 62.—For the viaducts No. 7 and 8, and the bridge.				
1.16 of stone, St. Maximin, at 55 fr. (No. 46)	..	63.80		
0.11 of mortar, at 19.10 fr. (No. 41)	..	2.10		
Labour, including use of tools and profits	..	9.50		
			75.40	
No. 63.—The viaducts No. 27 and 28.				
1.16 of stone, St. Maximin, at 68 fr. (No. 47.)	..	78.88		
0.11 of mortar, at 21.17 fr. (No. 42)	..	2.33		
Labour, &c., as No. 62	..	9.50		
			90.71	
No. 64.—Between transverse section No. 1 and 330.				
1.16 of stone (Vergelé) Mello, at 34 fr. (No. 48)	..	39.44		
0.11 of mortar, at 20.14 (No. 41 and 42)	..	2.22		
Labour, &c. as No. 62	..	9.50		
			51.16	
No. 65.—Between transverse sections 1 and 330.				
1.16 of stone (roche) La Gache, at 44 fr. (No. 49)..	..	51.04		
Mortar and labour as No. 64	..	11.72		
			62.76	
No. 66.—Between transverse section 1 and 330.				
1.16 of stone, La Gache, at 26 fr. (No. 50)	..	30.16		
Mortar and labour as 64	..	11.72		
			41.88	
No. 67.—Between transverse section 330 and 490.				
1.16 of stone, Blancfosse, at 47 fr. (No. 52)	..	54.52		
0.11 of mortar, at 20.12 (No. 43)	..	2.21		
Labour, &c. as 62	..	9.50		
			66.23	
No. 68.—Between transverse section 490 and 581.				
1.16 of stone, Faloise, at 45 fr. (No. 53)	..	52.20		
Mortar and labour as 67 (No. 43)	..	11.71		
			63.91	
No. 69.—Between transverse section 330 and 490.				
1.16 of stone (Vergelé) from La Gache, at 37 fr. (No. 51)	..	42.92		
Mortar and labour as 67	..	11.71		
			54.63	
MASONRY, with the beds and joints worked fair, per cubic metre.				
No. 70.—Between transverse section 1 and 330.				
Stone, (La Gache,) &c. (No. 65)	..	62.76		
Additional dressing all the beds and joints	..	15.		

	fr. c.	fr. c.	
Use of tools $\frac{1}{10}$ .. ..	1.50		
	16.50		
Profit $\frac{1}{10}$ .. ..	1.65		
	18.15	18.15	
			80.91
No. 71.—Between transverse section 330 and 490.			
Stone of Gannes, &c., as No. 66 .. ..	41.88		
Dressing the beds and joints, including use of tools, profit of contractor .. ..	30.00		
		71.88	
No. 72.—Transverse sections 480 and 581.			
Stone of Faloise, &c., No. 68 .. ..	63.91		
Additional dressing all the beds and joints, including use of tools, profit, &c. .. ..	15.		
		78.91	
No. 73.—Between transverse sections 330 and 490.			
Ashler stone, mortar, labour, (Blancfosse) &c. as 67 .. ..	66.23		
Dressing all the beds and joints, profit, &c. .. ..	25.00		
		91.23	
<b>RUBBLE MASONRY per cubic metre.</b>			
The following prices of stone in articles Nos. 74 to 79 it will be seen are calculated from the prices of stone detailed in Nos. 56 to 61, and $\frac{1}{10}$ added for waste.			
No. 74.—Between transverse sections 1 and 80.			
1.10 of rubble stone (Bethenconstel) at 6' (No. 56) .. ..	6.60		
0.333 of mortar, at 19.10 (No. 41) .. ..	6.33		
Labour, use of tools, and profit .. ..	3.50		
		16.43	
No. 75.—Between transverse sections 80 and 330.			
1.10 of rubble (Agnetz) at 7.75 (No. 57) .. ..	8.53		
0.333 of mortar, at 20.14 (No. 41.) .. ..	6.71		
Labour, &c. .. ..	3.50		
		18.74	
No. 76.—Between transverse sections 330 and 490.			
1.10 of rubble (Blancfosse) at 10.80 (No. 58) .. ..	11.88		
Mortar, labour, &c. .. ..	10.21		
		22.09	
No. 77.—Between transverse sections 330 and 490.			
1.10 of rubble (St. Just) at 6.50 (No. 60) .. ..	7.15		
Mortar, labour, &c., as 75 .. ..	10.21		
		17.36	
No. 78.—Between transverse sections 490 and 581.			
1.10 of rubble (Faloise) at 10 (No. 59) .. ..	11.		
Mortar, labour, &c. (No. 75) .. ..	10.21		
		21.21	
No. 79.—Between transverse sections 490 and 581.			
1.10 of rubble stones (Bimont) at 9.08 (No. 61) .. ..	9.99		
Mortar, labour, &c. as No. 75 .. ..	10.27		
		20.20	
If the rubble masonry be hammer dressed add per cubic metre on Nos. 74 to 79 .. ..	1.50		
No. 80.—Dry rubble work, per c. m.			
Stone rubble from Bethenconstel quarries, including $\frac{1}{10}$ for waste, no labour, see No. 74, between transverse sections, Nos. 1 and 80 .. ..	6.60		
Ditto Agnetz .. ..	80 and 330	8.53	
Ditto Blancfosse .. ..	330 and 490	11.88	
Ditto St. Just .. ..	330 and 490	7.15	
Ditto Faloise .. ..	490 and 581	11.	
Ditto Bimont .. ..	490 and 581	9.99	
To the above price add for labour, tools, profits, &c. .. ..	1.75		
No. 81.—Labour, per superficial metre.			
Dressing of ashler (hard stone) from the quarries of St. Maximin, on the face and beds, including pointing, use of tools and profit .. ..	11.		
Ditto, Mello quarries .. ..	5.		
Ditto, from the quarry of Blancfosse .. ..	6.		
Ditto Faloise .. ..	4.		
No. 82.—Pick-dressing rubble including pointing, use of tools, profit, &c. viz.			
For rubble stone from La Gache, Mello .. ..	2.50		
Ditto Blancfosse .. ..	3.00		
Ditto Faloise .. ..	2.00		
No. 83.—Rough hammer dressing of rubble ( <i>de roche</i> ) including pointing, profits, &c. .. ..	1.50		
Ditto, for the rubble from the quarries of Blancfosse, St. Just, and Faloise .. ..	1.10		
No. 84.—When the rubble is merely dressed and the pointing is not included, 0.25 will be deducted from the last two prices.			

STONE PAVING, per superficial metre, of the usual paving stones split in two, imbedded in hydraulic mortar.

No. 85.—Ten paving stones of the usual form, including waste, at

	fr. c.	fr. c.	
349.39 the thousand (No. 17) .. ..	3.49		
0.05 of mortar at 20.12 (No. 43) .. ..	1.01		
Splitting the paving stones, dressing them, and forming the basement, &c. .. ..	1.35		
			5.85
No. 86.—Bank or mound with covered drains for embanked roads, profits, &c. per lineal metre .. ..			3.00
No. 87.—Curb stones for footways, including dressing, carriage, and mortar, per lineal metre, of stone from St. Maximin .. ..			12.
Ditto .. .. La Gache .. ..			10.
Ditto .. .. Blancfosse .. ..			9.
Ditto .. .. Faloise .. ..			8.

#### STONE FOR MACADAMISED ROADS.

No. 88.—One metre of rubble stones, average price .. ..	8.35		
Carriage, labour, tools, profits, &c. .. ..	0.95		
			9.30
Per superficial metre .. ..			9.30

#### BRICKWORK, per cubic metre.

No. 89.—Between transverse sections 330 and 581.			
720 bricks at 41.50 the thousand .. ..	29.88		
0.25 of mortar at 20.12 (No. 43) .. ..	5.03		
Labour, including pointing, use of tools, profits, &c. .. ..	11.50		
			46.41

No. 90.—Pulling down old structures of stone, clearing the site, carriage to the average distance of 100 metres, and carrying away the rubbish, per cubic metre .. ..

No. 91.—Ditto where the building is of rubble masonry .. ..

No. 92.—Covering arches, &c. with a layer of "mortar of beton" per superficial metre.

0.05 metre of beton at 16.67 (detail No. 44) .. ..

0.03 of "sand beton" at 12.34 (No. 45) .. ..

Labour, spreading evenly each layer, use of tools, profit included .. ..

1.50

2.70

#### ASPHALTE, per superficial metre.

No. 93.—For covering arches with a layer 0.01 m. in thickness

No. 94.—Ditto for footways, the thickness being 0.015 m. including profits, &c. .. ..

No. 95.—Fencing 1.30 m. high, per lineal metre, consisting of posts, rails, and iron wire, labour included

Profit  $\frac{1}{10}$  .. ..

1.40

0.14

1.54

No. 96.—Caulking, per lineal metre, the cradle serving as cofferdam, including profit, &c. .. ..

No. 97.—Pitching, per superficial metre .. ..

No. 98.—Tarpauling, of bituminous cloth, the thickness of the coating being 0.0065 m., per superficial metre .. ..

No. 99.—Resinous composition ("galipot") consisting of one part of grease with 2½ of resin, per kilogramme .. ..

No. 100.—Ditto per square metre, including labour and one kilogramme of "galipot" .. ..

No. 101.—Painting in three coats for all colours, on wood and iron, per superficial metre .. ..

N.B. The first coat on iron to be in red lead.

1.20

## PROCEEDINGS OF SCIENTIFIC SOCIETIES.

### INSTITUTION OF CIVIL ENGINEERS.

February 28.—The PRESIDENT in the Chair.—(Continued.)

"Account of the Victoria Bridge, erected across the river Wear, on the line of the Durham Junction Railway." By David Bremner, Associate Inst. C. E.

The district through which the Durham Junction Railway passes, for the purpose of completing the connexion between the city of Durham, with the towns of Newcastle, South Shields, and Sunderland, is extensively undermined by coal-workings, and great caution was requisite in the selection of a spot which suited the level of the railway, and where a foundation could be formed sufficiently sound to support such a structure as the bridge described in the paper. The advice of Messrs. Walker and Burges was therefore sought by Mr. Harrison, the engineer of the line, and their design was adopted; but subsequently several alterations were made, either to favour the locality or from motives of economy.

The bridge is 810 feet 9 inches long, and 21 feet wide, between the parapets. It is, with the exception of the quoins of the main arches, built of freestone, from the Pensher quarries; there are three semicircular arches, of 144 feet, 100 feet, and 60 feet span respectively, a centre arch of 160 feet



span, with a radius of 72 feet, and three arches of 20 feet span each at either end, forming the abutments. The main pier is founded upon rock, 24 feet beneath the bed of the river; and the height from the foundation to the top of the parapet is 156 feet 6 inches; the under side of the main arch, at the crown, is thus 121 feet 9 inches above the level of the sea.

The paper describes at length the nature of the building materials employed, the dressing of the stones, the composition of the mortar, the general detail and dimensions of the construction, the centering of the arches, with the precautions used in striking them, and gives a very full account of the travelling and other cranes employed in the construction; these are stated to have been very efficient. The north arch, of 100 feet span, containing about 980 tons of stone, was entirely turned with two of the cranes, in 28 hours, giving an average weight of 17½ tons of stone laid by each crane per hour.

The perseverance and practical skill of Messrs. Gibb, of Aberdeen, the contractors, are particularly mentioned, as the difficulties attending the getting down the foundations, especially that of the main pier, were very great, and required all their talent and energy. The detail is given of the precautions taken with the coffer-dam, in which at one period a steam-engine of 20 H.P., working two pumps of 18 inches diameter each, was insufficient to keep down the water, and it became necessary to drive a range of sheet piling all round withinside the dam, before the leakage through the bad strata above the rock could be stopped.

By calculation it appears, that the pressure on the foundations of the highest pier in the bridge is about 37 tons on each square foot, exclusive of the additional weight of the passing coal-trains, which frequently weigh 120 tons each.

The bridge was commenced on the 17th of March, 1836, and was finished on the 28th of June, 1838, occupying about 714 working days, and cost, with the extra works, nearly £40,000.

The paper is illustrated by three drawings, showing a plan and elevation of the bridge in several stages of its construction, and when completed; the details of the centres, hoists, and cranes, the coffer-dam, engine, pumps, and of the foundations of the whole structure.

Mr. Vignoles had examined the bridge very minutely, and had been much struck with the excellence of the workmanship, which was quite in accordance with the beauty and simplicity of the original design; it was an extraordinary example of care and attention on the part of the contractors, and did infinite credit to all engaged in it; yet with all this, it had cost less, in proportion to its dimensions, than any similar structure in this country.

The President observed, that the structure first proposed was to have been of cast iron, but when he and his partner, Mr. Burges, were consulted, they advised the employment of the freestone from the adjoining quarries, on Lord Londonderry's estate, and they furnished a design, based upon that of Trajan's bridge, at Alcantara, which was adopted by the directors; but subsequently an alteration was made, by introducing three small arches in each abutment, which, in his opinion, had injured the design; that was the extent of his connexion with the bridge; the merit of the construction must be given to the engineer and the contractors, and he must corroborate the statement of the superior manner in which the work had been executed. The bridge had been placed nearly at the spot marked out by Mr. Telford, for the Great North Road to cross the Wear, and as the railway would now form part of the line between Newcastle and Darlington, Mr. Telford's plan would be virtually executed, although with the difference of substituting a railway for a turnpike road.

"Description of the American engine 'Philadelphia,' made by Mr. Norris of Philadelphia, North America, for the Birmingham and Gloucester Railway." By G. D. Bishopp; communicated by Captain W. S. Moorsom, Assoc. Inst. C. E.

The engine described in the paper, was made in the year 1840, and has been in regular work for upwards of two years as an assistant engine upon the Lickey inclined plane, which rises at an angle of 1 in 37½, and is 2 miles 4 chains long. Its construction is what is termed a "bogie" engine, having a four-wheeled truck, to support one end of the boiler, while the other end rests upon the driving wheels. It has outside cylinders, inclined so as to clear the bogie wheels, over which they are placed, and it has inside framing.

The boiler is cylindrical, 9 feet long and 3 feet 4 inches diameter, of plates ⅝-inch thick. The fire-box attached to it has three of its sides square, and the front semicircular, with a spherical dome on the top, and the area of the fire-grate about 10 square feet; it was originally constructed of iron, with water spaces 2½ inches wide, the crown being supported by stay bars in the usual manner; but it was destroyed in about eight months, and has been replaced by a copper fire-box, of plates ⅝-inch thick, with a tube plate ¼-inch in thickness. The tubes are 94 in number, 8 feet 11 inches long, and 2 inches diameter outside; they were originally of copper, but were replaced by brass tubes when the new fire-box was fixed. Midway between the two end plates, is a third plate through which the tubes pass, so as to serve as a support, and to prevent them from sinking in the middle. The total internal area of the tubes is 404 square feet. The chimney is 13¾ inches diameter internally, by 13 feet 10 inches high from the rails, and has not any damper. The framing is entirely of wrought iron, with the axle guides, &c., forged upon it. The "bogie" frame is also of wrought iron; it is attached to the

smoke-box by a centre pin, and is carried by two pair of wheels, 2 feet 6 inches diameter, made of cast iron, chilled, and without tires. The driving wheels are 4 feet diameter, also of cast iron, but with wrought iron tires; they are firmly fixed upon a straight axle, as the cylinders are outside. The cylinders are 12½ inches diameter inside, with a length of stroke of 20 inches.

Minute dimensions are given of the steam passage and valves (the "lead" of which is ⅛-inch, and to the eduction pipe nearly ¼-inch, the motion of the slide extending 1⅜-inch on either side of the centre line); the steam chests, the regulator, the gearing, and feed-pumps, and all the other parts of the engine and connexions.

The general summary of the work done (the details of which are in the archives of the Institution of Civil Engineers)<sup>1</sup> shows that with a maximum load of 8 wagons and 20 men, making a weight of 53½ tons behind the tender, the engine ascended the Lickey inclined plane at a speed of between 8 and 9 miles per hour. That with 6 wagons, or 39½ tons, the speed was between 10 and 11 miles per hour; that with 5 wagons, or 33 tons, the speed increased to between 12 and 15 miles per hour, and that in assisting the ordinary trains, with 7 passenger carriages, the usual speed has been 13½ miles per hour. There are three engines of this class kept at the Lickey inclined plane for assisting the trains in their ascent, but one is generally found sufficient for the daily service.

