authors to the following tentative conclusions :—(1) The number 20″·445, proposed by Struve, is very near to the truth. It would be premature, in our opinion, to wish to modify it. (2) As M. Fizeau supposed, reflected rays behave in the same manner as direct rays from an aberration point of view. (3) The new method for the investigation of aberration may be regarded as proved and definite.

In a future communication the authors will give some details of the method, the observations made on four couples of stars, and the numerical value they find for the aberration constant.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON Thursday and Friday of last week, the spring meeting of the Institution of Mechanical Engineers was held in the theatre of the Institution of Civil Engineers, by permission of the Council of the latter Society, the President, Mr. Joseph Tomlinson, being in the chair. There were but two items in the programme—namely, the fourth Report of the Research Committee on Friction, and a paper on rock drills, contributed by Messrs. Carbutt and Davey. The meeting suffered a good deal, especially on the second evening, from the fact that the Institution of Naval Architects was in session at the same time. On both evenings very interesting papers on engineering subjects were being read before the latter Society, where the attraction appeared to be greater, for, whilst the Mechanical Engineers meeting was very thinly attended, the Naval Architects had, we hear, an overflowing house on both evenings. It is a pity the secretaries of two Societies having objects so nearly akin, cannot arrange for their meetings not to clash. There is this to be said in favour of the Naval Architects, however, that they were adhering to a time-honoured fixture.

FRICTION OF A PIVOT BEARING.

The Friction Committee's report was taken charge of by Mr. Beauchamp Tower, who was practically the author. The experiments were carried on last year at Simpson and Co.'s engine works, Pimlico, &c. The thanks of the Institution, and of the engineering world at large, are due to this firm for the assistance they have lent, and perhaps the name of Mr. Mair-Rumley should be especially mentioned in this connection.

The pivot bearing operated upon was 3 inches in diameter, and flat ended. The vertical shaft carrying the footstep was geared to a horizontal shaft, which was driven by a belt from the works shafting. Variations of speed were obtained by varying the size of pulley. The bearing was pressed upwards against the footstep by an oil press with a 6-inch diameter plunger. This plunger was made a good but perfectly free fit in its cylinder for a length of 9 inches, a number of grooves being turned in the cylinder throughout its whole length at close intervals. The pressure was applied by means of a small hand-pump, provided with an air-vessel, pumping oil out of a tank into the press. It was found that the leakage of the oil past the plunger, even with the highest pressures, was exceedingly slow, requiring only an occasional stroke of the pump to keep the pressure constant ; and at the same time the friction was practically *nil*. Into the top of the plunger was let a piece of hard steel, having a conical depression, wherein rested a hard steel conical centre, which was formed on the bottom of the plate L that carried the bearing. This plate was circular, and had a groove turned in its periphery ; a small chain was fastened to the plate and lay in the groove round a portion of the circumference, from whence it led off to a spring-balance attached to the fixed frame of the apparatus ; so that the rotation of the plate stretched the spring-balance, and the force tending to turn the plate was thereby indicated. The upper end of the vertical shaft that carried the footstep had a piston fixed on it, which revolved in a cylinder 6 inches diameter. This upper cylinder was connected by a pipe with the cylinder of the lower press, so that, whatever oil-pressure there was in the lower cylinder pressing the bearing upwards, there was the same in the upper cylinder pressing the footstep downwards. This was a convenient way of providing for taking the upward thrust upon the experimental bearing. The footstep having been set running at the desired speed, the hand pump was worked until the pressure gauge on the oil press indicated the desired pressure ; and the friction was then read off the spring balance connected with the bearing plate. The load could be quickly removed from the bearing by opening a cock for discharging the oil from the air-vessel of the pump. This method of applying the load was found to be exceedingly convenient. Efficient automatic means of lubrication were provided, which are well worth following, but which we have not space to describe. In the results the coefficient of friction was obtained by dividing the friction in inch-pounds by the product of the load multiplied by the area of the bearing.

The results of the experiments were given in the report by means of a table and in a graphic form. From these we extract the following outline particulars ; and must refer our readers to the report itself, which will be published in the Proceedings of the Institution, for fuller details upon this important and interesting subject.

Experiments on the Friction of a Pivot Bearing. Steel Footstep on Manganese Bronze Bearing.

