THE LOAN COLLECTION OF SCIENTIFIC APPARATUS.

VERY different in principle is the idea on which the present collection at South Kensington Museum has been formed, from that of our past "International Exhibitions," whether of 1851, 1862, or the special collections of recent years displayed in the galleries connected with the Albert Hall.

On all previous occasions the Exhibitions have been of an industrial character, as well as "international," and the great or well-known commercial houses have been looked to, to provide the intellectual feast. Again, it was found absolutely necessary, to insure a proper display from abroad, that each country should have space devoted to its special exhibit, though it would have been very desirable that all things of the same kind should have been grouped together, from whatever place they came, not only for the sake of comparison of designs and workmanship by ordinary visitors, but for facilitating the labours of the jurors, and placing them in a better position for arriving at just judgments under very delicate circumstances, where national rivalry was concerned.*

The present Exhibition, though of a strictly international character, ignores special space for each country, and blends the contributions of many lands into one general series, systematically classified, and includes not only the highly-finished exhibits of manufacturers, but the instruments and apparatus of scientific investigators, often roughly made with their own hands, the collections of celebrated scientific schools, and objects of historic interest from public museums and private cabinets, sacred relics of early and recent observers and experimentalists. It is this new element that will prove of the greatest interest to the general public, who will note the rough tools with which the earliest investigators groped their way to unearth the facts of nature, and the rough but ready self-made contrivances by which such men of recent days as Faraday and Graham, guided by inductive reasoning, wormed out the truths of science. To any scientific visitor who had personal acquaintance with these men, such relics are painful mementoes of faces once beaming with intellectual excitement, of active brains and ready fingers now stilled in death—sadder still, the remembrance of the last years of Faraday (universally loved for his sweet simplicity, unpretentiousness, and kindliness of character), when the failing powers of life had dimmed the far-seeing mind, that had made the greatest physical discoveries of his age, or paved the way for new roads of investigation.

As soon as the object and scope of the proposed Exhibition was made known, the idea was readily responded to at home and abroad. The Governments of the Continental Powers, and of the United States, appointed committees of their most eminent *savans* to encourage and facilitate this great international undertaking. The result of this co-operation is manifest in the extent of the "Special Loan Collection of Scientific Apparatus," opened by Her Majesty in person, in May last; it having been found necessary to apply to the Commissioners of the Exhibition of 1851, for the use of the Western Galleries of the International Exhibition buildings, available space at the South Kensington Museum being insufficient.

In Gallery A, Section 19, we enter upon Educational Appliances, and here meet with the collections of well-known manufacturing houses, as well as those of the mechanical illustrations used at our School of Mines, of the projection by lantern of physical experiments used by Professor Landolt, of the physical properties of steam by Dr. Bleekrode, of the measuring, mechanical, and physical illustrations of the Prussian Mining Department at Breslau, and last, though not by any means least, as to universality and perfection of illustration, of the Russian "Minister of War Pedagogic Museum."

Specially noticeable in the Russian Pedagogical Series are the Geographical, Ethnological (Heiser's), and Natural History (Strembitsky's) Models, on a convenient scale for class illustration, and embracing the most important types. Next come Galleries B and C, Section 12, Applied Mechanics, containing amongst the "prime movers" such objects of general and popular interest as the earliest forms of the steam engine, and embodying the development of that great implement of civilisation, from the crude ideas of Desagulier and Savary, Watt, Newcomen, Trevithick, to the engine of Henry Bell's steamboat *Comet*, of 1812, "Puffing Billy," and Stephenson's "Rocket" locomotive of 1829, down to the latest refinements of the present day. Near at hand may be noted the first hydraulic press of Bramah, made in 1795, and a series of models of various "linkworks," contrived by Peaucellier and others, for effecting parallel motions, which of late have greatly interested mathematicians. Here is to be seen Newsham's fire engine, made in 1721, the first that produced a continuous and uniform stream of water with great force, a contrivance employed in all fire engines of the present day, even in those worked by steam power. Sir Isambard Brunel's machine for winding cotton into balls illustrates how great inventive powers may be directed to *apparently* insignificant ends, but by this machine the employment of cotton for sewing became universal after 1802.

The bar lathe of James Watt is a relic of interest, for by its aid many of the models (to be seen close by) for working out his improvements in the steam engine must have been made. Next we meet with an extensive series of models illustrative of naval architecture and marine engineering, including Froude's models, made in hard paraffin, for determining the resistance of the ships they represent, and one of the electric cable ship, *Faraday*. Here may be traced the development of armour-plated ships of war, those expensive necessities of our peaceful (?) times.

* These difficulties I have discussed in detail, in *Cassell's Technical Educator*, under the heading of "International Exhibitions."

Very interesting are the Trinity House models of lighthouses erecting or erected, under great difficulties, off the coast of Ceylon, &c., and the series of ancient and modern lighthouse reflectors, and prismatic lanterns, those made by Messrs. Stevenson being the most optically perfect—in one form, all the light from the lamp being collected into a beam of parallel rays solely by means of glass, whilst another form is remarkable as embodying every kind of dioptric apparatus.