The communication is illustrated by seven drawings of the engine and its details of construction, which have been communicated through Captain W. S. Moorsom, Assoc. Inst. C. E.

Captain Moorsom, in answer to questions from members, explained that—

	Miles.	Chains.
The length of the Lickey incline, rising 1 in 37½, was	2	4
The bank engine ran out from its house at the foot of the incline, at each trip, for a length of . . . . .		14
And continued running at the head of the train after surmounting the incline, for about . . . . .		23

Thus giving an actual length on the ascent of . . . . . 2 41

And as the same distance was covered in returning, the length of each trip, was rather more than 5 miles. This was exclusive of some occasional piloting and train trips, which were, however, included in the general statement of expenses.

The account of the entire expense of the bank engine establishment was made up of—1°, The wages of the drivers and firemen; 2°, Cost of coke, oil and tallow; 3°, Repairs, including wages and materials; 4°, Depreciation of stock, stated at the end of each half-year; 5°, General charges, comprising wages of pumpers, cokemen, cleaners and labourers; cost of firewood, hose-pipes, cotton waste, and all other stores; salaries of superintendents, clerks, foremen, time-keepers, and store-keepers; and the premium paid to the men for saving the coke.

The cost of working the incline plane was therefore, for each half-year ending—

	31st December, 1841.	30th June, 1842.	31st December, 1842.
Wages . . . . .	£. s. d. 132 7 11	£. s. d. 95 9 10	£. s. d. 117 14 8
Coke . . . . .	324 13 6 <sup>a</sup>	191 11 4 <sup>b</sup>	165 19 0 <sup>a</sup>
Oil and Tallow . . . . .	49 8 4	27 1 7	17 18 6
Repairs . . . . .	245 1 0	260 3 8	92 6 11
General Charges . . . . .	237 19 7	93 15 7	76 6 11
	989 10 4	668 2 0	470 6 0
Depreciation of Stock	99 0 0	{ Nil, having been impvd. }	89 16 0
<b>Total . . . . .</b>	<b>1088 10 4</b>	<b>668 2 0</b>	<b>560 2 0</b>
Trips run . . . . .	1242	1276	1320
Miles run . . . . .	6210	6380	6600
Cost per mile run—			
1st. Exclusive of depreciation . . . . .	s. d. 3 2½	s. d. 2 1	s. d. 1 5
2nd. Including depreciation . . . . .	3 6	0 0	1 8½

The engines have been improved by the alterations made since their arrival in England. These changes chiefly consisted in suppressing the tender, and placing the receptacle for water and coke upon the boiler of the engine, and in using the waste steam to heat the water; these had increased the efficiency of the machine, and caused a considerable economy of fuel. All the other changes were of minor importance, and had been chiefly suggested

<sup>1</sup> "Account of a Series of Experiments on Locomotive Engines, &c.," by Capt. Moorsom, with Supplement, read April 7, 1840. Minutes of Proceedings, page 45.  
<sup>a</sup> 27s. per ton.      <sup>b</sup> 26s. 4d. per ton.      <sup>c</sup> 25s. 11½d. per ton.

by the exigencies of the peculiar locality where the engine worked. The economical working of the engine was due partly to the attention and skill of the driver, who had become better acquainted with the capabilities of the machine, had a better knowledge of the locality, and was stimulated by a premium upon the saving of coke and other stores consumed, but was principally to be attributed to the judicious alterations that had been made in the construction. There had not been any reduction of the men's wages. The usual pressure of steam was between 60 lb. and 66 lb. per square inch. The weights of the trains varied considerably; they rarely consisted of less than three carriages; the heaviest he remembered weighed 98 tons, exclusive of the weight of the two engines, which were employed to convey it up the incline. He had not made any accurate experiments, as to the amount of slipping of the wheels upon the rails, but with the ordinary traffic he did not believe that any practical loss was occasioned by it.

Mr. McConnell stated that the pressure of steam in the boiler of the American engine, when the experiments were tried, was more than 70 lb. per square inch; the spring balance was screwed down to 65 lb. pressure, and as owing to the reduced speed of the engine, the steam was generated faster than it could be consumed by the cylinders, and thrown off by the safety valves, the pressure continued increasing. It should be understood that Bury's engine, alluded to in the experiments, was intended rather for conveying trains at higher velocities, than for mounting the incline with a heavy load, it was therefore labouring under a disadvantage. The steam ports in the American engine were very large, and although steam was thereby wasted, that arrangement was of material assistance, in the peculiar duty for which the machine was intended.

Mr. Braithwaite observed, that the quantity of coke consumed appeared to exceed materially that upon other railways; he understood that an engine recently constructed by Messrs. Rennie used about 18 lb. per mile, and that on the Liverpool and Manchester line, the average consumption was 16 lb. per mile. It appeared to him that the real questions were, the absolute duty performed with a given quantity of fuel, and at what cost? and also whether the greater adhesion of the driving wheels was due to the weight imposed upon the engine, by fixing the water tank upon the boiler, and the coke boxes upon the foot-plate, after suppressing the tender.

Mr. McConnell replied that the peculiar duty of these bank engines required the steam to be kept up for about 16 hours daily, during which period they made eight trips, amounting in the whole to about 40 miles, of which, during 20 miles only actual duty was performed, so that the greater portion of the coke was consumed while the engines were at rest. When they were running with luggage trains on the line the quantity of coke consumed was very small. The difference of cost, in consequence of the various alterations, and the improved mode of working the engine, was very great. In January 1842, the cost per trip on the incline was 17s. 5d., but in January 1843, it only amounted to 7s. 1½d.

The average weight of the luggage trains was about 60 tons; two assistant engines were used for heavy trains, merely as a precaution, in case of the wheels slipping; otherwise one of the "Bogie" engines could perform the duty alone, as with the passenger trains, which were always conveyed up by the bank engine alone.

Captain Moorsom said that the main question arising from this investigation, was by what system steep gradients could be worked with the greatest efficiency, security, and economy; he would, however, in the present case suppose the two former positions to be equal in both cases, and would inquire only into the economy.

It appeared from the returns of the London and Birmingham Railway Company, that the annual cost of working the Euston Square incline plane, which was 1½ mile long, with an average angle of 1 in 98, with stationary power and an endless rope, was—

In 1840	..	£2150
1841	..	1376
1842	..	1215

On the Edinburgh and Glasgow Railway, the expenditure upon the Glasgow incline, which was about one mile in length, at an inclination of 1 in 42, also with stationary power, was £1516 in 1842. He had understood (but he could not produce authority for his statement) that, on the Great Western Railway, the cost of working the Box tunnel incline alone, was, in 1841, about £3500; and in 1842 it had been reduced to nearly £2500; that was worked by locomotive power. Taking into consideration the number and weight of the trains, their speed, and the relative length and the angle of the inclines, he believed that the Euston Square incline might be said to perform about half as much work as that on the Lickey.

Mr. McConnell presented drawings of the locomotive after being altered, of the detaching catch, and of the improved brake. After detailing some important alterations made by him in the valves, as well as the substitution of a different description of fire-bars and fire-frame, under an arrangement by which a considerable saving had been effected in the consumption of fuel, he stated that, for several reasons, but chiefly to increase the adhesion of the driving wheels of the engine, the tender had been suppressed, and a large tank constructed to be carried on the boiler of the engine. It was made of the best plate iron, ¾-inch thick; its length was 8 feet 9 inches, breadth 3 feet 5 inches, depth 3 feet at the sides, and 1 foot 11 inches at the centre; the bottom was made to fit the form of the boiler, and was bedded upon a coating of thick felt; it was held in its place by four wrought-iron straps passing round the boiler. Advantage had been taken of the waste

steam, by introducing a copper pipe from the top of the fire-box dome, into the upper part of the tank, carrying it, to and fro, from one end to the other, with an open extremity to allow the escape of the steam into the water; this pipe was furnished with a stop-cock; in addition to this a number of pipes were introduced from the smoke-box into the tank, by which arrangement, the water in the tank was maintained at the boiling temperature, previous to being pumped into the boiler, which, in addition to the saving of fuel, proved advantageous in diminishing the leakage and breakage of the tubes and stays, arising from the sudden contraction by pumping in cold water, when the steam was shut off while descending the incline. The tank contained upwards of 400 gallons of water, a quantity sufficient for the engine over 18 miles, and goods' trains had been taken the whole length of the line (53 miles) by these engines with safety and economy. The supply of coke was carried in sheet-iron boxes, each containing about 40 lb. weight, and of a size to fit the fire-door of the boiler, ranged on platforms on each side of the foot-plate, which platforms were fitted with boxes, to hold the necessary tools required for the engines.

Mr. McConnell then described a powerful and efficient description of brake, which he had constructed to act upon the driving wheels, it was so arranged that the whole weight of the fire-box end of the engine could be thrown on the wheel tires; one brake had been found quite sufficient to stop the engine on any part of the incline; from their position they were very easily brought into action; the end working upon the fore part of the wheel, was connected to a stud made fast to the framing of the engine; the other end was worked by a screw 1½ of an inch in diameter, passing through a bracket fixed on the boiler, which served as a nut. The main spring-plate of the brake was rendered flexible by the wood blocks being in short segments, thus enabling their entire surface to be brought into close contact with the periphery of the wheel.

A new form of catch, employed for detaching the engine from the train, was described, it was stated to be managed with facility, and at the same time was perfectly secure. The principal advantages of these engines were, he believed, the economy in the consumption of fuel, and the increased adhesion of the driving wheels (the weight upon them being upwards of 10 tons, thus rendering the engine more effective in drawing heavy loads). The expenses of repairs had also been much decreased by the improvements suggested by practice.

The following statement showed the comparative consumption of coke at different periods, viz. :—

For six months ending	June 1841,	92.41 lb. of coke per mile run.
"	January 1842,	86 "
"	June 1842,	53.35 "
"	January 1843,	43.2 "

#### March 7.—The President in the Chair.

His Royal Highness Prince Albert was elected by acclamation an honorary member.

"On the causes of the unexpected breakage of the Journals of Railway Axles; and on the means of preventing such accidents by observing the law of continuity in their construction." By William John Macquorn Rankine, Assoc. Inst. C. E.

The paper commences by stating that the unexpected fracture of originally good axles, after running for several years, without any appearance of unsoundness, must be caused by a gradual deterioration in the course of working; that with respect to the nature and cause of this deterioration, nothing but hypotheses have hitherto been given; the most accepted reason being, that the fibrous texture of malleable iron assumes gradually a crystallized structure, which being weaker in a longitudinal direction, gives way under a shock that the same iron when in its fibrous state would have sustained without injury.

The author contends that it is difficult to prove that an axle which, when broken, shall be found of a crystallized texture, may not have been so originally at the point of fracture, although at other parts the texture may have been fibrous.

He then proceeds to show that a gradual deterioration takes place in axles without their losing the fibrous texture, and that it does not arise from the cause to which it is usually attributed. From among a large collection of faggoted axles which had broken after running between two and four years, five specimens were selected, of which drawings are given, representing the exact appearance of the metal at the point of fracture, which in each case occurred at the re-entering angle, where the journal joined the body. The fractures appear to have commenced with a smooth, regularly-formed, minute fissure, extending all round the neck of the journal, and penetrating on an average to a depth of half an inch. They would appear to have gradually penetrated from the surface towards the centre, in such a manner that the broken end of the journal was convex, and necessarily the body of the axle was concave, until the thickness of sound iron in the centre became insufficient to support the shocks to which it was exposed. In all the specimens the iron remained fibrous; proving that no material change had taken place in its structure.

The author then proceeds to argue, that the breaking of these axles was owing to a tendency of the abrupt change in thickness where the journal met the shoulder, to increase the effect of shocks at that point; that owing

to the method of manufacture the fibres did not follow the surface of the shoulder, but that they penetrated straight into the body of the axle; that the power of a fibre to resist a shock being in the compound ratio of its strength and extensibility, that portion of it which is within the mass of the body of the axle will have less elasticity than that in the journal, and it is probable that the fibres give way at the shoulder on account of their elastic play being suddenly arrested at that point. This he contends would account for the direction of the fissure being inward towards the body of the axle, so that the surface of the fracture was always convex in that direction. It is therefore proposed, in manufacturing axles, to form the journals with a large curve in the shoulder, before going to the lathe, so that the fibre shall be continuous throughout; the increased action at the shoulder would thus be made efficient in adding strength to the fibres without impeding their elasticity. Several axles having one end manufactured in this manner, and the other by the ordinary method, were broken: the former resisted from five to eight blows of a hammer, while the latter were invariably broken by one blow. The vibratory action to which axles are subjected is then considered, and it is contended, that at the place where there is an abrupt change in the extent of the oscillations of the molecules of the iron, these molecules must necessarily be more easily torn asunder; and that in the improved form of journals, as the power of resisting shocks is increased by the continuity of the superficial fibres, so is the destructive action of the vibratory movement prevented by the continuity of form.

The paper is illustrated by five drawings, showing the section of the journals of broken axles, and their appearance at the moment of fracture.

*Remarks.*—Mr. York agreed with Mr. Rankine in several points, and stated, that since the last meeting he had made a series of experiments, which confirmed his opinion relative to the vibration in solid railway axles being arrested when the wheels were keyed on tight. In all such cases, where the vibration was checked, fracture would, he contended, be more likely to ensue, but with hollow axles there was very little difference of sound when struck, and no diminution of strength after keying on the wheels; this he attributed to the regular distribution of the molecules in the metal of the hollow cylinder.

Mr. Parkes coincided with Mr. York's opinion, and he believed that hollow axles would eventually supersede solid ones, particularly if they had sufficient rigidity for resisting flexure. Their faculty of transmitting vibration more readily was in their favour; it was well understood that in pieces of ordnance and musket barrels great regularity of proportion in the metal was requisite, in order to insure the equal transmission of the vibration, caused by the sudden expansion of the metal at the moment of the explosion, and unless the vibration was regular the barrel would burst or the ball would not be correctly delivered.

Mr. Greener, of Newcastle, among other experiments, turned the outside of a musket barrel to a correct taper, and fixed tight upon it at given intervals several rings of lead 2 inches in thickness; on firing a charge of 4 drachms of powder he found that all the rings were loosened and had all expanded regularly in their diameter. It was a well-known fact that cannon seldom or never burst from continuous firing; such accidents, unless they arose from peculiar circumstances, generally occurred in consequence either of inequality in the nature of the metal or irregularity in its distribution; to the latter cause must be attributed the bursting of the "Mortier monstre," before Antwerp, and of a large gun which was proved at Deal some time since; this latter gun burst at the third discharge, after delivering the ball better than on either of the previous discharges; it was evident that the fracture did not occur under the explosion of the powder, but on the re-entring of the air into the mouth of the gun after the discharge, and also because the thickness of metal was not well-proportioned, whereby the vibration was unduly checked, the cohesion of the molecules of the metal was destroyed, and the gun fell into several pieces, without any of them being projected, as they would have been by the usual effect of an explosive force.

The most practical millwrights were well aware of the superiority of hollow shafts, and they were frequently used, as they were more easily kept cool than solid ones, especially at high velocities, when shafts were peculiarly liable to injury from percussive force or from a series of recurring vibrations.

March 14.—The PRESIDENT in the Chair.

"Description of a method of laying down Railway Curves on the ground." By William John Macquorn Rankine, Assoc. Inst. C.E.

