

and animals, was given by Mr. Ernest Hart at one of the many meetings which have been held on the subject, when he mentioned that wax manufacture had been, during the last twenty years, successively driven further and further from the centre of London. Ten years ago it was possible to bleach wax in the sunlight at Shepherd's Bush, but the factory was now removed to near Richmond, as it was found that the bleaching power of the sun for the greater part of the year was almost nullified by the pall of smoke which hangs over the metropolis. We shall not speak to-day of the various appliances of which we have as yet had but a hasty view, but it is only fair to say that there are shown at the Exhibition a number of grates, some of which, such as the new "Everitt" grate shown by Messrs. Barnard, Bishop, and Barnard; Mr. Crane's grate, shown by Deane and Co.; and in some respects the "Excelsior" grate of Mr. Archibald Smith, mark distinct advance. The possibility of consuming the smoke of bituminous coal in ordinary grates by forcing the draught of air and smoke downward through the fire before it is allowed to escape has been shown, as has also the facility with which hard anthracite smokeless coal will burn in open grates without any sort of blower or other such contrivance. In addition to these there is an extremely interesting series of exhibits of mechanical stokers, fire-bars for furnaces, a new gas-kiln which will be shown in operation, as well as Dr. Siemens' gas-regenerator. Some extremely good household stoves and fire-places are sent from Germany and Canada.

#### DOUBLE-STARS

*Observations of Double-Stars, made at the United States Naval Observatory.* By Asaph Hall, Professor of Mathematics, United States Navy, and Rear-Admiral Rodgers, U.S.N., Superintendent. (Washington: Government Printing Office, 1881.)

WE welcome another addition to our knowledge of the positions and distances of double stars. Prof. Asaph Hall has published a volume containing 1614 observations of such stars made by him chiefly with the 26-inch refractor at the Naval Observatory at Washington. The objects of the observations are two. Firstly, the detection of constant errors of observations by the measurements of double-stars from a selected list, and comparing such measures with those of other observers made as nearly as possible simultaneously; and, secondly, the measurements of double-stars generally.

The list of stars adopted is that prepared by Otto Struve, with a few additions of stars of greater distance. There are 30 stars in all, and 296 complete sets of measures of these have been made, each set consisting of four measures of position and two double measures of distance, except in cases where the stars exceed 3" in distance, when four were taken. The measures appear to be made with care, and the discrepancies are not greater than may be expected from night to night.

In connection with this subject Prof. Hall has applied a geometrical test to such observations by means of measures of the multiple stars  $\approx 2703$  and  $\approx 311$  and the stars in the trapezium of Orion. He says:—

"In the case of three stars A, B, C, if we take the

origin of co-ordinates at A, and observe the angles of position and the distances of B and C only, then these quantities are independent, and we may put their differentials equal to zero. But if we observe also the angle of position and the distance between B and C we have obtained more quantities than the geometrical conditions require, and must adjust the parts of the triangle by the method of least squares."

In the case of the triangles and the quadrilateral there appear to be no important systematic errors.

Prof. Hall gives a detailed account of the use of "rough circles" for setting the instrument on a star. These circles are the edges of the ordinary setting circles divided by lines of black paint on a white ground so as to be read without trouble, a method already adopted in some observatories in this country. He also describes the difficulties he has had with the driving clock, difficulties which are too often experienced with driving clocks of all kinds, and often arising from insufficiency of power and strength of parts to stand varying strains, and often dust and damp, which ordinary clocks do not generally experience. The dome, which is 42 feet in diameter, now turns with more difficulty, and if our experience is worth anything, such a difficulty once commenced will keep on fast increasing, and will very materially militate against the continued use of the instrument beneath it. The flexure of the telescope, which is 31 feet in length, and of the mounting, is small, and the working of the instrument very satisfactory.

A filar micrometer has been used for all the observations, and great care has been taken to test its accuracy, which is all that can be desired; but we note that the wires are illuminated by a lamp held by an assistant, a method somewhat primitive, as Prof. Hall says, and a waste of energy which might, we should have thought, have been useful elsewhere.

In all the ordinary observations four measures of position and two double measures of distances have been taken, and in all cases the head of the observer was kept in an upright or natural position. Owing to this we shall expect to find, on comparison of the list of test stars with others, a considerable error depending on the position of the stars with the horizon. No doubt practice has a great deal to do with it, but we have generally understood that the observations were more accurate and differed less *inter se* when made with line joining the eyes parallel to that joining the stars under observation.

Prof. Hall has included a good many very close stars, and it is to them that the large telescope can be most profitably turned, leaving the wider ones for the small instruments, with which they are well able to deal.

#### OUR BOOK SHELF

*Zoological Atlas (including Comparative Anatomy), with Practical Directions and Explanatory Text for the Use of Students.* Invertebrata. By D. M'Alpine. 249 Coloured Figures and Diagrams. (Edinburgh and London: W. and A. K. Johnston, 1881.)

THIS Atlas is prefaced by the following remarks:—"In treating of the Invertebrata I have thought it advisable to depart slightly from the plan followed with the Vertebrata. There are five great divisions of Vertebrates recognised by naturalists, and a type or so of each was found to answer the purpose in view; but among Invertebrates the range of structure is immensely greater, and