REPORTS

ON THE

PARIS UNIVERSAL EXHIBITION, 1867.

VOL. IV.

CONTAINING REPORTS ON

RAILWAY APPARATUS.

The Reports on the Paris Exhibition will be printed in Six Volumes.

Volume I. will contain the General Report, with Tables of Statistics, &c.; Volumes II., III., IV., V. will contain the Reports on the various Classes; and Volume VI. the Returns relative to the New Order of Reward.

Presented to both Houses of Parliament by Command of [illegible]

LONDON:
PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.
FOR HER MAJESTY'S STATIONERY OFFICE.

20406. 1868.

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HEATING AND LIGHTING.
WAR MATERIALS AND MILITARY BUILDINGS AND EQUIPMENT.
MINING.
MACHINERY AND PROCESSES OF MANUFACTURE.
RAILWAY APPARATUS.
TELEGRAPHY.
CIVIL ENGINEERING.
NAVIGATION AND LIGHTHOUSES.

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INTRODUCTION.

THE following Reports on the various Classes in the Paris Exhibition, 1867, were prepared for the Science and Art Department in accordance with the directions of the Lords of the Committee of Council on Education, and must not be confounded with the International Jury Reports to be issued by the French Government, which are quite distinct.

The scope and object of these Reports will be gathered from the following extracts from the letter to the gentlemen who were requested to prepare them, and who in many cases were not connected with the International Jury:—

"The Lord President of the Council, following the precedent of the Paris Exhibition of 1855, is desirous of obtaining a series of Reports on the objects exhibited in the Paris Exhibition of this year. . . ."

"The special object of this Report is to direct the attention of British visitors, manufacturers, and others, to the useful novelties exhibited by various nations on the present occasion, to which it appears desirable their attention should be called. It is not intended to be an exhaustive Report upon the Class, which it is presumed will be made by the International Juries for the Imperial Commission. The British Report should have special reference to the objects exhibited by the British Colonies and by Foreign Countries, rather than those exhibited by the United Kingdom, although the latter should not be overlooked."

"It is desirable that the Report should be as short as may be consistent with the nature of the subject, and it is absolutely necessary that it should be published during the Exhibition. It will therefore be indispensable that if the Report be undertaken by you, the manuscript should be delivered before the 15th of June at latest, and as much earlier as may be possible, to Captain Donnelly, R.E., the Secretary to the British Juries, who will afford all neces-

sary information in Paris, and will act as Editor to the Reports."

"It is probable that the Exhibition will be sufficiently arranged to enable an examination of the Class to be commenced about the 15th April."

With the view of rendering these Reports useful to the public while the Exhibition lasted it was determined to publish them in a newspaper as quickly as possible. Arrangements having been made with the manager of the *Illustrated London News*, who undertook to produce them free of all cost to the Science and Art Department with a certain amount of illustration, the publication commenced on the 6th July 1867, and continued till the 7th December. By that time about two-thirds of the Reports had been published. These have been revised by the authors, and with the unpublished ones are complete in these volumes.

In arranging the Reports the order of the French classification has not been implicitly followed. The amount of matter rendering the division into four volumes desirable, those Reports were brought together in each volume which appeared most allied to one another, an arrangement dictated as much by what seemed likely to be to the convenience of purchasers of single volumes as by any idea of a scientific classification.

Report on Apparatus and Processes used in Paper Making, Dyeing, and Painting.—(Class 59.)—By Captain Fred. Beaumont, R.E.

General remarks.

This class is defined by the French regulations as follows:—

Apparatus for printing paperhangings and tissues; machines for engraving; cylinders for printing.

Apparatus for bleaching, and dyeing, and for the preparation of paper and tissues; apparatus for making paper by hand and by machinery; apparatus for embossing, ruling, glazing, and watering paper; machines for cutting out, paring, stamping paper, &c.

Materials, apparatus, and products of typefounding, stereotypes, &c.; machines and apparatus used in typography, stereotyping, copper-plate printing, lithography, authography, chaleography, paniconography, chromolithography, &c.

Printing of postage-stamps.

Machines for setting up and sorting types.

The object of the report which I am now writing is to serve as a guide to such of the English public as may take an interest in class 59, and it is not intended to be a scientific criticism on paper machinery; had such a report been required I should have felt myself incompetent to the task of preparing it. The visitor to the Paris Exhibition of 1867 will have found himself much puzzled in his attempt to study any particular class of machinery, both by reason of inaccuracies in the catalogue, and from the difficulty of finding readily the objects sought for, many of the exhibits having been placed out of the machinery gallery and in the various annexes in the park.

A considerable portion of the French class 59 was in a separate building, which had been established near Messrs. Schneiders' (the Creuzot) exhibition, opposite to the French agricultural gallery. A part of the Belgian exhibition, too, was in their annexe, on the west side of the grand avenue, leading from the Ecole Militaire to the main building.

It is somewhat difficult in writing a report of this nature to draw the line between a mere superficial glance and so much detail as to render it generally uninteresting. I propose to give such a description of the exhibits I have to notice as shall be intelligible to an ordinary inquirer having the subject

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matter in his mind; and I hope, farther, to be able to make my explanations by themselves tolerably clear to those who have some technical knowledge, or, at any rate, sufficiently so to give a general idea of the object alluded to.

I thought at first of attempting to classify the different sorts of machinery together of the various countries; it seemed, however, on consideration, that such an arrangement could not be very readily made, and I shall therefore go straight through the catalogue, taking up those of the exhibits as may be worth noticing in their numerical order, commencing with the French.

Before proceeding to a description of the machinery it may be of assistance to some to give a few general remarks on papermaking machinery and printing-presses. Speaking of the former, there does not appear lately to have been any very notable advance made; nor, indeed, has the system altered, except in some mechanical details, since the introduction of machinery to supersede hand labour, now some sixty years ago.

Paper making.

The manufacture of paper divides itself into two operations —first, the preparation of the pulp from which paper is made; and, secondly, the formation of that pulp into paper.

The pulp is produced originally from rags, or ropes, and old paper, which are dealt with us as follows: The matter is first sorted and dusted, then cut up; afterwards boiled in a boiler under a varying pressure of steam up to as high as 80 lb. on the square inch, broken up and reduced to half-stuff, and then bleached, usually either by chlorine gas or by steep bleaching with chloride of lime; after which it is passed through a rag-engine, the effect of which is to destroy the original character of the material, either as rags or rope, and to reduce it to its elementary fibre in the form of pulp, which is then ready to pass into the hands of the papermaker.