The method described in the paper depends on the well-known principle, that the angle subtended at any point of the circumference of a circle, by a given arc of that circle, is equal to half of the angle subtended at the centre by the same arc. The points which must be ascertained beforehand are the same as in every other method of laying down curves, namely,—the radius; the number of degrees, minutes, and seconds in the entire arc of the curve; and the length of the two equal tangents; either of which three quantities can be calculated from the other two. The commencement of the curve A, its termination B, and the intersection of the two tangents D, are to be marked on the ground as usual. It is supposed that the centre line of the railway is marked by stakes driven at equal distances—say of 100 feet. Let

E represent the last stake in the portion of the line immediately preceding the curve, the distance A F from the commencement of the curve to the first stake in it will be the difference between 100 feet and E A. The angle at the circumference subtended by the arc A F must be calculated, and a delicate theodolite having been planted at A, this angle is to be laid off from the tangent. The telescope will then point in the proper direction for the first stake in the curve, and its proper distance from A being set off by means of the chain, its position will be determined at once. The angles at the circumference subtended by A F + 100 ft., A F + 200 ft., A F + 300 ft., A F + 400 ft., &c., being also calculated, and laid off in succession, will respectively give the proper direction for the ensuing stakes G, H, I, &c., which are at the same time to be placed successively at uniform distances of 100 ft. by means of the chain. It is scarcely necessary to observe, that the difference between an arc of 100 ft. and its chord, on any curve which usually occurs on railways, is too small to cause any perceptible error in practice, even in a very long distance; but should curves occur of unusually short radii, it is easy to calculate the proper chord, and set it off from each stake to the next, instead of 100 ft., the length of the arc. When the inequalities of the ground prevent a distant view from any three stations to lay down the entire curve from them, any stake which has already been placed in a commanding position will answer as a station for the theodolite. By this method the operation of laying down a circular curve of any radius is made exactly analogous to that of laying down a straight line with the assistance of the telescopic sights of a theodolite. It is stated that by this method the curve is laid down with accuracy at the first operation; that any accidental error in the position of a single stake, affects that stake only; and it has been found in practice that the progressively increasing errors of the old method are entirely avoided.

*Remarks.*—Mr. Gravatt observed that a well-made theodolite\* was a convenient instrument for setting out curves for railways, and that it had been used by him and his assistants for this purpose for several years. The common theodolite was not, however, in practice universally applicable without some further contrivances for accommodating it to this peculiar service. He stated that the circular arc (used, he believed, almost universally on railways) was not the true curve for a line of rails; as might be proved by considering that a straight line of road required both rails to be at the same level, when viewed in the cross section, whilst on a curved road the outside rail required to be raised, in order to resist the tendency of the engine and carriages to fly off the rails in going round the curve. Where a straight line was joined on to a circular arc, the before-mentioned condition would require an instantaneous and vertical rise of one of the rails, which was a condition that could not be fulfilled. In curves of contrary flexure, if composed of circular arcs, the difficulty was increased; for the outer rail, which ought to be the highest, suddenly became the inner and the lowest, so that an instantaneous elevation of one rail, and a corresponding depression of the other was required; if the curves were of the same radius, the alteration would be of double the extent to that required when passing on to the same arc from a straight line. Therefore as the outside rail must be in all cases the highest, the circular arc, which required the manifestly false condition of an instantaneous elevation, could not be the true curve. He had several years since demonstrated that the true curve was one, which commenced with an infinite radius, decreased in a regular manner, in advancing on the curve, when the radius might be constant for some time, and then increased again to infinity, before it joined either a straight line or another curve of contrary flexure. He had fixed upon the elastic curve, which complied with all the conditions required, but other curves were also applicable. His late assistant, Mr. W. Froude, had found that arcs of a cubic parabola, whilst they complied with the necessary conditions, were extremely convenient in practice; the equation and its fluxions, or differential co-efficients, being very simple and easy of application. Mr. Froude had also applied other properties of that curve, so that, with the assistance of a few calculated tables, the process of setting out a true curve was rendered as easy in practice as setting out a circular arc. With any curve there was considerable practical difficulty in finding the direction of the tangents, the radii of curvature, and the position of the curves upon the ground. Mr. Gravatt used what he termed a skeleton plan, of several stakes driven into the ground nearly in the course of the intended line, expressing their position by columns of figures with reference to two co-ordinates; thus obtaining a numerical accuracy far greater than that of any drawn plan. By using a table of sines and co-sines, a few hours' calculation would save many days' labour in the field, besides ensuring an accuracy not otherwise to be obtained.

#### ON HORSE POWER.

"Results of the application of Horse Power to raising Water from the working shafts at Saltwood Tunnel, on the South-Eastern Railway, in 1842." By Frederick William Simms, M. Inst. C.E.

This tunnel is driven in the middle bed of the lower green sand, between which and the surface of the ground is interposed only the upper bed of the same stratum; but in sinking the eleven shafts for the work, it was found that at the level of the top of the tunnel the ground assumed the character of a quick sand, saturated with water, in such quantity that it could not be reduced by manual labour. Under these circumstances horse gins were erected for drawing the water by barrels, containing 100 gallons each, weighing when full about 1310 lbs.

The engineer's intention was to drive simultaneously from these shafts, in

\* Greener "On the Gun," p. 157; and "On the Science of Gunnery," p. 242.

the direction of the tunnel, an adit or heading, to carry off the water; but the earth, which was sand mixed with fine particles of blue clay, was so filled with water as to become a mass of semi-fluid mud, great exertions were therefore necessary to overcome the water, without erecting pumps. At first this was accomplished by making each horse work for 12 hours, and then for 8 hours per day, allowing one hour for food and rest; as the water increased it became necessary to work night and day, and the time of each horse's working was reduced generally to 6 hours, and sometimes to 3 hours. As all the horses were hired at the rate of 7s. per day, the author, who had the direction of the works, ordered a daily register to be kept of the actual work done by each horse, for the double purpose of ascertaining whether they all performed their duty, and also hoping to collect a body of facts relative to horse power which might be useful hereafter. This detailed register, which was kept by Mr. P. N. Brockedon, is appended to the communication.

The author gives as a proposition, "That the proper estimate of horse power, would be that which measures the weight that a horse would draw up out of a well; the animal acting by a horizontal line of traction turned into the vertical direction by a simple pulley, whose friction should be reduced as much as possible." He states that the manner in which the work was performed necessarily approached very nearly to these conditions; and after giving the principal dimensions of the horse gains, he analyzes each set of experiments, and by taking the mean of those against which no objections could be urged, he arrives at the following results:—

The Power of a Horse working for 8 hours = 23,412 lb. raised 1 ft. high in one minute.

Ditto	..	6	"	= 24,360	"	ditto.
Ditto	..	4½	"	= 27,056	"	ditto.
Ditto	..	3	"	= 32,243	"	ditto.

Of these results he thinks the experiments for 6 hours and for 3 hours alone should be adopted as practical guides, all the others being in some degree objectionable.

As a means of comparison, the following table of estimates of horse power is given:—

Name.	Pounds raised 1 foot high in a minute.	Hours of Work.	Authority.
Boulton and Watt ..	33,000	8	Robison's Mech. Phil. vol. ii. p. 145.
Tredgold .. ..	27,500	8	Tredgold on Railroads, p. 69.
Desagulier .. ..	44,000	8	Dr. Gregory's Mathematics for Practical Men, p. 183.
Ditto .. ..	27,500	Not stated.	
Sauveur .. ..	34,020	8	
Moore, for Society of Arts .. ..	21,120	Not stated.	
Smeaton .. ..	22,000	Not stated.	

These are much higher results than the average of his experiments, and would more nearly accord with the extremes obtained by him; but under such excessive fatigue the horses were speedily exhausted, and died rapidly. Nearly one hundred horses were employed,<sup>6</sup> they were of good quality, their average height was 15 hands ½ inch, and their weight about 10½ cwt., and they cost from 20l. to 40l. each. They had as much corn as they could eat, and were well attended to.

The total quantity of work done by the horses, and its cost, was as under:

Registered quantity of water drawn 104 feet, the average height, 28,220,800 gallons .. ..	= 128,505 tons.
Ditto, earth 3,500 yards, 1 ton 6 cwt. per yard..	= 4,550

Total weight drawn to the surface 133,955

Total cost of horse labour, including a boy to drive each horse .. ..	1,585 15 3
Or, 2-85 pence per ton, the average height of 104 feet	

As soon as the adit was driven, all the water was carried off by it, and the works are stated to be perfectly dry.

*Remarks.*—Mr. Palmer said, it should be understood, that in stating 33,000 lb. raised one foot high in a minute, as the measure of the power of a horse, Boulton and Watt had not intended to fix that as the average work which horses were capable of performing: they had taken the highest results of duty performed by powerful horses, in order to convince the purchasers of their steam-engines that they received all that had been contracted for. He had made some experiments on the amount of work performed by horses tracking boats on canals: on the upper end of the mast of the boat a pulley was hung; over this the towing rope was passed, with

the means of suspending to its extremity given weights, so as exactly to balance the power exerted by the horse. The results arrived at by these means were so various, that he could not deduce any average conclusions; as the power exerted varied between 30 lb. and 120 lb., the power diminishing as the speed was increased: he thought that 2½ miles was too high an average estimate, and that it should not exceed 2 miles per hour.

Mr. Field remarked that in all estimates of horse power, the speed was considered to be at an average of 2½ miles per hour, and all experiments were reduced to that standard.

Mr. Hawkins said, that some years since, he had made numerous inquiries respecting the work done by horses in drawing upon common turnpike roads, and found, that four good horses could draw an ordinary stage coach, with its complement of passengers, 8 miles a-day at the rate of 10 miles an hour; that if they ran stages of 10 miles in the hour, the horses must rest one day in each week: that good horses, so worked, would last only five years, each horse drawing about half a ton; he had been informed by wagoners, that good horses would walk, at the rate of 2½ miles per hour, for twelve hours out of the twenty-four, making 30 miles a-day, and that they would continue to do such work, day by day, each horse drawing one ton, for many years, provided they had been worked hard when young.

Mr. Gravatt observed, that although there might exist some hesitation in receiving these results of work actually performed, as a general measure of horse's power, yet as engineers frequently required to know what could be performed by horses, when employed for short periods, in works of haste or difficulty, he thought that the experiments were useful, and would form good data for reference. He was sorry to observe that in too many cases, an idea was prevalent, that it was cheaper to work a small stock of horses to death, than to keep a large number and to work them fairly; the results which he had been enabled to arrive at, were perhaps not a fair value of a horse's work, continued for any length of time, at the best rate of economy, for both the contractor and the employer.

The President believed that however, in cases of emergency, which he allowed did occur in engineering works, the forced system of labour mentioned by Mr. Gravatt might be tolerated, he was convinced that it was not the most economical, but on the contrary, humanity and economy would be found to go hand in hand. It would be desirable to know the average speed at which the different rates of work had been performed; this was essential in order to found any calculation upon the results given. Coach proprietors calculated that, at a speed of 10 miles per hour, a horse was required for every mile going and returning, so that one horse was kept for every mile of road. Now supposing a four-horse coach, with an average load, to weigh 2 tons, the load for each horse was 10 cwt.; whereas in the case of a horse drawing a cart, the gross load frequently amounted to 2 tons, but the speed was reduced to 2½ miles per hour, at which pace he conceived that 16 miles per day might be considered a fair day's work; this therefore was double the distance with four times the load, or eight times the coach-work, but with a heavier horse. The law that the quantity of work done, was as the square root of the velocity, or, as the cube root of the velocity, in equal times, was confined to work upon canals, or bodies moving through water.

Mr. Rennie had tried some experiments on the force of traction of the boats on the Grand Junction Canal. The towing rope was attached to a dynamometer which had previously been tested by weights. The horse, although urged at first starting, was afterwards allowed to fall into his natural speed, which was 2½ miles per hour on the average of 20 miles. The maximum speed was 4 miles, and the minimum 2 miles per hour. The dynamometer indicated an average of 180 lb., which was capable of overcoming the resistance of the loaded barge of 25 tons, being in the ratio of 1-500. The weight of the horse was about 11 cwt. He had also tried many experiments upon a fast boat lent to him in 1833 by the late Colonel Page. These experiments were principally made in order to ascertain the comparative resistance of vessels moving through water at different velocities, and the Grand Junction Canal afforded a convenient opportunity of undertaking them. The boat was 70 feet in length, 4 feet in breadth, and drew 9 inches of water. The traction indicated by the dynamometer the following resistance:

Miles per hour.	lb.	Miles per hour.	lb.
At 2½ the resistance was	20	At 6 the resistance was	97 to 214
3	27	7	250
3½	30	8	336
4	50	9-69	411
4½	60	10	375
5	70 to 75	11½	392

Average . . . . . 336

One horse was employed in these experiments. Two horses were employed in these experiments.

Stakes were fixed near the margin of the canal, so as to ascertain the rise and fall of the wave caused by the boat in passing; and it was observed that when the boat passed with a velocity of from 4 to 6 miles per hour, the rise of the wave was 5 inches, and the fall 5 inches, making a wave of 10 inches in depth; and when the velocity was 11½ miles, the rise was reduced to 2½ inches, and the fall to 2½ inches. Great difference existed in the power of

<sup>6</sup> The horses were supplied by Mr. Richard Lewis, Folkestone, Kent.

horses, their weights, and structure; and the large dray horses used by Messrs. Barclay, Perkins, and Co. did a full average duty as assumed by Boulton and Watt; but considering the average power of strong and of weak animals, he had adopted 22,000 lb. raised 1 foot high as the standard; much however depended on the nature of the work performed.

Mr. Charles Wood remarked that although, on an emergency, it might be necessary to work horses to the extent which had been mentioned, it had always been found more economical to feed them well, and not unduly to force the speed, the weight drawn, or the hours of labour. By the recorded experiments on ploughing, which were tried at Lord Ducie's and by Mr. Pusey, it was shown that any increase of speed diminished the amount of work done, in a greater ratio than it was affected by an increase of the load. In drawing loads the weight of the animal was a point of considerable importance; and when extra exertion and muscular action were required, the nearer horses approached to "thorough bred," the greater was the result.

Mr. Davidson gave the following statement of the work performed by a London brewer's horse per day; the cost of feed and of wear and tear per horse per annum, being derived from actual experience among a large number of horses at Messrs. Truman, Hanbury, and Co.'s brewery. The feed, &c., is supposed to have cost the same per quarter, per truss, &c. each year.

YEARS.	Lb. weight drawn 6½ mls. per horse per day.	Lb. weight drawn 6½ mls. per horse returning per day.	Average lb. weight drawn 13 miles per horse per day.	Cost of feed and straw per horse per annum.	Difference per horse, ditto bought and sold per annum.
	lb.	lb.	lb.	£. s. d.	£. s. d.
1835	5148	1716	3432	43 2 7	10 0 3
1836	5072	1707	3389	43 16 6	9 18 0
1837 <sup>7</sup>	..	..	..	..	..
1838	5057	1698	3377	41 18 0	9 15 9
1839	5287	1740	3513	42 9 11	9 7 1
1840 <sup>8</sup>	5786	1820	3803	46 11 7	7 17 11
1841	5311	1750	3530	45 0 1	10 16 11
1842	5263	1740	3501	47 0 9	10 8 0
Total	36,924	12,171	54,545	309 19 5	68 3 11
Average for seven years nearly.	5275	1738	3506	44 5 7	9 14 10

Mr. Horne stated that Messrs. Tredwell had a contract on the South-Eastern Railway, near where Mr. Simms' experiments were made; they had upwards of 100 horses, whose average cost was about 30*l.*; they were worked 10 hours per day, and were well fed, so that their value was but little reduced, and they were eventually sold for nearly the same prices as they originally cost. These contractors had about 400 horses on the Southampton Railway, which cost them about 25*l.* each. The same course of not over-working, and feeding them well, was pursued from motives of economy; and they found it answer. It was Mr. Jackson's practice to keep so many horses for his work as not to be under the necessity of working them more than 10 hours per day; he gave to each a peck of corn a-day; by this means he has been able to keep up their value. On the Chester and Crewe Railway he had about 300 horses at work, and towards the end of the contract, owing to circumstances over which he had no control, he was obliged to work them 14 or 15 hours per day; and in the course of four months horses that had been worth 25*l.* were so reduced as not to be valued at above 7*l.* He is a great advocate for steady work and good keep. On the Tame Valley Canal there had been sometimes between 300 and 400 horses, but as the work was nearly finished many had been sold. Those sub-contractors who had kept a sufficient number of horses for the work, so as not to have them in harness more than 12 hours per day, had realized nearly the same prices they had given for them in the first instance. The horses belonging to Mr. Edwards, the sub-contractor for the excavation of Newton Hill, and those of Mr. W. Tredwell, sub-contractor for the Friar Park Farm cuttings, were purchased from the same parties at prices varying from 20*l.* to 35*l.* The former had been acting on the principle of getting out of the horses all he could, working them frequently 15 and 16 hours at a time; and the consequence was, that all his stock was in bad condition, and he would be glad to get 6*l.* or 7*l.* a-piece for them. On the other hand, Mr. W. Tredwell, who was an excellent horse-master, and who did not work his horses beyond their strength, would be able to sell them for about as much as he gave for them—indeed he had done so already for those that he had

<sup>7</sup> In 1837 a disease was prevalent among the horses; therefore that year is omitted.