Passing through Mr. Frank Buckland's Piscicultural Museum, we come to Gallery F, Section 9, devoted to Magnetism and Electricity. First must be noted several antique natural magnets, and the greatest yet known, from the Teyler Museum at Haarlem, a locality celebrated, in connection with Messrs. Logeman and Van Wetterer, for the manufacture of the most powerful artificial magnets, single and compound, or, as they are termed in the latter instance, "magnetic batteries." Here may be seen Saxton's magneto-electric machine of 1833, and Faraday's collection of glass tubes, containing various gases and liquids, crystals, spheres, cubes, and bars of various metals, minerals, vegetable and animal substances, with the simple cradles and supports he constructed for freely suspending these specimens in "the magnetic field" of a powerful electro-magnet, on discovering that while "magnetic" bodies were attracted or took a straight linear direction between the two poles, other substances, which he termed "dia-magnetic," were repulsed, and took a position across the field at a right angle to the magnetic direction; also prisms of "Faraday's Heavy Glass," or borate of lead glass, used in his experiments on the action of magnets upon polarised light. Close at hand will be found Chinese and other obsolete forms of the mariner's compass, together with those actually employed by the Admiralty; also ancient and modern magnetic dip circles, and other appliances for important observations on terrestrial magnetism, both on sea and land, including the self-registering instruments of Kew Observatory, &c.

Next we enter upon Section 10, devoted to Electricity, where we find primitive and old-fashioned forms of the electrical machine, side by side with those of its more recent development, wherein carefully selected ebonite (or vulcanite) takes the place of the fragile glass plates formerly employed.

Gallery G introduces us to objects pertaining to Section 1, Arithmetic, such as slide rules, estimators, calculators for facilitating arithmetical problems of all kinds; which include Babbage's machine, an instrument that cost our Government about £17,000, and is still incomplete.

Here also may be seen specimens of "Napier's Bows," an obsolete arrangement for performing division and multiplication, invented by the originator of logarithms; and Sir William Thomson's recently invented tide-calculating machine, which will mechanically solve, in an hour or so, what hitherto has required not less than twenty-four hours' computation by skilled arithmeticians.

In Section 2, Geometry, we find an extensive series of "mathematical instruments" required for geometrical drawing, and for reducing or enlarging drawings with precision, wherein may be noted Colonel Peaucillier's compound compass, and the results of Perigal's compound geometric chuck.

Galleries H and K are devoted to Section 3, Measurement, wherein may be noted the collection of standard weights and measures, contributed by the Standard Department of the Board of Trade, and the instruments of precision employed for comparing other instruments with the standards. The refined workmanship in the delicate chemical balances of Oertling and certain foreign makers, is worth the attention of every knowledge-seeking visitor. Next come measures of Velocity, such as ship logs, chronoscopes, and chronographs; measures of Force, such as pressure gauges; measures of Work; measures of Angles; measures of Time, such as clocks, watches, chronometers, electric clocks, ancient sun-dials, and horological contrivances of great interest.

Section 4—Kinematics, Statics, and Dynamics—presents an interesting and valuable series of instruments illustrating the mechanical powers, gyroscopic motions, wave motions, and includes Prof. Reuleaux's magnificent collection of nearly 300 kinematic models.

Gallery L, the last on the ground floor, is devoted to Section 11, Astronomy. First we would direct attention to the antiquities of astronomical science, such as the collection of astrolabes, including one made in 1525, and another used by Sir Francis Drake; the quadrants of Tycho Brahe, and of Napier of Merchiston; the fractured object-glass and telescope of Galileo; the telescope of Torricelli, and other early Italian observers; the telescope made by Huygens; the Equatorial telescope made by Abraham Sharpe (the friend and assistant of Flamsteed the astronomer), when twenty-five years of age; and another belonging to Dr. Wollaston; the reflecting telescopes and specula of Sir William Herschel and Earl Rosse; the orreries of Huygens and others. Then to such triumphs of modern skill as Grubb's great Melbourne reflector of forty-eight inches diameter, and his great Vienna refractor of twenty-seven inches aperture; the application of photography to the spectroscope, and other physical appliances to the extension of astronomical observation and registration. The complete Transit of Venus equipment as used by the English expedition will afford a very good notion of the requirements of astronomical research at the present day, while many of the photographs and drawings upon the walls give an insight into the results of work.

Ascending to the upper floor, we come upon Gallery M, devoted to Section 15, Geography. The surveying instruments of the Ordnance Survey, of the Survey of India, and of the Hydrographic Department of the Admiralty command attention, especially the photographs of the magnificent series of instruments designed by Lieut.-Col. Strange for the new great trigonometrical survey of India, also the sounding implements employed by H.M. ships in deep sea explorations. In the Geographical Society's collection the instruments used by Livingstone and Cameron in Africa are to be seen.

Section 16, Geology and Mining, presents us with examples of the great work of the Geographical Survey of Great Britain, a series illustrative of the rise and progress of the art of geological surveying, commencing with William Smith's first large geological map of England, published in 1813. In the collection of mining implements, the series of Davy safety lamps will probably be the objects of most interest to the general visitor.