As rags and rope are expensive, it is a desideratum either to find a cheaper substitute or to supplement them by mixing with them more or less off an inferior material. It is difficult to find a pulp made from other matter which can equal in the quality of its fibre that prepared from rag pulp, without which essential desideratum the paper would possess no tenacity. Many substances have been proposed for the above purpose with more or less success, amongst which may be mentioned wood, straw, and some of the foreign grasses, which latter, from their long stringy nature, are more suited than those grown in England. Straw pulp has been extensively employed for the production of a medium description of paper, much used by railway and other companies. There are also some samples of paper in the Exhibition made from wood pulp

only; but hitherto the use of this substance alone has been exceptional. It can, however, be mixed in certain proportions with rag pulp for the manufacture of good paper, and its value under these circumstances is entirely regulated by its cost of production

When the pulp, properly prepared, and of the consistency of soup, comes to the paper-machine proper, it is dealt with as follows:—It is first passed through strainers to remove all knots and impurities, and, being mixed with a sufficient quantity of water, it is delivered in a regular stream on to a travelling wove wire, which, by abstracting the water, gradually causes it to assume the consistency of paper. The water first drips from the pulp, but to assist it the wire is carried over several vacuum boxes, or boxes where a partial vacuum is kept up; after which it leaves the wire and passes on to a felt with which it is pressed between rollers, whence it is taken round drying-cylinders warmed with steam. These cylinders gradually absorb all moisture, and eventually deliver the paper between glazing-rollers, where it is glazed by pressure, and issues ready to be cut up to the size required.

Printing.

There is a very fair collection of printing-presses shown, especially by the French, though, with one exception, there is little novelty of design, the principal differences being in matters of detail.

A printing-press has simply to ensure a sufficient amount of pressure between the type and the paper, to provide that the former be properly inked after each impression, and that the latter can be regularly delivered and taken away. There would appear to be about one rate of speed at which it is found practicable that the paper shall be brought in contact with the type; and after this speed is reached a multiplication of the delivery is made by increasing the number of sets of type employed—or, in other words, making more printing-machines, which can be done by adding to the number of cylinders or by grouping more sets of type round a single larger one. For newspapers, which require a very large number of impressions in a short time, the rate of speed to be got from a single printing-machine is found to be inadequate.

In all the machines exhibited it will be seen generally that the old method of inking the type is preserved—viz., by regulating the flow of ink on to the inking-table by means of a doctor, its equable spreading by rollers, and its transfer, through the medium of other rollers, to the type. There are three descriptions of printing-presses, viz.:—1st, those more or less resembling the hand press, where the pressure is brought to bear directly by means of screws or levers in connection with the type-table; 2nd, those where a cylinder is

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employed to press the paper on the type, the latter being moved horizontally under the former; and, 3rd, those in which, the type being fixed around one cylinder, the paper is passed betwteen it and a second; the two cylinders rolling against each other, with the paper between them. The latter system has much the advantage in point of speed; but it necessitates printing from stereotype blocks, as otherwise there would be peculiar difficulties in fixing the type to the circumference of a cylinder in motion. I believe an attempt has been made to get over the difficulty arising from the centrifugal force developed by the revolving cylinder, by fixing the type internally, but, so far as I know, without practical success.

France.

Felts and wires.

There are a considerable number of felts shown, all of good quality, but hardly so strong as those made in England; and, though the prices may be somewhat lower, there is not more than a proportionate difference.

The wires are also well made, and will bear a close inspection. Some of them are made with double warp; but this is no novelty, and in what the particular advantage of the arrangement consists it is somewhat difficult to see.

I shall now proceed to notice such exhibits as may present specialties, in their numerical order, according to the French catalogue.

Letang (14) shows a very well-made machine for stamping railway tickets. The general arrangements are somewhat similar to the presses made by M. Lecoq (described hereafter). The numbering apparatus is of the ordinary kind. The price of the press is 2,500f. complete.

Bordes (18) exhibits a printing-cylinder for printing continuous sheets of postage-stamps, by which an economy in cost of 75 per cent. is stated to be obtained over the method of printing ordinarily used. The cylinder has been prepared from a single stamp, which is made by hand to impress its figure, *in relief*, on the copper cylinder; the laborious process of engraving is therefore reduced to a minimum, while the surface which receives the engraving is, as a cylinder, the most convenient for rapid printing. The apparatus requires to be worked from a special press, which, though not exhibited, has been made.

Coblence (19) is one of the earliest persons who applied practically the system of electrotyping. He now shows a good sample, on a large scale, of the process, which may be briefly described as follows:—1st, the engraving is made on wood; 2nd, a cast is taken in some plastic material (M.

Coblence uses gutta-percha); 3rd, copper is deposited by the electrotype process on the cast, which copper becomes a facsimile of the original wood engraving, and which, from its durability, permits of a larger number of impressions, and those of a better and sharper outline, being taken than could be done from the original wood engraving.

Lecoq's stamping and numbering presses.

Lecoq (20) exhibits some well-made presses for stamping and numbering railway tickets and for stamping coupons; indeed, his presses can be adapted to any purposes in connection with stamping, printing, or embossing that may be required. As the arrangement and workmanship of Messrs. Lecoq's presses are unsurpassed by any in the Exhibition, I shall describe them somewhat in detail. The ticket-press will be seen to consist of—1st, a vertical motion, which is taken from a crank on the driving-shaft, and which effects the stamping; 2nd, of an extremely neat self-acting gear for presenting the tickets to the stamp; and, 3rd, of the inking apparatus. The inking is effected by three rollers: the first takes the ink from the pad and places it on a small inking-table, the second spreads it, and a third takes it from the table to the type. This arrangement ensures regularity in the inking.

The rotation numbering is given in a way which will be seen to be common to most presses of this description—viz., by having a series of wheels side by side and whose peripheries are stamped with figures, a self-acting motion causes the first or unit wheel to move regularly forward a step for each stroke of the press, the unit wheel picks up the ten wheel every tenth stroke, and the ten wheel picks up the hundred wheel every tenth of its strokes corresponding to a hundred of the unit wheel. The machine shown can number up to 10,000, it can stamp tickets at the rate of 8,000 or 10,000 per hour, and its price is 3,500f.

M. Lecoq shows also an ingenious machine for putting railway-tickets up in bundles; as also a stamp for paper which varies the pattern by a combination of embossing and printing in colour, which is effected as follows:—The die is made in two pieces, the central portion being withdrawn while the outside is being inked, und replaced before the impression is made; it results that the outside is stamped in colour and the centre of the pattern embossed dry.

Meyer and Co. (21) show a method of fixing rag-engine knives which is novel. The blades are embedded in a matrix of soft metal, which can be cut away as they wear or require sharpening. Blades have before been somewhat similarly fixed by being bolted up between pieces or plates of zinc or brass; the more usual plan, however, is to form the knives

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with bevel edges on their lower parts and then bolt them directly together. It may have been noticed that amongst the exhibits of Messrs. Meyer there is in one instance a peculiarity in the angle at which the knives are set.

Poirier's match-box making machine.

Poirier (24), amongst several well-made presses for various purposes, shows a machine which, though for a small object is well worthy of attention. It is an evidence of how much mechanical ingenuity may do towards lightening human labour when once it is clearly known what is required.

A lucifer match-box is both a simple and cheap thing to make by hand: but as matches are sold in small quantities, and at a very low price, the value of the box plays a certain not unimportant part in the price of the article. By this machine of M. Poirer the boxes are actually stamped complete at the rate of some 2,800 per hour. The action of the machine is as follows:—A rectangular piece of cardboard, of the required form, is taken, with the corners rounded off. This is pressed by a die into an oblong hole, giving it at once a box shape. The corners of the cardboard are not in any way cut, and it is not clear at first to see what becomes of the superabundunt stuff at the angles; the angles are, however, doubled upon the sides, and a sort of cold weld produced by sheer pressure. The machine is fed by hand, but it could easily be made automatic.