<sup>8</sup> Fewer horses were bought during the year 1840; the old horses were better fed, and harder worked.

parted with. Having been a good many years in the service of the late Mr. McIntosh, Mr. Horne could state that it never was his system to over-work his horses. It did sometimes happen that there was no alternative, but the deviation from the regular rule in every instance showed that his system was founded on right principles. The over-worked horses were most liable to disease, and the time lost by illness formed an important item; whereas there were plenty of instances in which horses that had worked their regular 10 hours per day, and had been properly fed, had worked for five or six years without losing a single day by illness. On the whole, he felt convinced that, both on the score of humanity and economy, the horse was the more valuable servant when treated with kindness.

Mr. Beardmore said that a case had occurred in a work near Plymouth which he believed would give the fair value of the work actually performed daily by a horse for a considerable period. A quarry wagon, weighing 2½ tons, carrying an average load of stone of 5½ tons, was drawn by one horse along a railway 960 feet in length, 260 feet of it being level and the remaining 700 feet having an inclination of 1 in 138; during 48 working days the number of trips was 1,302, or an average of 27.1 trips each day; the time of performing each trip was 4 minutes, or at a speed of 2.72 miles per hour; and the total weight drawn, including that of the wagons, was 23,959,600 lb. Repeated experiments proved, that upon the incline of 1 in 138, the wagons in their ordinary working state would just remain stationary, the friction was therefore assumed to be 16.2 lb. per ton; by calculation it was found that the horse raised 39,320 lb. 1 foot high per minute during the eight working hours each day, the useful effect, or net amount of stone carried, being 21,738 lb. raised 1 foot per minute. This difference between the work done and the useful effect, arose from the necessary strength and weight of the wagons. The animal employed was a common Devonshire cart-horse, eight years old, 15 hands high, and weighed 10¼ cwt.; he continued doing the same work throughout a whole summer, remaining in good condition; but a lighter horse was found unequal to it.

"Description of Lieutenant D. Rankine's Spring Contractor." By Wm. John Macquorn Rankine, Assoc. Inst. C. E.

This paper describes a contrivance for suiting the action of the springs of railway carriages to variable loads, so as to give the proper ease of motion to a carriage when heavily laden, and at the same time to be sufficiently flexible for light loads. Its effect is to make the strength and stiffness of the spring increase in proportion to the load placed upon it. Each extremity of the spring, instead of supporting a shackle or roller, as in the usual construction, carries a small convex plate of cast iron. The form and position of this plate are so adjusted, that when the carriage is unloaded, it bears on the extreme end of the spring, thus allowing it to exert the greatest amount of flexibility; but as the plate is convex, the more the load increases, and the further the ends of the spring descend, the nearer does the point of bearing of the plate upon the spring approach to the centre or fulcrum, so that the convex plate or contractor tends to diminish the virtual length of the spring in proportion to the load, the result of which is to increase the strength of the spring, in the inverse ratio of its virtual length, and its stiffness in the inverse ratio of the cube of the same quantity. The author then gives, in a tabular form, the details and the results of some experiments made on springs of this description, which are similar to those now in use on the Edinburgh and Dalkeith Railway. The springs were 4 feet long, each consisting of ten plates, each ½ inch thick, and 2½ inches broad. The contractors were cast with a radius of 12¼ inches, and so constructed as not to act until the load on each spring exceeded 10 cwt., and with a load of 30 cwt. they should have contracted the distance between the bearing points to 3 feet 4 inches instead of 4 feet; by this means the strength of the spring was increased in the ratio of 6 to 5, and its stiffness in the ratio of 216 to 125.<sup>2</sup> The advantages stated to be derived from the use of these springs on the Edinburgh and Dalkeith Railway, and other lines, are, that they afford the same ease of motion to a single passenger as to 40 or 50 in one carriage; they save wear both of carriages and railway track; they produce the strength and stiffness requisite for the maximum load with less weight of metal; they are not more expensive than rollers; and they are not offensive in appearance, indeed they would not be observed unless they were pointed out.

#### THE PRESIDENT'S CONVERSATION.

Mr. Walker, the President of the Institute of Civil Engineers, gave his annual conversation, at his residence in Great George Street, Westminster, on Friday 16th, and Saturday 17th ult., extending it to two evenings instead of one, as hitherto, in consequence of the crowded state of the rooms last year, and with his usual liberality to afford his numerous guests ample opportunity to examine the works of art and science distributed throughout

<sup>2</sup> Since this communication was made, contractors of greater length and increased radius of curvature have been applied, so as to produce a contraction of 6 inches at each end of the spring when fully loaded, which increases the strength in the ratio of 4 : 3, and the stiffness in that of 64 : 27. The details of the construction of these contractors, with a drawing of them, as applied to the springs of the carriages on the Edinburgh and Dalkeith Railway, are given in the addendum to the original paper.

his spacious suite of rooms. On the former evening about 300 persons attended, and on the latter a brilliant company assembled, comprising the most distinguished persons for rank in science or the fine arts, who all appeared to feel the hospitality and attention of the worthy host, who attended by Mr. Manby, the Secretary of the Institution, received the visitors on arriving, and directed their attention to the numerous models and works of art. The upper room was lighted by gas chandeliers, the burners of which were enclosed in glass globes, on Professor Faraday's ventilating principle, (ante p. 106.)

Soon after 9 o'clock on Saturday Evening, H. R. H. Prince Albert arrived, attended by Sir E. Bowater. The President escorted his distinguished guest through the principal rooms, explaining all the objects of note, and then, as H. R. Highness appeared so much interested as to intend seeing every thing, the Secretary attended to afford any explanation which might be needed. H. R. Highness, who has recently become an honorary member of the Institution of Civil Engineers, remained nearly an hour in the rooms, and won the good feeling of all, by his affability; on leaving, he expressed himself highly gratified by the reception he had experienced from the President and his guests.

The Duke of Wellington arrived immediately after H. R. Highness' departure, and went the circuit of the rooms, making his usual prompt and sagacious remarks.

Among the distinguished visitors we noticed particularly the Dukes of Wellington and Buccleuch, the Marquis of Northampton, the Earls of Devon, Lincoln and Courtenay, Lords Lovelace, Blayney, Lowther and Blantyre; Hon. C. Wood, M.P., Hon. W. B. Baring, M.P., and numerous members of Parliament, Engineers, Architects and Professors, and several eminent foreigners.

Our limits will not permit us to notice everything, but we must select a few of the most interesting objects. In the principal room was a marble group by Bailey, of great simplicity and beauty, some good sketches by Stanfield, Oliver, Stephanoff, Harding, and Kendrick. Scanlan contributed some sporting and military subjects in his usual happy style; some fine bronzes from Deville's collection; and in all the rooms were to be seen some exquisite specimens of wood carving from Rogers of Great Newport Street. The Bank machine for weighing sovereigns, invented by Mr. Cotton, the governor of the Bank of England; its action was explained by Mr. W. Miller, who has charge of it at the Bank: its delicacy and precision appeared to be fully appreciated. Casts of figures and busts by Bailey, Park and Behnes. Two busts of Mr. Field the eminent engineer and Mr. Davison, of Belfast, by Mr. Jones, were particularly noticed, on account of their faithful similitude to the originals, as well as the artistical feeling they exhibited. It is to be regretted that Mr. Jones does not convert his engineer's office in Cannon Row into a studio, and adopt the career of sculptor and modeller, which he has so auspiciously commenced, and for which his versatility of talent appears so peculiarly to have fitted him. The Duke of Wellington with his usual discernment, made many enquiries about the artist, and appeared much struck on learning that he was an amateur. There was an excellent medallion of Sir Isambard Brunel, by Warrington; Salter contributed some architectural models. Mr. Dent's chronometers, and Professor Wheatstone's galvanic engine occupied the room immediately preceding that in which the mechanical models were placed; and here we can scarcely pretend to particularise from "*l'embaras de richesses*." The splendid model of the *Great Britain* iron steam ship, 320 feet long, now building at Bristol, occupied the centre table; around it were grouped Cooke's electro telegraph at work, conveying messages; Whitworth's street sweeping machine; Palmer's corrugated cast iron roofs for ship building sheds; Tweeddale brick and tile machines; Rennie's beautiful boat the *Mermaid*; Clark's miser for sinking wells; the Jacquard loom worked and explained, in his usual able manner, by Mr. Cowper; Fairbairn's models of marine steam engines; a planing machine by the Butterley Iron Company, cutting Iron with Mr. Babbage's ingenious tool-holders; Mr. Smith's (Deanston) mule jenny, for cotton spinning; tools from Mr. Holtzapffel; models of bridges from Mr. Green of Newcastle, and Mr. Coulthard; an ingenious but simple model for measuring water on a large scale by Albano, adopted at Lombardy; cases of specimens of Minton's beautiful encaustic tiles. We cannot enumerate more although scarcely half through our list.

## ROYAL INSTITUTE OF BRITISH ARCHITECTS.

ON THE PRINCIPLES OF ARCHITECTURE AS LAID DOWN BY VITRUVIUS.

By W. W. POCOCK, B.A., &c., Associate.

Abstract of a Paper read March 6, 1843.

VITRUVIUS begins his first chapter by considering architecture as a science, embracing theoretical and practical knowledge, to the latter of which he devotes the last part of his 1st, and the whole of his 2nd, 7th, and 8th books. In his 2nd chapter he treats of it as an art of design, or the *ratiocinatio artis*, as he elsewhere calls it, and lays down the principles by which every architectural composition should be tested, and in the 3rd he adverts to the *opus* or mechanical execution of the design.

The 2nd chapter, which forms the immediate subject of this paper, has

been a stumbling-block to commentators and translators more perhaps than any other part of his writings. Barbaro, Scamozzi, Philander, Poleni, Perrault, Orsini, Jean Martin, Newton, and Gwilt, have all fallen into errors more or less gross in their comments and translations. Nor is this to be wondered at, considering the ambiguity of his style arising from the abstract manner in which he treats his subject, and the little knowledge we possess of the terms of art and modes of study of the ancients. The principles of composition which he would have us ever keep in mind in the formation of a design are six—ordination, disposition, eurithm, symmetry, decor, and distribution.

Ordination he defines as "the adjustment of the sizes of the several parts to their uses, and to the general scale of the building"—"*Ordinatio est modica membrorum operis, commoditas separatim, universaque proportionis ad sommetriam comparatio.*"

Perrault and Newton have quite altered this part of the text of their author, the former confessedly and without authority; whilst Martin, Galiani, Sir H. Wotton and others have been at a loss to comprehend what *ordinatio* meant, though it evidently stands for that principle of our art which teaches us to give to the parts of our designs their appropriate size; for instance, to the several apartments *sufficient* area for the purposes to which they are dedicated, without making them disproportionately large for the rest of the structure; it requires us to give to our doorways, corridors, stairs, &c., sufficient width for the number of persons likely to frequent them; to our windows size sufficient for the due supply of light; to our supports sufficient but not excessive thickness or strength, &c. &c.

Disposition, or *diastasis*, he defines as "a convenient collocation of the parts, and a desirable effect in the composition (putting together) of the work with respect to quality." As then ordination proportions their sizes, so disposition arranges them with reference both to their use (*apta collocatio*), and the general effect of the composition.

Eurithm, Vitruvius says it is "a slightly appearance, and a suitable look in the composing of members, (*i.e.* forming them out of their simple elements,) and is secured when the members are of a height suitable to their width, and of a breadth proportioned to their length, and, in short, when all things accord to their own proportion;" *omnia respondeant sua symmetria*. "So symmetry," he adds, "is a proper concord of the members of the work itself, and the accordance of any given one of the several parts to the appearance of the general form."

Eurithm then regards the ratios or relations of the dimensions of any single member, and symmetry the relations of one member to another, or of any given dimension of one member to the corresponding dimension of another. Proportion is therefore of two kinds according to Vitruvius, viz.: eurithmic and symmetric—a distinction lost sight of by all his annotators. The former exists between the height of a column and its diameter; the latter between the height of the column and the height of the entablature, and also between the diameter of the column and the width of the intercolumn. Eurithmic proportion obtains between the width and height of a door or of a window, symmetric between the door as a whole and the window as a whole, and between the widths and the heights respectively.

Decor-consistency or propriety, he defines as "a correct aspect of a work composed of parts, approved with reference to precedent or authority, and is threefold, as it relates to *statio* (*θεμα τιμο*) custom or nature. The first translated "station" "circumstance," "stanza," "abitation," "*situation d'un-lieu*," "*etat des choses*," "*statuo*," by Newton, Gwilt, Barbaro, Orsini, Martin, Perrault and Galiani respectively is exemplified, when temples to Minerva, Mars, Hercules, &c., are executed in the Doric order as suited to their stern attributes, and shrines to Flora, Venus, &c., in the Corinthian style to accord with the tender and delicate natures of these latter divinities. Conventional propriety, he says, forbids the infringement of usages approved in all ages, for instance the introduction of triglyphs into any other order but the Doric, or of Dentilo into this.

Distribution, his sixth and last principle, he explains as "an advantageous dispensation of the materials and site, and a careful and rational regard to economy." As a further explication of his meaning, he adds the Greek term *οικονομία* as a translation of *distributio*, a word more nearly equivalent to "stewardship," than to any other expression in our language. From this we may understand that it is the province of architecture under this aspect to furnish all the requisite parts of the design without lavish expenditure, but in such manner and measure as may be best afforded by the circumstances of the case.

These then are the principles of architectural composition which Vitruvius lays down. Ordination, by which the parts are made of a size appropriate to their use; disposition, by which they are placed in convenient and effective collocation; Eurithm, or the due proportion of the parts, each in itself; symmetry or unity of proportion between all the parts and the whole; propriety, or consistency and distribution or economical provision of all the essential requisites.

In this analysis we scarcely know which to admire most, its completeness and neatness, or the beautifully natural and correct order in which the elements are exhibited. No part is deficient—none redundant. Were ordination neglected, the parts would be some too small for their destined uses, and others equally too large; in other words, the utility of the structure destroyed by this one defect; without attention to distribution, it will be rendered equally useless by the inconvenient arrangement of the whole, whilst a disregard to either eurithm symmetry or decor will render it displeasing alike

to the observant eye, and the contemplative mind. The apartments though of sufficient area, might be too low or too long for their width to be elegant or noble, though sufficient light were obtained it might find its way through very ill-proportioned windows; the entrance though wide enough, might be inelegantly low or absurdly high; the vestibule though large enough for mere use and appropriately situate, might not be in keeping with the spacious saloons. Yes, a design though correct in all the above particulars, might prove to be abundantly too expensive for execution, or when executed, useless; because, forsooth! there was no staircase to the upper floors; or, if a palace, no state rooms in which to hold the levees.

That design, however, which gives appropriate size to all its parts justly assuages them, preserves the beauties of euristic and symmetric proportion without outraging propriety; incurring irrational expenditure, or omitting any of the essential features, is as excellent as the rules of art can make it, and requires only a due infusion of natural talent or genius to render it perfect.

Whence it follows that the text of Vitruvius in this part, at least, is not as Shultz and others, his licksittles, have called it, "sophistical twaddle put together by an ignorant compiler," but a beautifully perfect, concise, and consistent explication of the subject in all the views in which it can be regarded, and worthy of our highest admiration.

#### THE NATIONAL ADVANTAGES OF FRESCO PAINTING.

Abstract of a Paper by JAMES THOMSON, Fellow.