Revolutions per min.	Load : lbs. per sq. in.	Oil drops per min.	Friction. Total.	Friction. Coefficient.
			In. lbs.	
50	20	20	2·77	0·0196
	120	56	18·72	0·0221
128	20	79	1·13	0·0080
	160	84	12·82	0·0113
194	20	196	1·44	0·0102
	160	168	7·69	0·0068
290	20	Continuous stream	2·51	0·0178
	140	,, ,,	4·51	0·0046
	160	200	5·03	0·0044
353	20	Continuous stream	2·36	0·0167
	160	,, ,,	6·15	0·0054

The friction given is that of one face of the flat circular bearing surfaces, at the effective radius of the face, viz. 1 inch.

A white metal bearing surface was next substituted for the manganese bronze. The coefficient of friction was a little larger, but the difference was so small that the results may be looked upon as practically identical.

That the coefficient of friction is less at the higher speeds is doubtless due to the more perfect action of the lubricating device. After the completion of these experiments, the endurance of the manganese bronze and white metal bearings were tested. The former heated and seized at 260 pounds per square inch load on one occasion, and 300 pounds on another, running at 128 revolutions per minute without lubrication. The white metal bearing heated and seized in a load of 240 pounds per square inch at 128 revolutions per minute, without lubrication.

These experiments should be studied with those on the same subject which have preceded them.[1] A short but interesting discussion followed the reading of the paper.

ROCK DRILLS.

The paper on rock drills does not call for an extended notice at our hands. It grew out of some trials made last year at the Crystal Palace, in connection with the Mining Exhibition there held.

One cannot help comparing the carefully thought-out trials last described with those now before us. The only point upon which we can commend those responsible for the present competition is that they awarded no prize. Perhaps one of the most difficult subjects to decide by competition would be the superiority of any one rock drill over its fellows, and the conditions of trial would require careful planning and elaborate preparation. We were not present at the trials, but, to judge by the description, they seem to have been organized by persons having a very elementary knowledge of the conditions under which these machines are called upon to work. One of the judges stated that his qualification to act arose from the fact that he had been in the steam-hammer business, and the

[1] For previous reports see Proceedings of the Institution, 1883, p. 632 ; 1885, p. 58 ; and 1888, p. 173.

blow of the rock drill is similar to that of the steam-hammer. *Ex pede Herculem!* It appeared, however, that the makers of the machines framed the conditions of trial, so that, presumably, every one concerned was satisfied.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE annual meeting of the Institution of Naval Architects was held last week, on Wednesday, Thursday, and Friday, at the rooms of the Society of Arts, lent by the latter Society for the purpose. The meeting in question was one of the most successful held for many years; the merit of the papers and the large attendance of members speaking volumes as to the flourishing state of this excellent Society. As there were just a dozen items in the programme, including the President's Address, it will be evident that we can do no more than mention some of the papers read.

The one fault we have had to find in the management of this Institution is that it gives us too many good things at once. It holds but one meeting a year, and that is divided into five sittings. In this way matters that would supply a whole season's programme for many kindred institutions have been crowded into the sole meeting of the year, which has to be rushed through in three days. We have dwelt on this subject before, and know for a fact that our remarks have met with the approval of a considerable number of members. We are glad, therefore, to learn that it is proposed in future to hold two meetings every year. If an effort is made by the Council to improve the quality of the discussions—which can only be done by giving them more time—rather than by adding to the number of papers, the new departure will, we feel sure, be additionally welcome.

The following is a list of the papers read and discussed:—1. "Future Policy of War-ship Building," by Lord Brassey. 2. "On some recent American War-ship Designs for the American Navy," by J. H. Biles. 3. "On Boiler Deposits," by Prof. Vivian B. Lewes. 4. "Study of Certain Phenomena of Compression," by M. Marchal. 5. "Boiler Construction suitable for withstanding the Strains of Forced Draught," by A. F. Yarrow. 6. "Recent Improvements in Armour for Vessels," by M. Barba, Chief Engineer of Schneider and Co., Creusot. 7. "On the Alteration in form of Steel Vessels due to Different Conditions of Loading," by Thomas Phillips. 8. "The Internal Stresses in Steel Plating," by J. A. Yates. 9. "Certain Details of Marine Engineering," by Thomas Mudd. 10. "On Combined Crank, Crank and Intermediate Shafts, for Marine Engines, and on their liability to Fracture," by C. H. Haswell. 11. "An Assistant Cylinder for Marine Engines," by David Joy. The President, Lord Ravensworth, occupied the chair throughout.

The two great features of the meeting were undoubtedly Mr. Yarrow's paper on boiler construction, and Lord Brassey's contribution on war-ship policy. The respective values attached to these memoirs naturally depended on the walk in life of those appraising them; the Admirals mustering in unusual force to hear Lord Brassey, whilst there was a tremendous gathering of engineers to listen to Mr. Yarrow; indeed, we have seldom seen the theatre in John Street more crowded than it was last Thursday. Each of these papers had an addendum, Lord Brassey's in Mr. Biles's contribution, and Mr. Yarrow's in Mr. Mudd's paper, which gave some very valuable practical additions to our knowledge of the science of boiler construction.