There is also a machine for making envelopes shown which is worth attention.

Ducommun (31) has a machine for printing a continuous roll of material, in six colours. The stuff is passed round a central cylinder, about which are grouped impression-cylinders, corresponding to the number of colours to be printed, each roller being provided with a separate inking apparatus. For rough work this method answers well enough, but the colours cannot be so truly laid on as not occasionally to overlap each other.

Gaiffe's electrical engraving machine.

Messrs. Gaiffe (32) exhibit a machine for engraving by electricity, which, though not absolutely new, has been perfected since Messrs. Gaiffe made their first attempt in 1852. There are now some eight machines at work in Manchester for engraving printing-cylinders. The way in which the machine does its work, and the advantages the system appears to possess, are such as to make it one of the most interesting objects in class 59.

A design having been drawn in prepared ink, on a copper-plate, the machine reproduces it engraved on copper, either on the same or a reduced scale, and by multiplying the engraving apparatus any number of copies may be obtained from one labour of copying. The principle of the machine

is as follows:—A dumb tracer is passed over every portion of the original, and, by mechanism to be described hereafter, causes a diamond point to act on the copper-plate on which the engraving is to be produced every time that the said tracer passes over a line of the copy, producing thereby indentations in the copper corresponding with the original. Both the original and the plate have slow synchronous rotary motions, while the dumb tracer and the diamond point have horizontal motions over the surfaces of their respective plates. The diamond is carried by the armature of an electro-magnet, which, while the current is passing, keeps the cutter clear of the plate; but on being released a spring acts and puts the cutter in action. Now, the dumb tracer, the copper-plate of the original, and the electro-magnet form part of an electric circuit; hence, when the first is in contact with the second or, when no engraving has to be done, the electro-magnet keeps the diamond from the plate; and on the circuit being broken, owing to the ink of the original forming a non-conducting medium, the spring reacts and allows the diamond to cut. As the dumb tracer passes in a spiral over the surface of the plate, resulting from the combined motions of the tracer and the plate, it follows that the lines of the copy are not real lines, but a series of dots, which are so close together as to produce the same effect as whole lines. The only continued line that could be traced is a spiral corresponding to the track of the tracer, when this latter, travelling always on the ink, the electric circuit would be kept broken, and a corresponding spiral produced on the copy. By varying the the pitch of the screws carrying the diamond points the copies may be produced on any scale. In the machine exhibited there are several diamonds moving at various rates of speed, and, by a simple engaging apparatus, they may all at will take their motions from each or either of the screws. It will be seen that any number of copies may be taken at one operation if the apparatus be suitably arranged, and that without skilled labour. A second machine is exhibited with the plate laid horizontally. It is shown copying and reducing a military reconnoissance. During the Italian war M. Gaiffe was employed to reproduce the plans of the engineer officers on a smaller scale for the use of the Etat Major.

By drawing on tinned paper the original sketch may be used, the tin taking the place of the copper-plate as a conductor. But M. Gaiffe stated to me that he was able, by certain means which he did not wish to make public, to take any ordinary ink drawing and transfer it to a copper-plate in such a way as to permit of its being directly engraved

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from. Assuming that the above can be done, the sketches made by the engineers sent into camp over night might be engraved to the desired scale and any number of copies struck off by next morning.

When a large engraving has to be copied, with a view to saving time, two or more diamonds may be employed, each commanding a certain section of work and all working together. The system offers great facilities for economically copying to the same or different scales, and it permits the work of an artist to be reproduced on copper without the necessity of an engraver. The electricity is furnished by a Daniell's battery of three elements.

Each engraving, after it has left the machine, requires to be deepened by acid in the usual way.

A complete apparatus, suitable for a full-sized engraving and furnished with three diamond-cutters, costs 6,000f.

Godchaux's continuous printing-machine.

Messrs. Rebourg (33) show an ordinary well-constructed printing-press, to which is attached a simple and effective apparatus, by Messrs. Tournier (34), for ruling such lines as are required in account-books. It consists of a roller having the required lines raised upon it, and which is kept in contact with the paper before it reaches the ordinary type. The arrangement admits of lines being ruled in two colours —one in black, by the type, and the other red, by the roller. There is practically a difficulty in setting up lines in the type-box at right angles and crossing each other nicely, which is got over by the above system.

Godchaux (37) shows a machine for printing on both sides, a continuous roll of paper; it is exhibited printing the leaves of copy books. The machine consists of four cylinders, each pair printing one side of the paper; the paper is taken so distance above the cylinders before it is allowed to come fro the first to the second, for the purpose of allowing time for the ink to dry. The process can be aided if need be by artificial heat. The copper cylinders on which the characters are engraved revolve with their lower edges in the ink. A steel blade, to which a lateral motion is given, scrapes off all superfluous ink. There is a cutting-machine attached, which cuts the roll of paper up into proper lengths. This cutter consists of a single blade fixed in a revolving drum, on which are also fastened a series of vanes, the object of which is to keep a current of air playing on the paper, and so cause it to press against the fixed blades, ensuring a clean cut.

Varrall, Elwall, and Poulot (39), who have large workshops in Paris, and who make excellent machines, show, in class 59, one or two machines, which are all well turned out. A casting for a rag-engine, from a hand-made mould, is

worth noticing as an evidence of perfection in th at sorof work.

A machine is also shown, on the design of Messrs. Orioli and Henry, which has for its object to completely reduce any knots or other impurities, that they pretend, under certain circumstances, are inseparable from the pulp if the rag-engine alone be used. It consists of a small horizontal mill, with two bronze discs acting after the fashion of millstones, each one furnished with knives, similar to a rag-engine. The lower disc is kept revolving at some 300 or 400 turns per minute. As an amount of centrifugal force is given to the water and pulp, the apparatus may be put in any convenient position with respect to the paper-machine, since, if below it, the mill will itself deliver at a moderate difference of level. The apparatus may be said to be a varied form of Stuart's pulp-engine, subsequently described.

Messrs. Tulpin (40) exhibit, in the main building, a self-acting valve for regulating and reducing a pressure of steam. It consists of a diaphragm of india-rubber, which acts on a spindle in connexion with a throttle-valve in the supply-pipe, so arranged that when the pressure acting on the diaphragm exceeds a given amount it cuts off the supply. Any sticking, however, of the apparatus would permit an undue accumulation of pressure.

In the annexe in the park Messrs. Tulpin show three machines worthy of notice—one for washing skeins of cotton, which, being hung on rollers, are swung about in a trough of water. The rollers have the following movements:—1st, a lateral motion through the water; 2nd, a rotatory motion; 3rd, a slightly vertical motion. The above arrangement ensures all parts of the fabric being thoroughly acted on.

A well-arranged boiler, heated by steam, should be looked at, which has a very simple and effective system of stirrers attached to it.

Lastly, there is an apparatus for drying cloths which differs from the cylinders ordinarily in use by being of much larger diameter. The machine consists of a large wheel, the spokes of which carry the steam to the periphery, which is made of a pair of concentric plates, and forms the drying surface. This arrangement permits of any size of wheel and any pressure of steam being used, since the plates can readily be stayed as required. The cloth is carried by a set of sharp hooks attached to an endless iron chain passing round the cylinder, one set of hooks being fixed, and the other capable of lateral adjustment according to the widths of the cloths. The distances apart of the chains can be regulated while the machine is in motion by a sort of umbrella movement. The

Tulpin's drying cylinder.

diameter of the wheel shown is four metres. It has a speed at its circumference of 600 metres per hour, and is furnished with steam at a pressure of three to five atmospheres (45 lb. to 75 lb. on the square inch).