The Institute has been already favoured with two very interesting papers on the subject of Fresco painting. One by Mr. Parris (*Journal*, vol. 5. p. 95.) conveying many useful suggestions on the practical working of it; the preparation of the ground or plaster best adapted to the purpose, and the colours of which the chemical properties alone will combine with the material, without risk to the artist who uses them. Another by Mr. Severn (*Journal*, vol. 5., p. 188 & 310), setting forth in most animating terms the works of the Italian masters. No sooner was the art of Fresco painting thus introduced, than Mr. Thomson was led to consider the importance of it to architecture in particular—to the art in general, and as he was prepared to show, to the nation at large. He thus continues:—First, its advantages to architecture in particular. In this a great and primary benefit is, that it applies itself to those broad spaces of the interiors of buildings, which, if decorated in any other way, either become monotonous, or (if not monotonous), too laboured and costly to be often indulged in: and secondly, to supplant the meretricious style of modern decorations. At present embracing these two objects—the filling up of the internal surfaces of building, and the exclusion of details that are foreign to the edifice—I would observe: That the simplicity and purity of fresco painting demand the sober dignity of architectural forms and proportions, and would be utterly at variance with the tawdry patchwork of every day practice. To place a fresco of Michael Angelo's, Raffaele, or A. Del Sarto, in a modern gilded frame work, would at once exhibit the impertinence of such an association; and there are special reasons for this. The superior transparency of fresco pictures causes them to reflect light, while oil paintings absorb it; and again, the former in which, simple colours and grand outlines only are admissible, can dispense with such accessions, while the other by its extremes of depth (amounting frequently to blackness) and high lights, introduced at pleasure, requires the aid of some such boundary. A gilt framework is almost indispensable to an oil picture—while to a fresco (on account of its own brilliancy) it is not only unnecessary, but almost injurious. I shall illustrate this, by quoting examples well known to all who have visited the continent. In three of the most admirable works of the Italian school—and each of them by masters of rival excellence, Michael Angelo, Raffaele, and Guido—scarce any gilding has been employed. For instance, in the ceiling of the Sistine Chapel; the ceiling of the Farnasine Palace; and the "Aurora" in the Ruspigliose Palace at Rome: in neither of these do we find gilding to be much if at all existing. But there are other points to establish the affinity of fresco painting to architecture, and it is to be found in the necessary proportions of parts to each other, so that they may not only be good in themselves, but as integral parts of a uniform whole. To explain this, we must now refer to the labours of another great painter, A. Carracci, and place his great work at the Farnese Palace, beside the still greater production to which I have before alluded, the ceiling of the Sistine Chapel. In the former will be found that however bold and versatile are the decorations, there is an absolute want of subordination of parts to each other; the oblong forms (intended to be principal) are nearly equalled by the square ones—and the square compartments are almost overpowered by the medallions. There is a struggle as it were for preponderance, even the figures contained in each of the latter panels appear to occupy a secondary place. Now let us turn to the Sistine Chapel. We here find all the parts, whether panels, pilasters, or figures, to subservise the principal objects. Here are the Prophets seated on pedestals in sober majesty, and they are surrounded by figures in every variety of attitude—and such attitude indicative of some important office—yet all contributing by their subordination to the dignity of the sacred seers. The side compartments are here decidedly less than the central, and the medallions are comparatively small. And then how charmingly does the artist's eye direct the allusion. Some of the figures are 12 feet high, others not more than 3 feet, and though close beside each other, no confusion results. One is

turned into bronze, another into stone, and the third represents life; but the artist had yet another and another handmaid—perspective and foreshortening, a branch of perspective, and aerial perspective. But in point of beauty fresco painting stands unrivalled; what shall we say of its durability? It has been urged that the damp air of this country is unfavourable to it, that our walls steaming with condensed vapours would soon cause the labours of the artist to suffer damage and ultimately disappear. Now what have we to oppose to this? If fresco was like stucco painting, the objection would hold—the latter lies upon the surface; but as the former is indurated, and becomes a part of the material of the stucco itself, we know that is liable to no such contingency, but that on the contrary it is the most lasting of any style of painting whatever except it be enamel. We will prove this by past experience and analogy. True it is that the climate of Italy will afford us no criterion—but its fatalities will.

We are all more or less acquainted with the elegant frescos of Pompeii. These delicate productions are, we know, after a lapse of more than 1800 years, preserved to us in all their pristine freshness; now, it cannot be urged that their buried state was favourable to them, or if it could, it would be to establish another advantage over oil painting. What pictures in oil, whether on canvass or copper, could have stood the test which they have?

The most important division of the subject, is—the economy of Fresco painting as compared with the present waste by gilding. Adam Smith, in his "Wealth of Nations," says, "In the manufactories of Birmingham alone, the quantity of gold and silver annually employed in gilding and plating, and thereby disqualified from ever afterwards appearing in the shape of those metals, is said to amount to more than £50,000 sterling.

It is not here intended to object to the judicious use of gold, but to the abuse of it; nor either to the cost of gilding, but to the actual waste by gilding plaster and composition, and every description of worthless material. But, lest it should be supposed that the withdrawal of gilding from our interiors should have the effect of throwing large number of workmen out of employ, Mr. Thomson proceeded to show that it would be the sure means of giving occupation to hundreds and thousands that now seek in vain for it. The moment the use of gilding is restricted, increased aid of ornamental painting will be required, and the art of Polychromy will be revived; and it will, also, require further aid from the carvers, and sometimes the chasers. Mr. Thomson then proceeded to make some remarks on the vast quantity of gold used for gilding, and the number of hands engaged, and the cost. He then explained by what means fresco should be advanced,

"The first legitimate source," observed Mr. Thomson, "appears to me to be in our churches, because the talent of our countrymen could not be better engaged than in the suitable advancement of their Christian temples. The next source that suggests itself for the promotion of fresco painting is, our Art Unions. They cannot, indeed, draw lots for frescos before they exist; nor can they be ready made as easel pictures for competition, but they can do this: they can give encouragement to that lofty branch of art which is capable of being transferred to fresco by engravings, duplicates of which are secured to the candidates. The third, and not the least important means of its advancement, I would refer to, is—individual patronage. I would remind those whose exalted station can alone derive lustre by the services they are able to render their country—I would remind them, how much it may be in the power of one noble house to effect."

We have it in history, and that of the dark ages, that "when Italy was torn by intestine factions, and war raged through the length and breadth of the land, that even this turbulent epoch was most glorious to the fine arts. In the midst of battles—engaged in the mortal struggles for the existence of his country, we find M. Angelo constructing the defence of his native Florence—fighting on the ramparts, and at the same time producing those marvellous specimens of art which have immortalised his name.

"Coeval with him we have the bright galaxy of talent which illumined Italy, so that, in the course of nature, one person might have lived to see them all. Born with Titian in 1477, he might have passed his life with Michael Angelo, Leonardo da Vinci, Raffaele, Correggio, Giorgione, Tintoretti, Bassano, Paul Veronese, Gilio Romagno, and Andrea del Sarto—he might have outlived them all, and, even within the ordinary limits of human life, have witnessed the close of M. Angelo's brilliant career in the year 1563. Such was the rich harvest, which left but slender gleanings to succeeding ages. It had shot up and ripened in the midst of storms, and seemed, like the palm tree, to gather strength from the difficulties opposed to its growth—to spring with vigour in proportion to the strength employed to bear it down."

It is added—"The stimulus which gave it life and energy to brave these adverse circumstances—was the encouragement and foresight of one enlightened family—THE FAMILY OF THE MEDICI."

#### WILTSHIRE TOPOGRAPHICAL SOCIETY.

The third Anniversary Meeting of this Society was held on Saturday, the third of June, when the LORD BISHOP OF SALISBURY presided. It was then reported that "the first volume of the society's publications would be ready for the members early in July—that it would contain the Rev. J. E. Jackson's *History of Gritleton*, and Mr. Britton's *Introductory Essay on Topography*, with Glossaries to Domesday Book, and other Archæological Records, &c.; and that the volume was exclusively for the members of the

society." It was further reported that other works were in progress, and that it was expected, one, two, or more volumes would probably be ready by the ensuing anniversary. The only alteration in the list of officers was the election of A. Caswall in the room of F. Whitmarsh.

KING'S COLLEGE, LONDON.—OPENING OF THE NEW MUSEUM.

The opening of the museum of this noble establishment took place on Thursday the 22d ult. under the immediate auspices of His Royal Highness Prince Albert, who arrived at the college punctually at 12 o'clock: he was received by the Bishop of London and Archdeacon Lonsdale, the principal of the college, and led into the grand hall which is quadrangular, and has two large staircases on either side, with a gallery or corridor above. These were all lined with students of the college and of the school, who, together with the council and professors formed rather an imposing coup d'œil.

Among the company we observed the Archbishop of York, Bishops of London, Norwich, and Gloucester, and many other dignitaries of the church, Lords Brownlow, Radstock, Sir Robert Inglis, Mr. Faraday, &c. &c.

After the repeated hurrahs and cheers had subsided, Mr. Slater, one of the students, advanced to the Prince and read a Latin speech, and at the close, Mr. Hullah's pupils, who lined the right hand staircase, broke out and sung our national anthem "God save the Queen."

The Prince, attended by the principal of the college and the Bishop of London, then ascended the staircase for the purpose of opening the new museum. On his way he inspected the Marsden library, so called from the presentation of a most valuable collection of works in the Eastern languages, by Mr. Marsden, and the grand library, which, though small, contains some of the most select classic authors in ancient and modern literature. On His Royal Highness's arrival at the new museum, he was joined by the Crown Prince of Wirtemberg and suite, and was received by Professor Wheatstone, who accompanied His Highness through the museum, and explained the various apparatus, with all of which the Prince seemed well conversant, and much interested. The museum is to be attached to the engineering department, it consists principally of instruments from the royal collection at the Kew observatory, formerly belonging to King George the Third, many of which were of his own workmanship, and it has been since further enriched by royal munificence and by private liberality, in the presentation of Babbage's celebrated calculating machine; models of well known bridges, and of the most ingenious and difficult engineering works, and also a statue of George the Third, by Turnerelli, presented by H. Pownall, Esq., and it is hoped that it will become the nucleus for the formation of a scientific museum, which the manufacturer and man of science will frequent, and where all models and inventions of known utility will be sent for their inspection and approval, and for the publicity that they will thus obtain.

After the ceremony of opening the museum, the Prince proceeded to the great theatre and its ante-room, the one containing a small but choice collection of birds, and the other a valuable present from Her Majesty, of English and foreign insects and butterflies. This theatre, which is the large theatre of the institution, was filled with an assemblage of the highest rank and fashion. The Prince was here attended by the lecturer, Mr. Cowper, who explained various models and drawings. A valuable full length likeness of Jacquard, the inventor of the celebrated Jacquard loom, woven in silk, very much attracted the attention of his Highness, it was scarcely to be distinguished from the finest engraving; the whole process was fully detailed by the lecturer, the Prince entering warmly into the detail of a machine whose results had been so beautifully displayed in the specimen before him. The Times printing press, spinning and other models were also severally explained; afterwards his Highness proceeded to the theatre of Materia medica, and the chemical theatre where he was received by Prof. Daniel who explained several interesting experiments connected with the voltaic battery, and the decomposition and formation of water, he then adjourned to the terrace of Somerset House where the experiment of letting off a cannon on the top of the shot tower on the opposite side of the river Thames from a galvanic battery on this side of the river was to have been performed; this did not take place, but we could not positively ascertain wherefore; we believe the communication of the wires passing across the river had been destroyed. After parading the terrace attended by the principal, the Prince retired to his carriage evidently much gratified with the strong expressions of loyalty that he had met with, and the many interesting experiments he had seen.

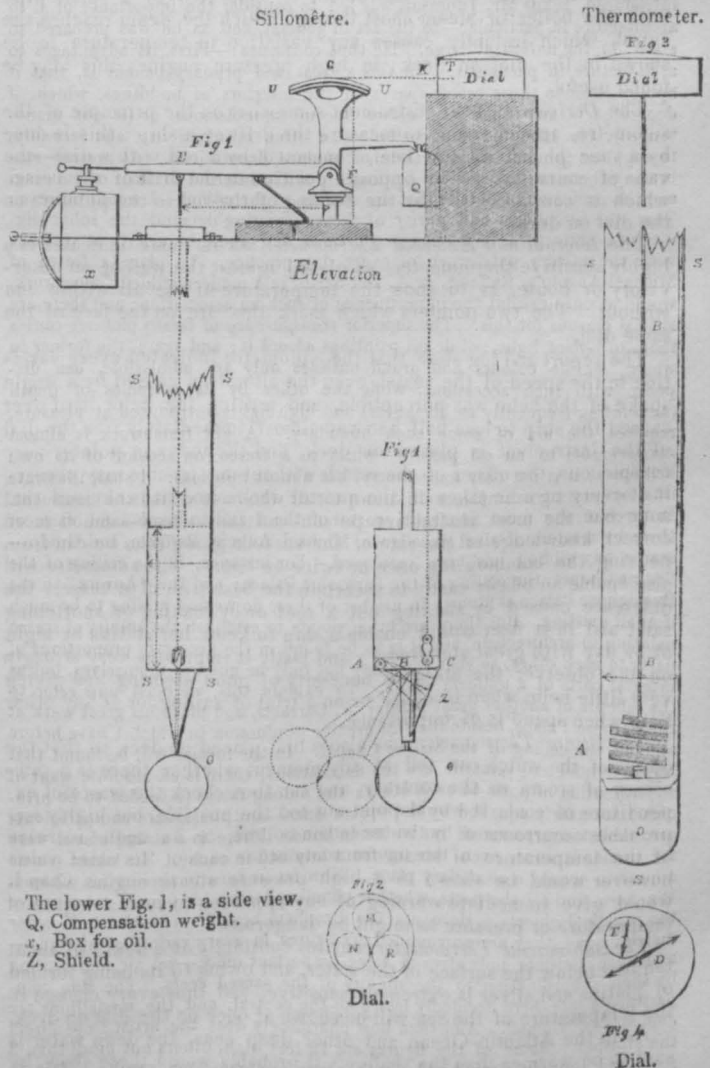
We believe we are authorized to state, that the public are at liberty at any time between the hours of 10 and 3 o'clock to visit the museum and other parts of the college.

M. CLEMENT'S NAUTICAL INVENTIONS.

In the Journal for last January, page 28, we gave an account of M. Clement's ingenious inventions, together with some particulars respecting an experiment, made by order of our government, to try their merits; since then more extended experiments have been made in H. M. steam vessel *Blazer*, which has proved very successful; the results, communicated by Captain Washington, R.N., are to be found in the *Nautical Magazine* of last month, from which we have obtained the following description and drawings of the instruments.

The name *Sillomètre* is composed of the two French words *sillage* (headway) and *mètre* (measure), and might be well rendered in English Speed-gauge. This instrument consists of a hollow copper ball O, Fig. 1, about five inches in diameter, suspended under the ship's bottom, nearly amidships, from the middle of a bent lever A C, about five inches long; one end of this lever moves on a joint A, its fulcrum, attached to the lower end of a metal rod which passes vertically through a copper tube carried from the deck through the bottom of the ship near the keel; at the other end of the lever is attached a chain C, which leads upwards and acts upon a second horizontal lever E F, on deck. This second lever corresponding to the lower one, gives motion, by means of a spring, to an index which marks on a dial the speed of the ship expressed in knots and tenths of a knot.

Such is the whole of the apparatus of the simple *Sillomètre*. It will be readily understood that as the vessel moves through the water, the fluid acts upon the ball, which being circular, always presents the same section, and causes it to move aft, thereby depressing the fore end of the lever which by the chain communicates with the dial on deck. The scale by which to graduate the knots on the dial was found by M. Clément after numerous experiments. This instrument in its simple form shows the speed of the vessel, not the amount of distance run.



The lower Fig. 1, is a side view. Q, Compensation weight. x, Box for oil. Z, Shield.



The compound sillomètre consists of the same mechanism, Fig. 2, with this addition, that the power which moves the index M, is applied at the same time to a watch N, and accelerates its movements in proportion to the intensity of the moving power, or as the vessel quickens her speed. A second watch R, is placed by the side of the first, in order to show how much the former gains upon the latter; and knowing that for every six seconds of gain the vessel will have made a mile, it is easy to know the distance run. It is evident that this compound instrument is very superior to the simple one, but its accuracy depends upon the regular going of two good watches, a result not very easily obtained at sea.