In Section 17, Mineralogy and Crystallography, Plattner's blowpipe, Haüy's, Leeson's, and Mitcherlich's goniometers are of interest as the working tools of their inventors, while Victor von Lang's (as exhibited by Prof. Maskelyne) may be regarded as the most perfect form of the modern reflecting goniometer, as Groth's may be taken for investigating the optical characters of crystal. The wire models of axe systems, and models in wood, &c., of endless modifications, for crystallographic studies, are interesting to the general visitor, as illustrative of the geometry of nature.

Gallery N is devoted to Section 18, Biology—a term of recent days to indicate the branch of science which investigates that "mystery of mysteries"—life, whether vegetable or animal. Here we find a grand collection of microscopes, simple, compound, and binocular, many of the instruments being of great historical interest, such as those of Janssen of 1590, of Leeuwenhoek and Musschenbroek of about 1680—1726, of Benjamin Martin of about 1740. Varied are the appliances displayed in this section for the ends of physiological research, but which have interest for the medical rather than the unprofessional visitor. Amongst the appliances for lecture purposes may be noted the series of preparations of fruits from Kew Museum, the gigantic models of typical plants by Brendel of Berlin, the College of Surgeons' method of articulating entire skeletons so that the surface of the bones at any section can be examined; and lastly, Prof. Huxley's method (as adopted in his lecture room at the new "Science Schools," South Kensington), as shown in the skeleton of a dog, whereby any bone can be removed and compared with the corresponding bone in the skeleton of another animal similarly mounted—undoubtedly the best system for facilitating the practical study of osteology of any yet suggested.

Passing through the Conference Room, where descriptions of objects in the Loan Collection or lectures thereon are given at stated times, we enter gallery P, devoted to Section 13, Chemistry. Here the objects of historical interest are the apparatus made and employed by Dalton; the balances used by Cavendish, Young, Davy, and Black; Faraday's apparatus for the condensation and liquification of gases, and the specimens prepared thereby—supplemental to which is the apparatus designed and employed by Dr. Andrews in his recent researches on the solid, liquid, vaporous, and gaseous states of matter; "Nobilis Metallochrome"—Graham's apparatus, noticeable for its simplicity. It is interesting to note how the air-gas furnaces on the principle better known as "Bunsen's Burner," but in reality worked out by Dr. Beale, and employed by the present writer over twenty-five years ago, have replaced the early cumbrous iron furnaces with fire-clay linings; as well they might, considering their compactness and power of regulating the temperature, or extent of surface over which the heat is to be spread. Another novel laboratory appliance to be observed is Sprengel's water vacuum pump, for the exhaustion of gas tubes, &c. Far too numerous are the varied forms of chemical apparatus, models, diagrams, plans for laboratories, manufactories, rare or interesting specimens of chemical products, &c., to admit of further notice in our limited space.

Passing into Gallery Q, we come upon the domain of Light, Heat, Sound, and Molecular Physics. We here find sources of light, lenses of all forms, magic lanterns, oxy-hydrogen and electric light, lanterns for demonstrating lectures on history, natural history, astronomy, physical laws, in conjunction with photographic lantern-slides and suitable apparatus; camera obscuras, spectroscopes for analysing chemical substances in the laboratory, or the atmospheres of far-distant planets—in connection with which should be noticed the magnificent specimens of optical glass, prisms, objectives, &c., by Steinheil of Munich, and Laurent of Paris; polariscopes, photometers, and that wonder of the day, "Crooke's Radiometer," respecting the motive power of which arrangement "doctors disagree;" apparatus for illustrating or studying the laws of reflection, refraction, and diffraction; fluorescent fluids; and lastly, illustrations of photographic apparatus and processes.

In Section 8 we come upon sources of Heat: delicate thermometers—one recently invented by John Williams, with a *millegrade* scale, being of great value to the chemist and physicist—calorimeters, and freezing machines; out of which Melloni's apparatus for investigating the laws of radiant heat, and the Florence Institute collection of objects of historic interest, may be selected for special attention.

Section 6 introduces us to sources of Sound, which includes "singing flames," "chemical harmonica," "sirens," which give out sounds "most musical, most melancholy;" and whistles with notes so shrill as to be beyond the ordinary limits of human hearing, though detectable by many of the lower animals; tuning-fork arrangements for producing the beautiful acoustic figures of Lissajous; and numerous appliances of interest to the physical experimenter on the phenomena of sound; while objects of more general interest will be found in the ancient musical instruments (fully described in Carl Engel's South Kensington Handbook), and Bosanquet's enharmonic harmonium, which was played before Her Majesty, by Dr. Stone, at the opening of the present Exhibition.

Lastly, we come upon Section 5, devoted to Molecular Physics, which includes hydrometers, air-pumps, and other pneumatic appliances, gas-condensing apparatus, &c.; the objects of historic interest being Otto von Guericke's air-pump, his celebrated "Magdeburg Hemispheres," and book on Vacua, published in 1672, and Thilonier's original apparatus for liquifying carbonic acid—by which he lost his life.

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