The wheel is made in pieces, so as to be readily transported; and its cost is 7,500f.

Kocher and Houssiaux (41) show a lithographic press which differs from others in that the lithographic stone is cylindrical, in place of being flat. The greatest rate of speed are obtained from cylindrical printing-machines; and Messrs. Kocher and Houssiaux wish to take advantage of the principle for lithographic printing. The machine has been worked, but cannot as yet be said to have passed the experimental stage.

Brisset (49) has a well made ordinary lithographic press, which, when I saw it, was using two colours shaded together on a stone, which produced a very pretty effect in colouring a printed ink-sketch.

Blanchard and Desban (50) exhibit a pentograph which engraves, and, if need be, reduces at the same time, an original design, the latter being passed over by a dumb tracer. This machine does by hand what Messrs. Gaiffe's apparatus does automatically.

Messrs. Boildieu (51) show a complete exhibition of printers' tools: the house is noted as having especially devoted themselves to this branch of business.

Lapeyre (54) shows lithographic stones, and a method of joining broken ones, which he avers is so strong that the stone is thereby rendered practically as good as ever, thus recovering the loss which is incurred when a large stone is broken. The mended stones which are shown look well done; but their value is dependent on their strength, which I had no means of ascertaining.

Moulde and Wibart's double colour printing-press.

Moulde and Wibart (55) offer a press for printing in different colours. As there are several presses for the above purposes shown by different exhibitors, it may be well to describe in a few lines the two methods of producing double-coloured impressions; the first is, by having a separate inking and printing arrangement for each colour, the paper being passed as many times under the press as there are colours; thus, if a chessboard pattern had to be produced, all the black squares would be printed by one set of type, and all the red ones by another; were the border required of a third colour, there would be no difficulty in forming it in the same manner. It is obvious that this method necessitates a very exact register—that is, that each colour should come up exactly to the edge of its neighbour, and not overlap. This is effected

by care in the arrangement of the type, and providing that the position of the paper shall remain absolutely the same during the whole operation. But with all care, it is very difficult in this manner to produce quite perfect impressions.

There is no example in the Exhibition of the other method of printing in different colours; but printing-presses on this principle have been made for many years by Messrs. Bryan Donkin, of London, who have supplied them to banks for printing bank-notes, the difference of colour presenting a great obstacle to the notes being forged. By Messrs. Bryan Donkin's method the type is divided into as many portions as there are colours, one portion falling away from the rest, each is inked separately of the required colour, and, the type being rejoined, the impression is taken at one operation. By this method all difficulties in connexion with the register are avoided; but no press has yet been made to print in more than two colours.

Messrs. Moulde and Wibart have arranged the printing cylinder between two sets of type, each provided with their separate inking apparatus of the colours required, the impression-cylinder passes over either set of type once, the paper receiving at each operation that part of the impression belonging to the particular colour, and the two together making up the complete print. The press is well made, and an arrngement has been introduced by which all shock to the machinery is avoided at each change of motion, and the moving parts are brought steadily to rest.

Marinoni's lithographic and typographic press.

Marinoni(56) exhibits a press which may be used at pleasure for lithographic or typographic printing. There would appear to be no reason why a press should not be used for both purposes, provided arrangements are made to enable the printing-table to receive either the type-box or the lithographic stones, which are of different thicknesses. This is effected by supporting the press table on screws which admit of vertical adjustment. The reciprocating movement is given to the table by means of a crank, and its movement is kept synchronous with the periphery of the impression roll by the two being geared together by teeth on the roll which take into a rack on the table; the return of the latter is effected without moving the former as a blank is left in the teeth of the roll at the end of its course, a self-acting motion being given to the table to enable the rack to retake in gear on commencing a fresh stroke.

Frédureau and Chavannes' paper cutting and folding machine.

Frédureau and Chavannes (63) show a machine for hand labour in folding and cutting sheets of paper. The details are carefully and mechanically worked out, and the precision with which the machine does its work is remarkable. Without

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a drawing it is impossible to explain properly this machine, but its action is as follows:—A sheet of paper having been presented, it is cut in two; each part is then passed through a narrow slit-like opening, and, a knife being brought against it, it is cut again, and again passed through openings which cause it to be folded. The paper is guided in its course by being held between endless tapes, which are carried round rollers. The tapes may, in fact, be said to take charge of the sheet of paper, and, where a cut is required, to present it to the action of a knife, and, where a fold, to a slit-like opening in a metal plate, a blunt knife forcing it through the latter. The cutting-knives are made serrated, so as to give a drawing cut through the motion of each point in the blade is, while cutting, nearly at right angles to the paper.

It is easy to see that the above principles may be applied to any material requiring folding, but a great deal of ingenuity is needed to make the movements work well together.

Various printing presses by Messrs. Perreau, Gaveaux, and Dutartre.

Perreau and Co. (65) exhibit a press which they state can print 1,200 leaves per hour on both sides. It has two cylinders, and can print from a carte-de-visite up to a sheet of paper 1m. 15c. long by 80c. broad; it is especially adapted for the production of illustrated books where accuracy is required, as great care has been taken to ensure a perfect similarity of motion between the type-table and the outside of the cylinders. The general arrangement of this press is of the ordinary kind; the reciprocating movement is given to the table by a pinion-wheel working alternately above and below a rack attached to the former, somewhat after the fashion in which mangles are often worked. As this action necessitates the pinion working on an axle having a universal joint, it follows that an inequality of motion would arise, were it not that a modification in the shape of the teeth of the pinion has been made which ingeniously neutralises the irregularity, and thus permits of this form of motion being used, which has some advantages on the score of simplicity and compactness.

The beautiful edition of the Bible published by Messrs. Mame et Fils has been printed by this machine.

M. Gaveaux (66) exhibits a printing-press for journals which is the only striking novelty in presses shown. The special object M. Gaveaux has in view is to reduce the size of his machine. The length of a press must depend on the size of the sheet to be printed, as the whole of the type must pass clear of the impression cylinder. With a view of reducing this dimension, M. Gaveaux has given a motion to the cylinders as well as to the table in opposite directions,

hence the travel of the latter is diminished by one-half. To judge from appearances, an amount of complication results from this arrangement, which would hardly be balanced by any question of gain of space or weight of machine alone, and I am not aware that it is anticipated that the system will present particular advantages in point of speed.

This press has not yet been practically tested, though it is in working order, having had blank sheets of paper passed through it; possibly it may be at work ere these pages are published.

Alouzet (67) shows further examples of what the industry of France can produce in the shape of well-made presses.

Messrs. Dutartre (69) are remarkable for the mechanical excellence of the presses shown and the care taken in their design. Messrs. Dutartre claim that their presses are made with sufficient accuracy to permit of the impression being passed more than once under the printing cylinder, a proceeding which renders an incomplete impression impossible. A double-colour machine is also shown, which is in principle the same as others previously described, the impression-cylinder being in the centre, and having on each side of it a type-table and inking-rollers for each colour, and which together, having at separate operations transferred their impression to the paper, complete the operation. For each impression two revolutions of the impression-cylinder are necessary, one corresponding to each colour.