The *Sub-Marine Thermometer* is a very delicate instrument composed of a ribband formed of two metals of unequal contraction and expansion, as platina and silver, and rolled in the form of a helix A, Fig. 3, round an axis B, which turns as the temperature of the water varies. This motion by a train of wheels and pinions is immediately communicated to two pointers on a graduated dial on deck, and which may be read off easily to hundredths of a degree.

The whole of this apparatus is enclosed in a metal tube, which passes through the bottom well aft in the run of the ship. The helix or thermometer is therefore always at a certain depth in the water, say 10 feet below the surface; and it shows instantly every change in its temperature.

As few observations have been regularly made on the temperature of the water of the sea at a certain depth, this machine may lead to some novel results.

The *Steam Indicator* points out the temperature and consequent pressure of the steam in the boilers; it is composed of a ribband or blade of two sensitive metals of unequal expansion, turned in a spiral form; one end is fixed to the tube or pipe in which it is contained, the other connected with a spindle bearing the pointers which indicate the temperature of the steam on a dial on deck, in degrees and tenths of a degree. This instrument is connected by a small pipe with the boiler or steam chest through which the steam reaches the spiral, which instantly causes any variation in temperature to be shown by the dial on deck: in high pressure engines this may be found useful.

The *Derivometre* is an instrument somewhat on the principle of the sillomètre, and intended to measure the drift of a ship; this is done by a vane placed on the keel, connected by a rod with a dial—the vane of course takes the opposite position to the drift of the vessel, which is communicated by the turning of the rod to the pointers on the dial on deck.

The *Internal and External Thermometer*, as its name indicates is a highly sensitive thermometer, so placed against the wall of an observatory or house, as to show the temperature of the air within and without. The two pointers which mark this are on the face of the same dial.

The report and log show that the sillomètre indicated every variation in the speed of the vessel, even the alteration caused by a single spoke of the helm was perceptible, and putting the helm hard over caused the ship to lose half her way almost immediately; as the dial of the instrument is placed on deck, and the index or pointer very conspicuous, the officer of the watch without any trouble may observe it at every turn he takes on the quarter deck; and it is obvious that none but the most inattentive person can fail to have a much more correct knowledge of the rate of the vessel's going than he can from heaving the common log once or twice an hour. The sillomètre will also enable an officer easily to ascertain the best trim of a vessel; the difference caused by shaking out a reef or by making or shortening sail; and in a fleet would enable a ship to keep her station by night or by day with great steadiness; and lastly it impresses very strongly on the observer the absolute necessity of good steering and giving very little helm when in chase or on a trial of sailing, or at any other time when speed is of importance.

The *Steam Thermometer* has also a dial placed on deck so that the officer of the watch can tell at any moment whether there is a sufficiency of steam or the contrary, and can thus check the wasteful expenditure of coal; it would point out too the possible, but highly improbable occurrence of no water in the boilers, or an undue increase of the temperature of steam from any other cause. Its chief value however would be shown in a high pressure steam engine when it would give immediate warning of any approach to such a degree of temperature or pressure as might be dangerous.

The *Sub-marine Thermometer* remains constantly at a depth of about ten feet below the surface of the water, and owing to its being formed of platina and silver is extremely sensitive, and thus every change in the temperature of the sea will be shown at once on the dial on deck.

As in the Atlantic Ocean and other deep seas, the deep water is said to be warmer than the shallow; it probably would there show, by

mere inspection, the approach to shoals, rocks, or land, and serve as an excellent warning. At this season of the year however in the shallow waters of the North Sea we observed no such effect, on the contrary the temperature of the water gradually decreased from 50° Fahrenheit at Woolwich to 44½ at about 20 miles to the eastward of the North Foreland, and as gradually increased on our return to the same point.

Possibly as the summer advances this may be different, and in order to discover when the change of temperature takes place, I have directed the instrument to be registered every two hours night and day. As the thermometer is highly sensitive and may be read off with ease to hundredths of a degree, and agrees perfectly with the best mercurial thermometers, it may possibly furnish some novel results of value to the philosopher as well as to the navigator, since I am not aware of the existence of any continued series of observations on the temperature of the sea at all seasons of the year.

## WESTMINSTER BRIDGE.

*Report to the Speaker, by Messrs. WALKER and BURGESS, on the alterations proposed by Mr. BARRY.*

SIR,—As that portion of Mr. Barry's report to His Royal Highness Prince Albert (on the decorations, additions, and local improvements connected with the new Houses of Parliament) which refers to Westminster-bridge, may naturally lead to the opinion that our plans, made under the direction of the Bridge Commissioners, were confined to the repairing and extending of the foundations, for our superintendance of which he kindly compliments us; we consider it, therefore, a duty to prevent such a mistake, by stating, that the designs, estimates, and the contract with Mr. Cubitt, included the repair of every part of the bridge, the "removal of the present steep and dangerous acclivities, and the lowering of the parapet and road-way to the lowest possible level" that appeared at the time to be consistent with the safety of the present arches. The second contract with Mr. Cubitt, is for lengthening the piers, which are being carried to above high water level, to receive arches for widening the bridge twelve feet. It will then be of the same width as London-bridge. All, in fact, that we have done to Blackfriars-bridge, is designed and contracted for, to be done to this bridge, with the very important addition of the preparation for widening. The steepest part of Westminster-bridge road-way will, when the designs are executed, be as easy as that of Blackfriars-bridge. That which rises one in fourteen, will be reduced to one in twenty-four, and even this rise will be for only a limited length.

To secure the foundations, which were in danger of being undermined by the scour consequent on the removal of old London bridge, has been the first object. The supposed difficulty of doing so effectually, was increased by the opinion entertained by Labeyle, the original engineer, and others since his time, that owing to quicksands, coffre-dams could not be applied; and the commissioners have been desirous of removing all doubt on this point, before proceeding with the spandris, road-way, or parapet. Five out of the seven coffre-dams have been built; so far, we have been completely successful: and while the water was excluded, all the work which was required in repairing and lengthening the piers to above high water, has been done; seven out of the thirteen arches have also been repaired, as the coffre-dams gave facility for the scaffolding necessary for doing this. Thus far, therefore, our design proposed to, and approved by, the Commissioners, corresponds with, and has anticipated Mr. Barry's; but the idea of taking down the present semi-circular, for the purpose of substituting pointed arches upon the same foundations, is not ours, and we beg to state shortly, why we do not concur in the expediency of this proposal.

Mr. Barry's first argument for this change is, "that the pointed arch will enable the road to be lowered, by materially reducing the thickness of the crown of the arches, within what is considered necessary for arches of a circular form." Now, we consider that the whole thickness of the stone-work and covering of the present centre arch may be reduced to about seven feet, which is the same thickness as Mr. Barry's ribs, arch and covering, measured upon his section; so that, even supposing the principle he states, of the pointed arch requiring less thickness than the circular arch, to be correct, he obtains no reduction in thickness, and only lowers the road-way, by lowering the soffit of the arch. The generally approved theory of arches is

<sup>1</sup> The commissioners have power to suspend or supersede the contract in respect of any works not commenced.

however, directly at variance with Mr. Barry's. In "Pratt's Mathematical Principles of Mechanical Philosophy,"—considered a standard work, and, as we are informed, a text-book at Cambridge,—the theory is so clearly explained, that we give it in his own words: "A pointed arch," he says, "must have a great pressure on its crown to prevent its falling, because it may be considered as consisting of two extreme portions of a very large circular arch brought together, so that the pressure on the crown must at least equal the pressure of the portion of the circular arch which is removed. Flying buttresses always have a great pressure upon their highest part. The pointed arch will sustain almost any weight on its crown, provided the lowest stones do not give way, and, consequently, the Gothic arch is stronger for lofty buildings than the circular; but the circular arch is far better adapted than the Gothic arch for bridges, since the pressure of weights passing over may act upon any part of the arch, not only on the crown." Mr. Whewell comes, in different words, to the same conclusion; and the same can be deduced from Attwood, though not so clearly expressed. These are no mean authorities; indeed, we do not know an exception in any author, British or foreign, to the opinion, that the pointed arch requires a greater thickness of material at the crown than the circular arch to keep it from rising; and if so, the substitution of the pointed arch should, in place of allowing a reduction, demand an addition to the least thickness required for the present arches. Add to theory, the experience of every modern engineer of this or other countries, as shown in their bridges of any considerable size: for we are not aware of any example of a pointed arch for a bridge of any magnitude in the works of Smeaton, Rennie, Telford, Perronet, or indeed of any other.

Mr. Barry's second argument for substituting the pointed arch is—"the elevation of its springing above the level of high water, by which the water-way of the bridge will be the same at all times of the tide, in place of being contracted by the present spandrels at high water, nearly equal to one-twentieth of its sectional area, occasioning currents, with a fall, and sometimes danger to craft in passing through the bridge under the influence of high winds." Mr. Barry appears here to have stated "sectional area," when he must have meant width or chord; for we find, that in the section of his scheme, the contraction of the middle arch by the spandrels is about one-twentieth of the width, at the level of Trinity high water; but as the contraction is only a few feet in depth, before the arch falls into the vertical line of the pier, the diminution of sectional area is not one-twentieth, nor more than one one-hundred-and-twentieth, and this at high water only;—and even this small diminution is in effect reduced practically to nothing as respects the current, when it is considered, that the greatest velocity does not take place until half ebb, by which time the water has sunk below the level of the spandril. It is, we think, therefore evident, that the proposed alteration will not produce any useful effect upon the currents or the falls. When the bed of the river under the arches is lowered (which also is part of the contract), and the cofferdams removed, the present current through the bridge will be materially lessened. Some practical good would be effected by the higher point of springing of the pointed arches, in giving more head room for craft near to the piers; and, as the Westminster-bridge arches have less space for navigation than any of the four City bridges, any increase of accommodation is desirable; unfortunately, however, while an addition is thus made for one-fourth of the width of the arch near the springing, a portion is taken away from the height for the remaining three-fourths, nearest the crown, where it is of the greatest importance; this diminution varies from eighteen inches to thirty inches; so that the centre arch will not then have more height for navigation than the two arches, adjoining the centre arch now have; and when we inform you, that at high water of good tides, the centre arch is the only one which some of the steamers can conveniently pass under, we think you will allow with us, that the proposed lowering will, in such cases, be rather a practical evil, as it will take from the convenience of what is now the least convenient bridge for navigation, to say nothing of the liability to the ribs being injured by masts and chimneys striking them.

The artistic point of view is the last insisted on by Mr. Barry; and on this, what we may say, is with a due respect to his better judgment and taste in matters of architecture. The contract with Mr. Cubitt does not alter the present elevation below the crown of the arches; but, as you are aware, we have long since suggested that a new elevation for the bridge after the Norman style would be a great improvement. In this, however, we would not propose to reduce the magnitude of the features of the bridge, considering that simple boldness, and strength, are essential qualities in a bridge over the river Thames, in London; and if so, that it is scarcely fair to reduce the parts of the bridge because those of the elegant florid edifice, which is now being erected near it, are small. For palace architecture, the latter may be

the best, and we do not venture an opinion as to the effect of Mr. Barry's work, in which our professional employment was confined to the construction of the coffer-dam and the river wall; but for a bridge, particularly in a city, with constant and heavy rough trade under and over it, the style of architecture ought, we conceive, to be more masculine. May not the new houses be better displayed thus, than by accordance of style? The beauty of the detail of the new houses is very great; the length 800 feet, without, at present, any striking feature or variety, also great; but we submit, whether an additional 800 feet of according composition and style, of still lower elevation, would not rather tend to render the "ensemble" dull and flat than effective? The style of the new buildings must stop somewhere. Can it do so better than at the bridge, which, as we have already said, appears to require a character different from the Houses of Parliament? If both faces of the arches are proposed by Mr. Barry to be alike, would there not be a want of accordance between the north face of the bridge and the buildings and mansions near to it, and which there is, we presume, no intention of altering? Is a continuance of the same style required for so great a length, as the houses and the bridge together, although the pointed may be the prevailing character of the building? Does not precedent reply to this in the negative, and prove it, by the fact that the periods of the original erection and of the additions that have from time to time been made to some of our finest buildings may be discovered by the style; the Saxon, the Norman, the Pointed, and varieties of each being found in the same building, and yet the "ensemble" not inharmonious. We hope, therefore, that the superstructure of the bridge, though it may be different in style from the Houses of Parliament, may not be discordant.

Westminster-bridge has been where it is, and as it is, for a century; it was there when the designs for the new houses were made, and we never heard that to pull down Westminster-bridge to nearly low water, was to be a necessary accompaniment to the adoption of any of the designs. If you and the other commissioners had known that such alterations were contemplated, you would not, we are sure, have allowed the works to have proceeded as they have done, until nearly two-thirds of the whole to above high water had been completed, including the renewal or repair of the arch stones.

We may name here an objection to the form which Mr. Barry has proposed for the arches, as tending to lessen the stability of the bridge. Labelle considered that by adopting the semi-circular arch, which presses vertically upon its piers, each pier might be considered an abutment, so that if one arch were to give way, the piers would support all the others. From the great height at which the proposed pointed arches spring from the piers, and their greater lateral pressure or thrust upon the piers, the above would not be the case. On the contrary, the failure of one arch would, we conceive, cause the destruction of all the piers and arches. This consideration is not to be disregarded in a bridge, the piers of which have been so badly founded, that to support them has been a constant expense, and is at this moment a source of considerable anxiety; although the works we have in hand, if as successful as hitherto, will render the piers much more secure than they have ever been; we hope, perfectly so.

On the whole, therefore, we have reason to be pleased, that Mr. Barry approves the various improvements in the bridge which the commissioners have contemplated, and, with one exception, contracted for. The only addition he makes to them is, the substitution of the pointed arch, which, for the reasons stated, we cannot advise. We agree to the advantage, in point of taste and utility, of keeping the road-way of the bridge low; we have designed doing this as far as can be done, having regard to the funds of the commissioners, and therefore without disturbing the present arches. There is a way by which the height of the road-way might be reduced below what either Mr. Barry or we have yet proposed, at one-fourth of the expense of his plan (which would, we think, much exceed his estimate), and without lowering the soffit of the arch, or diminishing in any way the convenience of navigation; but we avoid entering upon, or committing ourselves to this, until we have considered the subject more in detail, and understand it to be the wish of the commissioners that we should do so; for the works we have already recommended may go as far as their unassisted funds would justify.

We have the honour to be,

Sir,

Your obedient servants,

WALKER AND BURGESS.

23, Great George Street,  
31st May, 1843.

The Rt. Hon. CHARLES S. LEFEVRE,  
Speaker of the House of Commons,  
Chairman of the Commissioners of Westminster Bridge-

## NOTES ON EARTHWORK, &amp;c., UPON RAILWAYS.

## ARTICLE 7. CAPITAL, SHARES, AND TRANSFERS.

The previous papers that have appeared in the *Journal* on the above subject, have reference to the constructive operation in the formation of railways, which is more in my line than the title or heading of this paper; yet, I am induced, however imperfectly, to give some account of the ways and means by which the necessary funds have been raised, as I know of no work where any information is to be obtained, except in isolated and unconnected passages of various works bearing more or less on railways.

The necessity of a railway for the public convenience being fully established, and the probable cost of the works ascertained, the number and amount of shares necessary to be raised is then considered, which are proportioned to the magnitude of the undertaking, the liability of calls being limited to the amount of share. The amount of each share has been generally fixed at 100*l.*; in some instances at 50*l.*, and in a few cases as low as 20*l.* per share, the greater or less amount giving the undertaking a more or less speculative character. The legislature require the whole capital to be subscribed to the deed before any step is taken in the execution of works, and in 1836, to check the mania for railways, a standing order was passed requiring  $\frac{1}{3}$ ths of the cost of the undertaking to be subscribed for, and a deposit of 10 per cent. paid thereon, before an application could be made to Parliament for a Bill, which was evaded in 1837 by the Edinburgh and Glasgow Railway Companies, who borrowed the money from their bankers, the Company at the same time claiming exemption from the standing order, on account of the project being started before the framing of the order. The amount of capital being fixed, Parliament as a general rule allow a third to be borrowed by the executive as a mortgage. In almost every case the capital has been found to be inefficient for the construction of the works, and application to Parliament a second, third, and fourth time, has had to be resorted to, and fresh powers obtained for raising more money, either by issue of new shares to pay off loans, or to obtain further loans on mortgage, or bond on the credit of the company, by way of loan notes, or promissory notes of the director under the seal of the company, also by debentures, which are mortgage bonds according to act of Parliament, the interest of which has preference of any dividend, and if not paid within 30 days after due notice, two justices of the peace may appoint a receiver of the tolls and profits of the railway; and the same course may be taken with respect to the principal, unless paid within six months after it is due. The company reserve power to pay off bonds any time after three or six months' notice. The debentures are very convenient, as interest warrants or coupons are attached for the whole period, made payable every six months at the bankers of the company, during the whole period for which the money has to remain, which is generally for three, five, seven, and never more than ten years, being at the same time transferable like shares, a form for which is provided in the acts of Parliament.