We have used the term "science of boiler construction" advisedly. Last week we should have hesitated to apply it, as being a subject almost non-existent. Steam engineers have woefully neglected the source of their power in time past. The engine has been like a favourite child, no trouble too great to expend upon it; but the boiler has been, figuratively speaking, left out in the cold. Such improvements as have been made in its construction have been due to inventive ability of the ingenious mechanic order. Hardly anyone has thought of treating the boiler philosophically; at least hardly any one before Mr. Yarrow. The boiler has had its revenge. It has been the uncertain factor, and, in marine engineering, the prime source of trouble. We wish we could give all the beautiful experiments by which Mr. Yarrow illustrated the reason of the ills to which boilers are subject when they are pressed to a high rate of duty. Everyone has heard of the difficulties that have arisen in our own and foreign navies from the endeavour to apply forced draught to war-vessels. The curious fact has remained that whilst time after time the larger vessels of the navy came back from abortive trials with boilers leaking at every tube, Mr. Yarrow could run the trials of his torpedo boats, having a high forced draught pressure, with almost unvarying success. The prime reason for all which was made apparent by the paper of Thursday evening last. It may be explained in a few words: Mr. Yarrow has treated his subject in the true spirit of scientific research. He has taken each difficulty as it arose, and investigated it to the bottom, dealing with material he had to use, and the method of construction, upon a basis of scientific reasoning. A good example of this was shown in the manner in which he explained the ovalling of tube plate holes, one of the most fruitful sources of trouble to those who run marine boilers with forced draught. Mr. Yarrow first gathered together all the known facts on the subject. He took the two metals of which tube plates are composed—namely, copper and steel—and tabulated their rates of expansion under various temperatures, and their ratio of conductivity of heat. By the facts so ascertained, and the analogy of a well-known blacksmith's operation—that of reducing the size of a tire by repeated heatings and coolings on one side only—he formulated certain hypotheses, which he proved by experiment to be well founded. His reasoning was clearly set out in his paper, and his experiments were successfully repeated before the meeting. The conclusions involve some interesting problems of molecular physics, and we regret we cannot give the matter the space it deserves; but a satisfactory explanation would involve the reproduction of Mr. Yarrow's diagrams and illustrations of his apparatus. We have dwelt somewhat at length on this paper, partly because it is likely to be of especial interest to our readers, but more especially because it affords a most welcome precedent which we hope many other principals of engineering factories will follow.

Turning to the other papers, we find them all at least of moderate merit, and many of them excellent. Mr. Phillips's contribution on the alteration in form of steel vessels was a praiseworthy effort to put an important branch of ship construction on a more satisfactory basis. From his exceptional position he was able to carry out a series of practical investigations as to the alteration of form of ships under certain conditions of stress, which are so far satisfactory that they go to prove the existing regulations in force on this subject are sufficient. The paper did not pass without criticism, and indeed gave rise to one of the best discussions of the meeting. The paper of Mr. Yates was a more philosophical effort on a cognate subject. A consideration of the internal stresses in steel plating due to water pressure involves some very debatable matter, and the author's mathematics did not pass without criticism. It is characteristic of the time that Mr. Bryan, whose admirable paper on the buckling of a thin steel plate will be remembered, journeyed up from Cambridge purposely to speak on this paper. His mathematical analysis of the subject will form a valuable page in the Transactions.

Prof. Lewes's paper on boiler deposits was eminently practical, and a most welcome addition to a too little studied subject. The Institution and the engineering world in general are fortunate in getting a competent chemist to turn his attention to these matters. M. M. Marchal's paper was taken as read. The paper by M. Barba was somewhat disappointing, and the discussion which followed it was decidedly "shoppy." The two remaining papers which were read, those of Mr. Mudd and Mr. Joy, were of a practical engineering interest; more especially Mr. Mudd's, which was full of instruction for working marine engineers. Mr. Haswell's contribution was not read.

SCIENTIFIC SERIALS.

American Journal of Science, March.—On gold-coloured allotropic silver, by Mr. M. Carey Lea. The present paper is in continuation of one published in this *Journal* in June 1889, and has for its object the description of the reactions of gold-coloured allotropic silver. It is shown that there exists a well characterized form of silver, intermediate between the allotropic silver previously described and ordinary silver, differing in a marked manner from both. All forms of energy act upon allotropic silver, converting it either into ordinary silver or into the inter-