The exhibitors from 72 to 81 show a variety of felts and inks, all of which are good, and some of them, no doubt, of a very high degree of excellence.

Dry ink printing press for cards, by Leboyer.

M. Leboyer (82) shows a novel arrangement for printing, which, under certain circumstances, presents advantages. The object effected is to print without ink, or rather with dry ink. The card to be printed is pressed on to the type dry, but having between it and the type a ribbon, which is imbued with the colouring matter—black, red, or green, as may be required—the nature of which is such that it only comes off under pressure. Hence it is transferred to the card at no other point except where it touches the types, which are set up in the usual manner. By successively using different-coloured ribbons ornamental business or invitation cards may be produced. The press is well made, and has a self-acting arrangement by which the cards, which are put into a hopper, are struck out one by one, passed under the stamp, and delivered complete. The advantage of the system appears to be that it simplifies the machinery of the press, as it does away with the inking apparatus, substituting a simple endless band, while, furthermore, the mess and dirt of wet ink is

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avoided. The machine costs 800f., and will print 5,000 cards per hour.

Flamm's typographic compositor, composing direct on the matrix.

M. Flamm (86) exhibits a typographic compositor, or matrix printing-machine, the intention of which is to obviate the necessity of setting up type for the stereotype process.

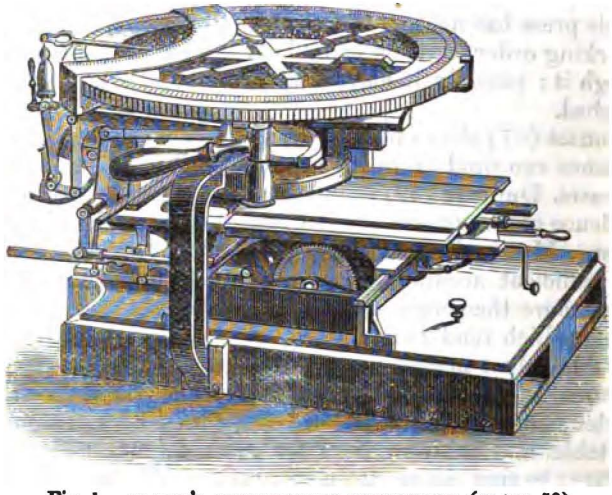

Fig. 1.—FLAMM'S TYPOGRAPHIC COMPOSITOR (CLASS 59).

As previously stated, in printing only a certain speed of cylinder can be used, hence the number of impressions is limited which can in a certain time be taken from one set of types; where more than this number are required, as in the case of a journal having a large circulation, they could only be obtained by using other cylinders, which would necessitate the provision of more types, involving also the tedious and expensive operation of setting them up. To avoid this the stereotype process is resorted to, which consists in using the original type as a model from which blocks of stereotype can be cast. An impression having been made in some soft matrix, the metal is poured in, and a facsimile of the original produced, which is printed from in the ordinary manner. Any number of stereotype blocks can be cast from one set of types when once they are set up. The object of M. Flamm is to do away with the preparation of the type by hand preparatory to the above process, and to impress the characters by machinery on the soft matrix, which becomes at once the mould in which the stereotype is cast.

In a large printing establishment it is necessary, at considerable expense, to provide a great quantity of type, which requires frequent renewal, as from use it wears out. To recast a fount of type is a somewhat costly operation; further-

more, after the type has been used it requires, before it can be again available, to be distributed—involving a farther expenditure of labour. It will be noticed that by the matrix compositor the types are only employed to produce impressions on the matrix; hence they are rather stamps than types, and can therefore have such care bestowed on their manufacture as to make them last a long time, working on to the soft matrix, with which only they are brought in contact. With the compositor, therefore, no founts of type are necessary; moreover, the labour of composing by the machine is less irksome than in the ordinary manner.

The cost of the machine is 1,500f., and six have been up to the present time made, all of which are stated by the inventor to have given satisfaction. It seems that there have hitherto been legal difficulties in the way of introducing this machine into France, as it would interfere with certain printers' privileges.

As regards the speed at which the machine can be worked, Mr. Flamm states that from 1,200 to 1,500 characters per hour may be printed, which is the most that an experienced compositor can effect.

With a slight exception, the effect obtained by this and Mr. Sweet's machine is the same; a description of the latter will be given when I come to the American section. The dates of the two patents are—Messrs. Flamm, June 1864; Mr. Sweet, November 1866.

The former gentleman's machine consists of a horizontal wheel, on the axis of which is a second one, this latter carrying a series of movable types, which on being struck down, leave their impression on the matrix beneath them. When the type-wheel has been put in the proper position it rests with the machine to cause the type to be depressed and replaced, and to advance the matrix the distance necessary for it to receive another impression.

The upper wheel is notched at its edge, each indent agreeing with a letter of the alphabet engraved alongside. This wheel is turned by hand until the required letter is opposite to a fixed point which ensures the corresponding type in the type-wheel below being over the requisite spot in the matrix. A movement is then given by a hand lever, which causes the following effects to be produced:—1st, it locks the upper wheel; 2nd, causes a hammer to descend on the proper type and make an impression; and, 3rd, causes the form carrying the matrix to advance a distance corresponding to a letter.

If the upper wheel be not adjusted exactly the locking action cannot take place; thus the attendant is warned that

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something is wrong. The form carrying the matrix is very similar to the slide-rest of a lathe, where the horizontal motion is in connection with the hand lever above described, and the movement at right angles, corresponding to the width apart of the lines, is given independently by hand.

The first of these motions is capable of variation at will, by means of a small lever, so that the printer using the same type can vary the distances apart of his letters, thus facilitating the justification of his lines. This is a movement which is wanting in the American machine.

To compose, therefore, three motions are necessary:—

1st, the adjustment of the big wheel; 2nd, a movement of the side lever affecting the printing and the advance of the matrix; 3rd, at the end of each line the revolution of a handle which causes the whole form to advance a distance equal to that which the lines are apart.

It is the first operation that, as the machine is now arranged, must consume some time which possibly might be avoided.

The apparatus may be used for lithographic as well as stereographic purposes.

M. Flamm has not divulged the way in which he prepares his matrix, but while soft and at the same time firm, it admits of being rapidly hardened by heat, so that the metal may be poured on it in some 20 minutes after it has left the machine.

Attached to the form is a table carrying a piece of paper, on which, at each action of the stamp, a pricker descends and makes a mark, the object of which is to enable the printer to have constantly before his eyes the position in which his work stands.

A commission, which was appointed, in 1866, by the French Government, to inquire into the merits of this invention, thus sum up and conclude their report:—"The "typographic compositor of Messrs. Flamm is likely to "render good service. 1st, to lithographers, for general "press-work; 2nd, to large administrative offices; 3rd, to "public companies; 4th, to armies during a campaign. "Nor does it withal menace the handicraft of the ordinary "typographic workmen."

With this latter opinion, though it may be correct as far the machine exhibited goes, I differ, as if the system is good, it is essentially of value in doing away with the skilled labour ordinarily required for setting up type.