In the second Report on Railways, from a select committee of the House of Commons, printed August 9, 1839, where much valuable information is to be had on this subject, the Committee particularly direct attention to the course pursued by the different companies in coming to Parliament, for the purpose of raising sums rather than enforce payment of money empowered to be raised under former Acts. It has been already stated, that in the second application to Parliament, the companies have been empowered to raise further sums, by issue of new shares, and conversion of bonds into shares. The amount of the shares has been reduced in these cases by the companies, and rendered more speculative in character, perhaps purposely so, by the 100*l.* share being divided into halves, quarters, thirds, fifths, tenths, and so forth. In such straits have some concerns been, that after all means for raising money by bonds or mortgage, and loans on credit of the company, have been exhausted, new shares have been issued at a discount of 50 per cent, and in some instances preference or privileged shares have been created, with a guarantee of interest at the rate of 6 per cent., and bonds have been converted into shares with a guarantee of 5 per cent. in priority of original shareholders, to be received out of the paid up capital of the company.

In only one instance has a public railway been offered for sale by auction, and this was by the seizure of a line by the Exchequer Loan Commissioners, who can suddenly sell to the detriment of all other lenders; but the sale was prevented by an arrangement with Government for the liquidation of the debt and accruing interest, by instalments during a period of 20 years.

Scrip shares are certificates for shares prior to their legal creation, and pass from hand to hand without registration, and are not transferred by deed, the payment of duty on transfer is thus evaded, but

registration is necessary to receive a dividend. Privileged or preference shares have a fixed interest or dividend secured upon the paid up capital, in priority of any dividend to original shareholders.

The influence obtained by the possession of a great number of shares, varies in almost every company, but the general average may be about twenty votes for twenty shares, and an additional vote for every five more shares; in other cases four and five shares are requisite to obtain even one vote: and to prevent the leviathan swamping the minnow, no one person is to have more than 10 or 15 and up to 60 votes; the latter is the greatest latitude allowed in any company. The qualification for becoming a director, is the possession of from 10 to 20 shares, which also differs in various companies. The estate of shares is declared in all railway acts to be personal property, and a form of transfer is prescribed, which, however, cannot be acted on until calls are paid, that is during the collection of a recent call; neither can shares be transferred for some days previous to the general meetings of the company. Shares may be forfeited at general meetings on neglect to pay calls after notice by post, or left at the abode of the owner. The defaulter is subject to be fined for neglect, and three months' notice of forfeiture; but the company must not sell more than will pay the calls that are due. The forfeiture of shares is an indemnity against actions for calls (the other resource of the company against defaulters) and absolve the defaulter from further responsibility after, but not before, forfeiture.

The companies may purchase shares to merge into the company, or to be held in trust; when this is done, and held in the name of individuals, a power is obtained very detrimental to the interest of the small holders of shares. The calls are stipulated in the acts of Parliament to be made at intervals of from sixty days to three months, and from 20*l.* up to 100*l.* is the limit to be called for in one year; the minimum amount has been more generally acted on, and money borrowed in anticipation of calls. Notice of calls are to be advertized from 10 to 21 days previous, and the amount of each varies in different companies from 3*l.* 5*l.* 10*l.* 15*l.* to 20*l.* per share, but the executive have in this case also preferred the smaller amount. With respect to transfer of shares, it is provided in railway Acts to be done by deed, which is, to be registered in the books of the company, but no time is stipulated within which such registration must take place. This has been taken advantage of by the public, and the deed is completed between the vendor and purchaser, except as to the insertion of the purchaser's name, and bearing the stamp of the *ad valorem* duty, at the time it passes from hand to hand without the payment of any more duty until a purchaser thinks proper to register; then the transfer is taken to the office of the company, and his name inserted as the purchaser. This system is connived at by the companies, who, to give an assurance to a purchaser of the validity of a transaction, do not hesitate to give a memorandum, under the hand of the secretary, of a long bygone transfer, which, to all intents and purposes, answers fully as well as a recent actual transfer; although the companies prefer giving out a filled up transfer. A transfer with a good stamp is accepted without inquiry. The purchaser, on the receipt of the transfer, can hold it as long as he likes, the seller having no means of compelling registration; the seller is, therefore, liable to the calls after he has sold his interest in the company, and without any means of compulsion in his hands whereby he might regain his shares; again, provided he paid the call, the vendor may sell his share a second time, and the second purchaser, upon priority of registration, would be entitled to the share; he, the vendor, is at the same time liable for calls upon his share after its sale, so long as his name is retained on the company's books; also so long as his name is retained, his share is liable to be taken in execution for the debt of any individual creditor, or in the case of bankruptcy his creditors would claim it as part of the general estate, in preference to the title of the first purchaser. These are the legal difficulties that accrue from the use of the blank transfer (that is blank as regards the name of the purchaser) in addition to the loss to the revenue of the stamp duty on the increase of the share's value, and on each transaction subsequent; there is also the uncertainty and inconvenience to which the company are put in ascertaining the opinions of their proprietary.

The new registry of shares has also been turned to account by the executive of the Companies, so as to increase individual influence. It has been previously stated that no one person is to have more than from 10 to 60 votes, and that 20 shares are entitled to 20 votes, with an extra vote for every five shares in addition, but not to exceed, in all, 60, whatever the number of shares held may be. In a recent case, quoted in the *Railway Times*, an individual held 299 shares in a Company, and was registered for only 25, holding the remaining 274 shares in different names in lots of 20 each; by this means his number of votes was increased by 220 votes, in addition to 25 votes which he was entitled to by the act, which in question decided by vote

of proxy must be obviously "undue influence." Individual influence, and thereby patronage and favouritism is also increased by companies having the power of purchasing shares to merge in the company, which are held not in the company's name, but by directors in trust for the company. This is of immense importance in the appointment, or otherwise, of committees of inquiry into management of companies; one recently appointed was carried by a majority of 715 when nearly 8,000 votes were polled. The committee of inquiry reported; the directors replied; the committee answered, and the directors published a rejoinder, and another poll took place, the direction beating the committee by a majority considerably less than before; to gain which every move was tried, and thirty votes held in trust in names of directors were openly used and it was at the same time strongly contended that the right to vote was in the share, not the individual; he might be bankrupt, a convict, a felon, or even dead, and being known to be dead, he would be revived for the day.

Sales or purchases of shares are generally made through a share broker, who uses the prefix "share" to distinguish him from other brokers; those of the Stock Exchange generally act as London agents for the provincial brokers, and sometimes the fees on commission are divided between them. For shares under five pounds the commission varies from a shilling, as the circumstances may differ. The following is the usual scale of brokers' commission:—

£.	s.	d.	
5	-	1	0 per share.
5	under 20	2	6
20	"	50	5 0
50	"	10	0 per cent. Debentures 5s. per cent.

The stamp duty payable on transfer of shares is the same as the *ad valorem* duties on assignment of lands.

In addition to the stamp duty, which is paid always by the purchaser, some of the companies make a charge of 1s. to 2s. 6d. for each transfer in the company's books, which is charged to the credit of the company, or allowed as a fee to the secretary as an augmentation of his salary. The charge for registration of a transfer which is adopted by some companies, as the Greenwich, Taff Vale, and Newcastle and Darlington Junction and South Eastern Railways, varying from one shilling to half-a-crown, tends also to further the continuance of the practice of using blank transfers and the consequent evasion of the duty, and I apprehend those who adopt the charge do not improve their undertaking in the estimation of the public.

I have omitted to notice that in many of the companies the fifth part of the shares in the first allotment are reserved for the landowners on the line; and that in the creation of new shares, old shareholders have priority, the shares being allotted in proportion to their holdings, and that some companies have been in the practice of paying interest, during the execution of the work, on capital or paid up shares, so soon as one-fourth of the share has been called. Among those who have so acted, that I can call to mind, are the Greenwich, Grand Junction, and Newcastle and Carlisle Companies.

As I said on the commencement of this paper that this subject was not my forte, or in my line, I cannot therefore enter on the zoology of the two animals "Bull and Bear," or the inexpediency of what are called time bargains to individuals on the Stock Exchange, and their detrimental effects to the undertaking in which the transactions are made, the directors having no control over the parties operating, who unnaturally depress the value of the shares, no matter what may be the depressed state of the market, these fine gentry are generally obliged to get out by hook or by crook, and at any sacrifice to themselves and the undertaking. The companies have also to a certain extent adopted the principle of time bargains both with respect to the issue of loan notes and debentures; of the latter mode of proceeding the Eastern Counties is an example, who give the holder of each debenture of 8l. 7s. 6d. the option in three years of taking a 25l. share of the former; the Croydon company give the option for the same period to the holder of loans, to convert 15l. loan notes into a share of 20l., and the Brighton for a similar period of three years to the holders of their loan notes of conversion into quarter shares at 10l. each.

A system of leasing the works of one company to another has been, to a certain extent adopted, which was done, I think, first, by the York North Midland taking the Leeds and Selby line for a term of years. The following have also followed the example: The Birmingham and Gloucester have a lease of a portion of the Cheltenham and Great Western Union from Cheltenham to Gloucester, and the Great Western have a lease of the Bristol and Exeter, and a portion of the Cheltenham and Great Western Union; the rent of the former being 30,000l. and the latter 17,000l. per annum. The South Western or Southampton Railway took up the Gosport Branch Railway, and paid the shareholders 5 per cent., with option after a certain time of joining in a general dividend with the main line, and a similar course has been

pursued with the Warwick and Leamington Company, and the Birmingham Company. The system of letting or leasing railways to private individuals has been attempted on the Northern and Eastern and the Brandling Junction Railway; the committee of inquiry, on investigation, recommended that system in respect to their lines, but no case as yet has it been carried into practice.

To conclude this rambling paper I refer to the greatest difficulty that railway companies have to contend with, viz., the closing of capital account in consequence of disputed accounts with contractors, and the excess of capital required over previous estimates, rendering it almost impossible for the uninitiated to form any opinion as to the merits of an undertaking so situated, with reference to their solvency or otherwise, and the consequent uncertainty of railway stock as an investment for the widow or trustee, and all experience shows that until a railway is finished, and its traffic fully developed, the greatest uncertainty attaches to such works. I have endeavoured, however, imperfectly to point out the manner adopted by railway companies of raising capital by shares and loan, also the mode of transferring shares, the amount of share and the consequent liabilities, and the influence of holding, as to individuals and directorates in the management of railways and the power of control as to the shareholders at large. At the same time I have pointed out that little or no information is to be had in any work expressly devoted to railways, on this subject, they being more generally devoted to the description of the construction of the more important bridges, &c. on each railway, its course and direction, and the towns in the vicinity. I am nevertheless in hope that this paper will call attention to the subject by one more competent to the task.

One desideratum yet required to give stability to railway property is, the closing of capital account, and the publication of shareholders and the number of their holdings, and the full development of passenger traffic as regards the third class carriages, which ought not to be so constructed, that 70 persons are made to stand up without cover or shelter; the principle on which the companies ought to act is, to carry people cheaper than they can walk, as notwithstanding the saving of time, another element in the calculation is money, which is said to be also time; but in the present depressed state, many have time to spare for travelling, but not money also, at least in quantity sufficient for pleasure, even at second class fares. As to goods traffic, I think that as regards general merchandise, that the old system will be able to compete with railways; and as regards coal or other produce, always conveyed in one direction, the local or large holder generally makes a bargain consonant with his own notions. Passengers are the main support of railways; and the safety to passengers is no speculative point, eighteen millions of persons having travelled by railway in 1842, and only one was killed whilst riding in a train; and there is no doubt that the traffic and returns have also exceeded the most sanguine expectations of the original projectors, as well as the amount of capital required. Railways must ultimately pay, and settle down into one of the most eligible of investments, as the facility with which a transfer can be made in comparison with a freehold, is greatly in their favour.

I have annexed to this paper the different forms of transfer, certificate for a share, and a scrip certificate also of a proxy, and the memorandum given by the secretaries that a share or shares on a given date were transferred from a certain name to another.

*St. Ann's, Newcastle-upon-Tyne.*

O. T.

#### APPENDIX.

##### No. 1.—London and Paris Railway.

John Doe, of the town and county of Newcastle-upon-Tyne, agent, in consideration of £100., paid by the said Richard Roe, do hereby bargain, sell, assign, and transfer to the said Richard Roe, ten shares, numbered 3270, 3269, &c., of and in the undertaking called The London and Paris Railway. To hold to the said Richard Roe, his executors, administrators, and assigns, subject to the same rules, orders, and restrictions, and on the same conditions that the same were held immediately before the execution hereof. And the said Richard Roe does hereby agree to take and accept of the said shares, subject to the same rules, orders, and restrictions, and conditions. Witness our hands and seals this twelfth day of June, in the year of our Lord one thousand eight hundred and forty three.

Signed, sealed and delivered (being first duly stamped) by the said John Doe, in the presence of \_\_\_\_\_ } John Doe.

Signed, sealed and delivered (being first duly stamped) by the said Richard Roe, in the presence of \_\_\_\_\_ } Richard Roe.

## No. 2.—The London and Paris Railway Company.

No. 14228.

These are to certify that John Doe is the proprietor of the share numbered 14228 of the London and Paris Railway Company, subject to the rules, regulations, and orders of the said company.

(Seal of company.) Given under the common seal of the said company, the twelfth day of June, in the year of our Lord one thousand eight hundred and forty three.  
Registered No. 665.

Secretary.

On the back—

Transferred to Richard Roe and registered.

Secretary.

## No. 3.—London and Paris Railway.

Scrip certificate. 10 shares.  
No. 841. No. 841.

The holder of this certificate will be entitled to ten shares of £50. each, upon the performance of the several conditions relating to the second and subsequent instalments contained in the resolutions of a special General Meeting of the proprietors of this company, held on Thursday, the 28th of April, 1842, a copy of which is at the back hereof.

London and Paris Railway Office,  
10, ——— Street, London,  
May, 1843.

Entered—John Doe, Accountant.

Richard Roe, Secretary.

## No. 4.

Memorandum.

London and Paris Railway Office,  
10, ——— Street, London,  
6th day of Feb. 1840.

Ten shares in this company, No. 3261 to 3270, were this day transferred from Mr. Richard Roe to Mr. John Doe.

For John Noakes, sen., Secretary.  
Thomas Styles.

## No. 5.

Form of Proxy.

I, ——— of ——— one of the proprietors of the London and Paris Railway Company, do hereby appoint ——— of ——— to be my proxy, in my name and in my absence to vote or give any assent or dissent, to any business, matter, or thing, relating to the said company, that shall be mentioned or proposed at any meeting of the proprietors of the said company, in such manner as the said ——— shall think proper, according to his opinion and judgement, for the benefit of the said company, or anything appertaining thereto.

In witness whereof I have hereunto set my hand the ——— day of ———

## A TRIP TO BOULOGNE AND BACK IN ONE DAY.

SOUTH-EASTERN RAILWAY.

Hitherto this railway has been open as far as Ashford only, but it is now completed up to Folkestone, to which point the public are now enabled to go. The company having purchased the harbour of Folkestone, one of their objects is to establish a steam communication direct from that port to Boulogne, in addition to that which, when the line is completed, will be effected from Dover to Calais. To demonstrate the ease with which this may be done, and at the same time to show the practicability of a trip from London to France and back in a day, an experimental journey was performed on Saturday the 24th ult, the result of which was perfectly satisfactory. At 6 o'clock a special train, containing the directors and their guests, started from the London-bridge station, which arrived at the Folkestone station, a distance of 81 miles from town, in two hours and 40 minutes, having stopped at five stations by the way, losing 10 minutes.