Derriey's bank-note numbering machine.

Derriey (87) has a very good exhibition of presses for printing and numbering railway and other tickets, which are well designed and arranged; they embrace, however, only

well-known mechanical movements, and present no peculiarity of arrangement. M. Derriey exhibits besides them a machine for numbering bank-notes, which is worth very close attention. The object of the machine is simple enough; the difficulty consists in handling auomatically so thin and flimsy a thing as a bank-note; moreover, any mistake in the working of the machine might be productive of serious consequences.

The apparatus is fitted on to a flat metal table, and consists of two parts: first the stamping arrangement; and, second, the means for presenting the notes successively to its action.

The first part is simply a press, having no specialty, and consisting of the usual stamping and inking arrangemenst, the stamp itself being numerical, and similar to those described in a former part of this report.

The second part is as follows:—The notes are placed in a receiver, sunk below the level of the table, and at a certain distance therefrom is a second receiver, into which they have eventually to be transferred, between the two being the stamp.

A form slides from one hopper to the other, having cut in it a hole corresponding to but smaller than the bank-notes. Round the edge of this hole is a longitudinal slit, passing only half way through the metal, and in communication with an air-pump worked by the machine serving to keep a partial vacuum in the slit. On the hole in the form being brought over the hopper the vacuum attracts the uppermost note, which is thereby securely held. A blast of air playing for the moment against the edges of the notes in the hopper ensures only one being taken at a time. Having thus caught the note, the form moves under the stamp, when the impression is given, and a second motion takes the note to its destination, when, the vacuum being replaced by a puff of air, the note is released and falls into its place. It will be noticed that the notes in the two hoppers require to be always under a given pressure, and so placed that the position of the upper levels of the two bundles is the same. An ingenious self-acting arrangement effects this, and counteracts the irregularity that would otherwise arise as the notes are gradually withdrawn from one hopper stamped and transferred to the other. The price of the machine is 12,500f.; but though it is well made, and works, no doubt, very efficiently, the above sum would appear high; still, it should be borne in mind that the number of machines that can be required is small.

Mathieu (87 bis), Trouillet (88), exhibit small presses and stamps with mechanical numbering apparatus. Both makers

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effect nearly the same object by means of neatly-constructed and efficient little stamps resembling those which, in one shape or another, are now to be found in general use in large offices. The numerical stamp can be arranged so as to print consecutive numbers, to print always the same number, or to print the same number two or three times before passing on to the next. The prices of these apparatus vary from 20f. to 200f., the cheap ones not being self-inking. A very good serviceable stamp for general purposes may be had for about 70f.

Stuart's pulp reducer.

Montgolfier (108) shows an American machine, which is the invention of a Mr. Stuart, for further grinding up or reducing pulp for paper-making, of whatever material it may be composed. This machine is in a building in the park, nearly opposite to the Rue de Normandie of the main building. It has been employed in America, but has not as yet come into any very extended operations in Europe. The mill consists of a vertical revolving disc, which is faced or serrated with knives; this disc is placed between two others, which are stationary. The stuff to be ground enters at a central opening in one of the stationary discs and passes out by a similar hole in the opposite one. The knives are ordinary steel blades, much the same as those of a rag-engine, and set in a soft matrix, after the manner of the fastening shown by Meyer (21). The stuff to be ground is mixed with water in a reservoir above the mill, and thence allowed to flow between the stones. It would appear that the functions of this apparatus are very similar to those of an ordinary rag-engine, and the advantages of employing it would turn on the first cost of the apparatus and the power necessary to drive it. The machine did not often work, and it was somewhat difficult to get full information; a small portable engine, of apparently six-horse power, was attached for the purpose of setting it in motion.

Machine for copying medals, by Delos.

Delos.—This exhibitor is not in the catalogue of class 59; but, nevertheless, belongs to it, and has been judged by the same jury. The exhibit will be found not far from the exhibition of hatmaking. The machine is for copying medals or other objects of a similar nature on copper in such wise that the copper-plate may be printed from, and the principle on which it works is, so far as I know, original. A dumb tracer passes over the medal to be copied, and a cutting point of diamond is put in such relationship with it that the vertical elevations af the original give equivalent horizontal motions to the diamond, a sort of shading effect is thereby produced which forms the copy. Were a plain surface only to be copied the result would be a series of simple parallel

lines; any raising of the surface producing a figure would result in corresponding bends in the lines (still on the same horizontal plane) of the copy. There is an arrangement by which the scale of the copy can be altered, and the manipulation is evidently irrespective of skilled labour. The samples of work done that were shown me were not artistic, but they were curious; and, moreover, I was informed that they should not be considered as fair evidence of what the machine was capable of doing.

This completes my notice of the French section of class 59. It will, I think, be generally allowed that, while no striking novelty has been brought out, the display is a very good one, and proves that, so far as regards printing and paper machinery, the French are keeping up to the times. They have displayed great ingenuity in the arrangement of some of their smaller machines, as for instance, MM. Poirier's machine for folding envelopes, the stamps of Messrs. Mathieu and Messrs. Trouillet, or the machine by Messrs. Fredureau and Chavannes for folding and cutting the leaves of books.

BELGIUM.

Belgium.

Passing over Algeria and the Pays-Bas, who exhibit nothing in class 59, Belgium is the next country that is reached. There are eleven exhibitors in the catalogue, of which two have failed to appear. The Belgian machinery, generally, has been considered as on a par with that of France, and the two together offer the best examples of what the workshops of the Continent can turn out. The price of labour in Belgium is low, which makes her a very formidable industrial opponent; at the same time that very lowness in the value of handicraft is of itself a bar to the progress of manufactures in the country, as it stands in the way of the introduction of machinery, and, consequently, of improvement. The Belgian exhibition, in class 59, is not so large as might have been expected, more especially as some of the Belgian makers have a good name for their paper-machines. However, the only complete paper-machine shown in the whole Exhibition is a Belgian exhibit.

Continuous paper machine by Dautrebands and Thiry.

Dautrebande and Thiry (1).—This machine is well constructed, but presents no very striking peculiarities; the pulp is received on an ascending and descending strainer—that is, the perforated metal plate or sieve used for separating all knots and impurities from the pulp is made in two halves with a division separating them, and the holes in each are cut the reverse way to one another, so that the pulp must pass twice through the strainer before being delivered to the machine. The shaking motion is given by means of a cam

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at one end of the strainer, which arrangement causes the amount of movement to diminish from a maximum above the cam to *nil* at the point where the pulp is delivered on to the wires.

The top couche roll is furnished with a brush doctor in place of a piece of felt, which is the ordinary arrangement. The brush has given to it a reciprocating motion to ensure its efficient action. The steam for the drying-cylinders is brought by pipes both in and out of the same end, an arrangement which would hardly appear so good as to take it out at the opposite end of the cylinder to that at which it was introduced. The whole of the driving gear is situated at one side of the machine, leaving the other free for the circulation of the attendants.

The felts which accompany the roll of paper in its passage round the drying-cylinders are kept in their proper positions by self-acting gear, the mode of action of which will be readily understood. It consists of making one end of the rolls carrying the felt and paper moveable, its bearing being connected with a screw; attached to the end of the roll is an eccentric pin which gives a vertical motion to a couple of pawls working into a double-faced ratchet, and according as one or the other side of the ratchet is in gear so the screw is moved backwards or forwards; the pawls are, by means of a lever, acted on directly by the edges of the felt.

This arrangement is not new, nor is it in all cases considered necessary, as a certain amount of superintendence cannot be dispensed with, and such attention as is necessary to keep the felts running properly is within what the attendant can well give. Under certain circumstances, it is questionable whether a point may not be reached beyond which it is undesirable to make a machine entirely automatic, as by so doing the attendant is relieved from all necessity of attention, though nothing in point of economy is gained thereby, since his presence cannot be dispensed with. For the above reason I am inclined to think that all automatic arrangements for feeding steam boilers are in principle wrong, since it is impossible to make them in such wise that it is absolutely certain that they should never fail to act.

After the paper has left the drying-cylinders, it is received between rollers, whence it passes to the cutting engine, which cuts it in two ways, horizontally and transversely. There is a single stop-cock which shuts off the steam from all the drying-cylinders, and each of the pressing-rolls is furnished with a conical friction-clutch, so that it can be at once thrown out of gear.

The price of the machine, as it stands in the Exhibition, is

55,000f.; but, as certain parts have been got up for show, a machine in every way as good for work can be made for 51,750f., packed ready for delivery in the maker's yard. The exhibited machine cannot, however, be said to be complete, as it would need several accessories before it could be set to work.

Type-composing and distributing machines, by Delcambre.

Delcambre (2).—There is no work which it is more desirable to reduce in cost than that connected with printing, since it is the universal and almost the sole agent for propagating knowledge; hence all reasonable proposals for reducing the labour in connection with typography deserve especial study. That branch of work in a printing establishment connected with the manipulation of the type is of a peculiarly distressing and wearisome nature, necessitating constant attention both of the mind and body. The machines exhibited by M. Delcambre have been designed with a view to lessening the work of composition and redistribution of the type after it has served its purpose in the printing press.

The first machine is for composing. The ordinary method is for a workman to have before him a box containing in different compartments all the type he requires; thence he selects and arranges them by hand into words and sentences. It is this selection and setting up which M. Delcambre proposes to effect by his machine. The letters and various symbols used in printing are contained in reservoirs consisting of long slits, which are closed at the bottom by a sort of valve or lever, which on being actuated permits of one, and only one type to fall out. The valves are each in relation with the keys of a keyboard similar to that of a piano, each note of which would correspond with a letter. Thus, on pressing down any one key, the action would permit a corresponding type to fall out of its reservoir. The connection between the keys and the valves is by means of a very simple system of levers, which, in the event of anything going wrong, can be readily readjusted, since they are open to view. Under these circumstances the compositor has only to read the sentence he wishes to compose, and, touching the keys, the letters and blanks he requires will fall out of their reservoir in the order in which the keys are struck. It remains to arrange for their being formed in the composing-box. To this end the types are received on a series of inclined planes, all ending in one channel; and the lengths of these planes are so arranged by suitable curves that the time necessary for a type to traverse each one is the same; hence the letters arrive in the single channel in the order which the keys are struck.

At the end of the channel each type falls over and takes its place in the sentence. To ensure its doing this, a small

lever keeps up a constant light vibrating motion acting on the head of the type, and rendering it impossible that it should stick fast. This lever is driven by a simple movement from a wheel which is kept in motion by the foot of the workman.

Fig. 2.—DELCAMBRE'S TYPE-COMPOSING MACHINE (CLASS 59).

The type is thus composed into one long string of words, which is afterwards broken up into lines by the ordinary means.

One would be apt to think that accidental circumstances, readily occurring, would interfere with the even flow of the type in their respective channels, and produce confusion; but it is remarkable how regularly the machine did its work, and it is obvious that any mistake made can be rectified as readily as if the type had been set up by hand.

The distributing-machine acts in a manner the reverse of the compositor, its object being to take the type when the sentences require to be broken up and distribute the letters

into their respective reservoirs ready to be re-used by the compositor.

The machine consists of a single hopper or reservoir in which the sentences to be broken up are placed, the bottom of which is closed in a way similar to that employed in the machine before described. The types, in falling, are received in a channel down which they slide, until arrested by points something similar to railway points, which shunt them into the channels leading to the different reservoirs; these points are in connection with, and worked by, the keys of a key-board, similar to that of the compositor.

The compositor with his right hand presses down the keys one by one, and thus turns the points corresponding to the reservoir into which he wishes the type to pass. With his left he works a lever which permits a type to fall from the

Fig. 3.—DELCAMBRE'S TYPE-DISTRIBUTING MACHINE (CLASS 59).

general hopper. It would be easy to put this latter motion in connexion with the first, and so make one movement effect the two objects. As all types are not the same thickness, it

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will be noticed that an ingenious provision has been made against the difficulty that this difference of size would involve in their delivery from the reservoir.

The price of the composing-machine is 1,500f.; that of the distributor, 600f. The inventor states that, by the use of these machines, one person can do the work of four; and their manipulation is so simple that a person of ordinary intelligence can obtain full proficiency in a very short time. Indeed, this would appear probable, as the work is confined to reading, and touching the keys accordingly.

Machines similar in principle to the above have been shown at previous Exhibitions, though not quite in the form which they have now assumed.

It is only, of course, by full and long trial that the value of these machines can be ascertained in an economical point of view. An inspection of them in the Exhibition will show that they are worked out in a practical manner, and do the work up to a certain speed expected of them. I should like to see whether the machines would work properly up to the highest rate at which an expert operator could strike the keys.

Gouweloos (4) shows a machine for perforating postage-stamps, which consists of a series of small punches, corresponding to the holes to be made, to which a vertical motion is given. The sheet of stamps has also a progressive motion, and the two movements are so timed that the punches strike the paper at intervals corresponding to the length of a stamp. No doubt the machine would do a large amount of work; but the arrangements of mechanical parts to produce the result aimed at presents no difficulty.

Washer (11) exhibits a paper-cutting machine for general purposes, which is well constructed and arranged in a mechanical manner.

Prussia.

Prussia brings forward sixteen exhibitors in class 59, but they show little machinery; indeed, the greater part of the exhibits consist of samples of production, including several exhibits of cakes and wood and straw ready to be manufactured into pulp for paper-making.

Printing-presses for ordinary purposes and for colour printing, by Klein and Hammel.

Klein (1) shows some exceedingly well-made presses for general printing purposes. The movement which M. Klein has selected for giving a reciprocating motion to his printing-table consists of two wheels, one half the diameter of, and working within, the other, the table being attached to a point in the lesser wheel, which, under the above circumstances, describes a mathematically straight line. This method (which,

of course, is very old) for converting a circular into a rectilinear motion would appear to be very well adapted to the requirements of a printing-press. M. Klein uses in connection with his printing-cylinder an apparatus for ruling lines similar to that of M. Tournier, which has been described in my notice of the French section.

Hammel, whose name does not appear in the catalogue, shows some very well-made machines, an ordinary printing-press, and also a machine for printing a continuous roll of paper in six colours; the paper is passed round a single large cylinder, about which are grouped the separate printing or impression cylinders, corresponding to the number of colours which are required; each cylinder is furnished with its separate inking apparatus, and completes that portion of the pattern belonging to its colour.