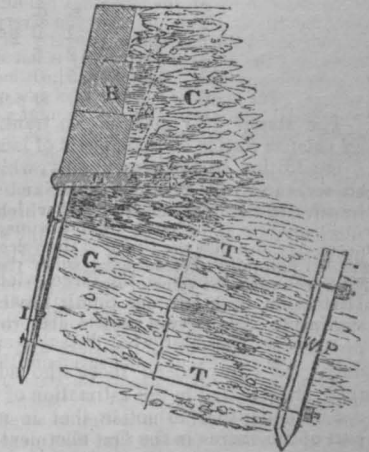
Mr. Wright, the resident engineer of the line from Folkestone to Dover, was in attendance on the arrival of the company, and conducted them to Folkestone harbour, when the "Water Witch" steamer was lying ready to receive them; the period of walking from the railway and embarking occupied 39 minutes. The vessel got under way at 40 minutes after 8 o'clock, and made the voyage across the channel in 3 hours and 6 minutes, and arrived at Boulogne at 25 minutes after 12; the company landed and presented to the mayor, who was in attendance to receive the company, with the *Times* of that morning, containing the debates in parliament of the previous night. After partaking of a splendid entertainment at Boulogne, and remaining at that place 2 hours and 13 minutes, the company returned on board the steamer, and landed again at Folkestone after a passage of 3 hours and 45 minutes, and with a loss of 45 minutes in landing, and walking again to the railway. The company left the station at Folkestone at 7 minutes after 7, and arrived at London-bridge at 6 minutes after 10, losing 15 minutes in 5 stoppages; thus, the whole journey to and fro, occupied 16 hours and 6 minutes; and deducting stoppages of 4 hours and 7 minutes, the time actually travelling was 12 hours within a minute. A saving in time of at least half-an-hour will be effected when the proposed branch is made to the harbour of Folkestone. With a fast-going steamer, the trip across might be performed upon an average, in about 2 hours-and-a-half, thus the journey direct from London-bridge to Boulogne, may be completed in 5 hours.

## MISCELLANEA.

**THE CARTOON EXHIBITION, WESTMINSTER HALL.**—We understand the designs sent in far exceed in merit the anticipation of the Commissioners, and those persons fully competent to judge. We are informed that they are to be opened for public exhibition, on Monday, July 3rd; during the first fortnight an admission of one shilling each person will be demanded, after that time it will be open free to the public, excepting on Saturdays, in the morning of that day it will be closed, and in the afternoon opened to the admission of those who will pay one shilling; the funds to be devoted for the promotion of the fine arts, as the commissioners may determine hereafter, according to the amount. We are sure that this arrangement will give the greatest satisfaction both to the competitors and the public.

**ROYAL SCHOOL OF DESIGN.**—Professor Dyce has resigned the office of director, and has been elected on the council. He is succeeded as director by Mr. Wilson, of Edinburgh, some of whose communications on art have appeared in our columns, and are sufficient to show that intimate knowledge and appreciation of art which Mr. Wilson possesses. A better appointment could scarcely be made.

**GREENWICH PIER.**—We abstained last month from giving any account of the failure of this pier, which took place on 16th of May last, as we had not then an opportunity of personally inspecting it, or of ascertaining its construction; we have since been favoured by our valuable correspondent, O.T. with the following observations, and sketch of the pier. He observes, "The failure of Greenwich pier is not a matter of surprise to parties who understand the practical construction of such works. The immediate cause of the failure was dredging in front of the piles after the contractors had left the works, and the arrangement of the piles being faulty, as regards construction; the upper part is composed of brickwork in cement (B), 18 feet high, and 14 inches thick at top, capped with granite 1 foot thick, backed with concrete (C), and standing upon a foundation of Yorkshire stone landings (L), laid on a small quantity of concrete, with a substratum of foul gravel (G). The landing in front rests on a row of cast iron piles (I. P.) 25 feet long, and 5 feet apart, grooved to admit between them three cast iron plates, each 6 feet in height, these iron piles were fastened by four, or two pair of wrought iron land ties (T) 2 inches square, to wooden piles (W. P.) 18 feet long, and 12 inches square, driven in land at a distance of 25½ ft. from the front, and 5 ft. apart." The high water mark is about 4 feet from the top, and low water mark 22 feet below, or about 7 feet below the stone landing. From enquiry, we rather suspect the lower ties, as shown in the sketch, were not fixed, nor do we see how they could be, as they are shown considerably below low water mark. The superincumbent weight of the brickwork appears to have forced out the upper part of the iron piles to a considerable distance, and caused the brickwork above to slip down, and force out the iron plate; but, it is very difficult to say, whether this is the real cause of the failure, for until the ruins are cleared away, nothing positive can be stated.



**SUNDERLAND.**—Several fissures are said to be apparent in the celebrated Victoria Bridge, over the Weir. The Sunderland Harbour Commission have abandoned the plan of Mr. Murray, for converting the harbour into a dock, but they have another plan of improvement which is not yet public.

**NEWCASTLE.**—The new church of St. Peter has been opened, Mr. John Dobson, Architect, and a Catholic cathedral, by Mr. Pugin, is now being roofed in, the style is early English; stone is used throughout in both these edifices, the tower has been left unfinished until further funds are obtained. Messrs. Green are architects for Lord Durham's monument, which is to be a Grecian Doric temple, and built on Panister Hill.

**WARKWORTH HARBOUR.**—The works are again commenced by the company, the contractor having made arrangements to surrender the works to the company.

**NEWCASTLE AND NORTH SHIELDS RAILWAY COMPANY** are excavating a cutting 50 feet deep for a road from the Station to the New Quay, with retaining walls, and a bridge to carry a road over it at a cost of about 7,000l.

**BIRMINGHAM AND DERBY RAILWAY.**—No arrangement is likely to be made in respect to the unfortunate differences with the Midland Counties Railway, upon terms fair to the shareholders of either company.

**MIDLAND COUNTIES RAILWAY.**—The Weir across the Trent, at the Soar Mouth, is being constructed, not of Ashler stone, but of timber piles and waling, and supported with inclines of Rubble stone above and below. The Weir of ashler has been rescinded by a late Act, on condition of the railway company maintaining it for ever; its cost is about 5,000l. The Trent company insist upon its being done this summer, in consequence of several boats having been sunk by coming in contact with Trent Bridge.

**HERTFORD AND WARE RAILWAY.**—The works are taken by Grissell and Peto, who have also taken extensive improvements of the Severn, in Gloucestershire, to the amount of 129,000l.

**NOTTINGHAM AND DERBY CANAL.**—The tonnage on this canal has much fallen off during last year. The Yorkshire route of rails taking the Hull, and some of the Boston and Lincoln goods over their lines to Manchester, and even grain and timber to Derby.

**MORPETH.**—A new church is to be built, and the Rev. Mr. Grey, a relative of Earl Grey, has subscribed 1,000*l.*, and nearly another thousand was lately of subscribers.

**NOTTINGHAM.**—St. Mary's church, tower unsafe, secured temporarily by Mr. Cottingham, architect, and Hawksley, architect, has been called in by the corporation; the columns are split vertically which support the tower, and temporary trussing is used to support them.

**ATHENS, May 12.**—A statue larger than life, and executed in the Egyptian style, has been found near Marathon, and is just brought to our museum. The figure has an iron disc in each hand. Some assert that it is a representation of Antinous: others consider it an Apollo.

**THE SPEAKING MACHINE.**—I have as yet seen no notice in your valuable periodical of an invention, which is, at present, attracting great attention here, and which certainly merits every praise that can be bestowed upon unwearyed perseverance and successful ingenuity. It is the *Sprachmaschine* or the Speaking Machine, not quite appropriately called Euphonia, of M. Faber, the result of a beautiful adaptation of mechanics to the laws of acoustics. You are aware that the attempts of Cagniard la Tour, Biot, Müller, Steinle, to produce articulate sounds, or even to imitate the human voice, have not been very successful; in fact, our knowledge of the physiology of the larynx and its appendages has been so limited, that we have not even an explanation of the mode in which the falsetto is produced. Mr. Faber's instrument solves the difficulties. I can only give you a very imperfect idea of the instrument. To understand the mechanism perfectly, it would be necessary to take it to pieces, and the dissection naturally is not shown the visitor—less from a wish to conceal anything, than from the time and labour necessary for such a purpose. The machine consists of a pair of bellows at present only worked by a pedal similar to that of an organ, of a caoutchouc imitation of the larynx, tongue, nostrils, and of a set of keys by which the springs are brought into action. [The further description would be unintelligible without diagrams.] The rapidity of utterance depends of course upon the rapidity with which the keys are played, and though my own attempts to make the instrument speak sounded rather ludicrous, M. Faber was most successful. There is no doubt that the machine may be much improved, and more especially that the *timbre* of the voice may be agreeably modified. The weather naturally affects the tension of the Indian rubber, and although M. Faber can raise the voice or depress it, and can lay a stress upon a particular syllable or a word, still one cannot avoid feeling that there is room for improvement. This is even more evident when the instrument is made to sing, but when we remember what difficulty many people have to regulate their own chordæ vocales, it is not surprising that M. Faber has not yet succeeded in giving us an instrumental Catalani or Lablache. Faber is a native of Freiburg, in the Grand Duchy of Baden—he was formerly attached to the Observatory at Vienna, but owing to an affection of the eyes, was obliged to retire upon a small pension; he then devoted himself to the study of anatomy, and now offers the results of his investigations and their application to mechanics, to the world of science.—(A Correspondent of the *Athenæum*.)

Hamburg, March 31.

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## LIST OF NEW PATENTS.

(From Messrs. Robertson's List.)

GRANTED IN ENGLAND FROM MAY 30, TO JUNE 21, 1843.

Six Months allowed for Enrolment, unless otherwise expressed.

William Newton, of Chancery-lane, civil engineer, for "improvements in obtaining copper from copper ores, some part or parts of which improvements are applicable to obtaining certain other metals contained in some copper ores." (A communication.)—Sealed May 30.

William Edward Newton, of Chancery-lane, C.E., for "improvements in the method or system of constructing boats and other vessels, which the inventor intends to denominate the "Mondotian system." (A communication.)—May 30.

John Tappan, of Fitzroy-square, Middlesex, gent., for "improvements in apparatus applicable to flues or chimneys, for the purpose of increasing the draft therein, and promoting the combustion of fuel." (A communication.)—May 30.

Thomas Forsyth, of Salford, Lancaster, engineer, for "improvements in machinery for making bricks and tiles."—June 1.

Pierre Frederic Ingold, of Buckingham-place, Hanover-square, watch-maker, for "improvements in machinery for making parts of watches and other time-keepers."—June 1.

Henry Fox Talbot, of Locock Abbey, Wilts, Esq., for "improvements in photography."—June 1.

Martyn Roberts, of Carmarthen, Esq., for "improvements in machinery for preparing, spinning, and winding wool, cotton, flax, silk, or any other fibrous bodies."—June 1.

Fennell Allman, of Salisbury-street, Strand, surveyor, for "improvements in apparatus for the production and diffusion of light."—June 3.

Junius Smith, of Fen-court, Fenchurch-street, London, gentleman, for "improvements in machinery for sawing wood."—June 3.

William Brown, of Glasgow, merchant, for "improvements in the manu-

facture of porcelain china, pottery, and earthenware, and which improvements are also in part applicable to the manufacture of paper, and to the preparation of certain pigments or painters' colours."—June 3.

Richard Farmer, upholster and cabinet-maker, and Joseph Pitt, plumber's brass-founder, both of Birmingham, for "improvements applicable to fixed and portable water-closets, and beds or bedsteads, a part or parts of which improvements are also applicable to raising and forcing water."—June 6.

Robert Smart, of the Commercial-road, Redcliff, Bristol, ship-owner, for "improvements in paddle-wheels."—June 8.

John Burns Smith, of Salford, Lancaster, cotton spinner, for "improvements in machinery for preparing, carding, roving, and spinning cotton, and other fibrous substances."—June 8.

Cartaret Prialx Dobree, of Putney, Surrey, civil engineer, for "improvements in the manufacture of fuel."—June 10.

Henry Page, of Cambridge, painter, for "improvements in the mode of painting, graining, or decorating with oil, and other colours."—June 10.

Henry Austin, of 87, Hatton-garden, civil engineer, for "a new method of gluing or cementing certain materials for building, and other purposes."—June 10.

Edward Joseph Francois Duclos de Boussois, of Clyne Wood Works, near Swansea, engineer, for "improvements in the manufacture of lead, tin, tungsten, copper, and zinc, from ores and slags, and other products, and in the manufacture of their alloys with other metals."—June 10.

Ernst Leutz, of Eastcheap, gentleman, for "improvements in machinery for raising and forcing water and other fluids, which machinery, when worked by steam or water, may be employed for driving machinery." (A communication.)—June 10.

Alfred Francis, of Vauxhall, Surrey, Roman cement manufacturer, and Isaac Funge, workman in the employ of the said Alfred Francis, for "improvements in the manufacture of ornamental tiles."—June 10.

Samuel John Knight, of Water-side Iron Works, Maidstone, Kent, founder, for "improvements in kilns or apparatus for drying hops, malt, and other substances."—June 10.

Thomas Wells Ingram, of Birmingham, engineer, for "improvements in pressing and embossing wood, and other materials, in order to apply the same to various useful purposes."—June 10.

Samuel Sparkes, of Wellington, Somerset, foreman at a woollen manufactory, for "certain improvements in machinery for carding wool, cotton, and other fibrous materials."—June 10.

John Tappan, of Fitzroy Square, gentleman, for "certain improvements in apparatus for grinding and polishing cutlery, and other articles, whereby the deleterious effects on the lungs and health of the workmen, produced by the dust and metallic particles arising from the said operations, are entirely, or to a great extent obviated."—June 10.

William Edward Newton, of Chancery-lane, civil engineer, for "the novel application of certain volatile liquids for the production of light, and improvements in the lamps and burners to be employed for the combustion of such or other volatile liquids."—(A communication.) June 10.

John Galley Hartley, of Narrow-street, Limehouse, mast and block maker, for "certain improvements in paving and covering streets, roads, or other ways."—June 13.

Frederick William Eggleston, of Derby, confectioner, for "certain improvements in the combustion of fuel and consumption of smoke."—June 15.

Henry Bessemer, of Baxter House, Saint Pancras, engineer, for "certain improvements in the manufacture of bronze, and other metallic powder."—June 15.

Prosper Antoine Payerne, of Paris, doctor of medicine, for "certain improvements in keeping the air in mines and other confined places in a pure and respirable state."—June 15.

Thomas Johnson Irvine, of Peckham, lieutenant in Her Majesty's navy, for "certain improvements in packing cases, boxes, trunks, portmanteaus, and other articles for containing goods, which improvements may, under certain circumstances, be applied to the preservation of life."—June 15.

George Lister, of Dursley, Gloucester, card-manufacturer, and Edward Budding, of the same place, machinist, for "certain improvements in the means of covering the cylinders of carding and scribbling engines with wire card, and in condensing the rovings delivered from such engines, and also an apparatus for sharpening or grinding the points of the cards, which latter apparatus may also be employed for grinding other articles."—June 15.

Edward Hammond Bentall, of Heybridge, Essex, iron founder, for "certain improvements in ploughs, and in apparatus which may be attached thereto, for ascertaining the draft of instruments employed in tilling land."—June 15.

George Bate, of Bloomsbury, Wolverhampton, Stafford, carpenter, for "improvements in apparatus for raising and lowering window blinds and maps."—June 15.

James Gardner, of Banbury, Oxford, ironmonger, for "improvements in cutting hay, straw, and other vegetable matters for the food of animals."—June 15.

Samuel Brown, of Gravel-lane, Southwark, engineer, for "improvements in the manufacture of casks and other vessels."—June 17.

James Mackenzie Bloxand, of Hampstead, esquire, for "improvements in meridian instruments."—June 20.

John Read, of Regent-street, machinist, for "certain improvements in ploughs for draining, subsoiling, and cultivating land."—June 21.