Close to this machine there is another, similar in principle, for printing in one colour only, attached to which is an arrangement of brushes which have a combined horizontal and rotatory motion, for scouring the paper after it has left the impression-cylinder, and so removing any irregularity in the colouring. The principle of these presses is the same as that ordinarily employed for printing in several colours, and of which there are several examples in the Exhibition, amongst others the press of M. Ducommun, in the French section (31).

The Grand Duchies of Hesse and Baden have each one exhibitor in class 59, but they show nothing worthy of special notice.

WIRTEMBERG.

Apparatus for preparing wood pulp, by Voelter and Decker.

In Wirtemberg, though the kingdom boasts of only two exhibitors, it includes the most interesting exhibit made in class (59), and which should be closely looked into by all those interested in the manufacture of paper.

Voelter and Decker (1) show a complete apparatus, made according to the most recent patents of Messrs. Voelter and Decker, for making pulp from wood. The machinery is in a building by itself in the park, not very far from the grand avenue by which the Exhibition building is approached from the side of the Ecole Polytechnique. It will be found without difficulty, as the exhibition is a popular one.

Messrs. Voelter and Decker have been for twenty years experimenting on the use of wood for making paper, and have succeeded in introducing it on the Continent; but in England, for some reason or another, the system has not found much favour. In their advertisement circular, it will be seen that

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ninety machines have been supplied, of which two, one each, have gone respectively to England and America.

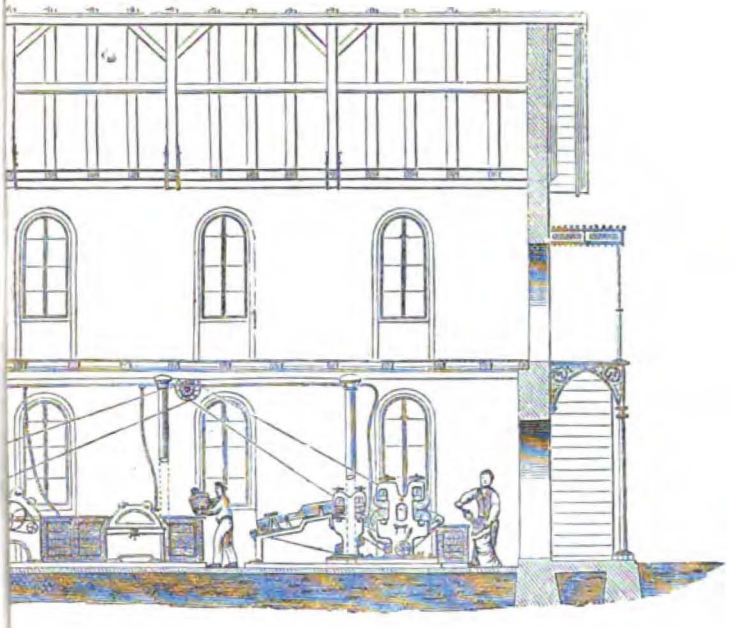
Of course, the only object in substituting wood or grass for rags as a material for making pulp is economy; and possibly the relative prices of rags on the Continent and in England, together with facilities in the former locality for producing wood pulp, may be such as to account for the fact of little use having been made of the process in England. The value of rags will be affected by the duties to which in some countries they are subject, and the price of labour and power in those situations where paper manufactories are generally established may be higher in England than abroad.

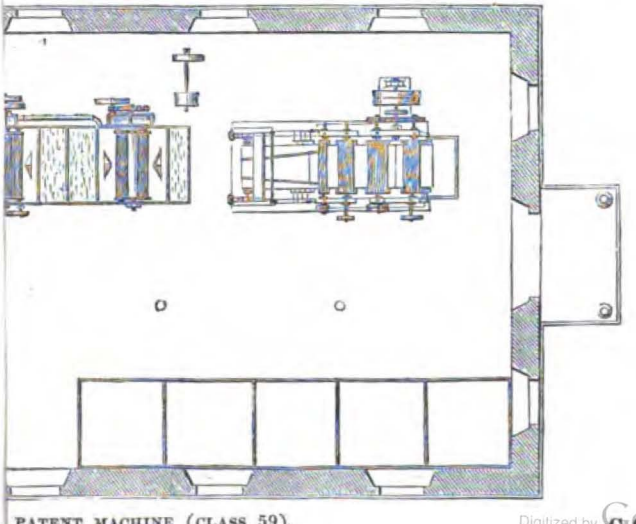
The following statistical information in connection with Messrs. Voelter and Decker's process is taken from their circular. Wood pulp manufactured according to their process may be mixed with rag pulp in proportions varying from 18 to 80 per cent. according to the quality of the paper—viz, 15 to 50 per cent. for good writing and printing paper; 50 to 70 per cent. for ordinary writing, printing, and wrapping paper; 50 to 80 per cent for common paperhangings and cardboards. Pasteboards may be made entirely of wood pulp. The advertising circular above referred to, in the shape of a pamphlet, is printed on paper containing different proportions of wood pulp, hence the nature of effect produced may be very closely examined by noticing the texture of the different leaves.

Pine and fir wood give the best fibre, while ash and lime produce the whitest pulp; all woods of similar character may, however, be used; and indeed, any wood will produce pulp. Birch and beech have been used extensively both in Belgium and France.

It is very desirable that the water used in the process be clear; if dirty river water be used it must be filtered, or the pulp will be coloured. Hard water containing lime is not only not unfit but very suitable for the purpose. An expenditure of 5-horse power effective is required for twenty-four hours to produce 1 cwt. of wood pulp air dry. Therefore, a 40-horse power mill, working day and night, will produce 8 cwt. of pulp. An excess of power, even on that liberal allowance is, however, recommended. For the production of 1 cwt. of pulp 2 cwt. of wood is required. Young wood from 3 in. to 12 in. in thickness, is preferred, and it should not be kept in store more than six months before being used. The wood must be cut into pieces about 12 in. long, and all the knots, bark, and other impurities removed. Waste pieces of wood, provided they are not too small, may even be utilised.

For every hundredweight of pulp made, a water supply





PATENT MACHINE (CLASS 59).

throughout the twenty-four hours has to be kept up of from one-half to three-quarters of a cubic foot per minute.

Besides the foreman, each hundredweight of pulp made in the twenty-four hours requires one man. From the price-list, a 60-horse power machine will weigh nearly 9 tons, and cost 515*l.*, irrespective of packing, delivered in the manufacturer's yard. It is likely that, besides the above sum, a heavy bill for extras would have to be paid, irrespective of driving-power.

From the above details it will be seen that, with a 60-horse power machine, working day and night, 12 cwt. of air-dry pulp would be produced, at the cost of the wages of 12 people, irrespective of foremen, engine-drivers, and stokers, if steam be used, to which must be added the price of power and wood, depending on the locality; and, farther, the charge of transporting the pulp to the paper-machine, unless the pulp and paper mills happen to be close together.

Now, if all the above charges are fairly assessed and added to interest of capital, and the wear and tear of machinery, a figure will be arrived at which will throw some light on the question why the system has found so little favour in England, where labour and wood are high priced, and where water-power is not so common as on the Continent.

Messrs. Voelter state that they have tried to use wood pulp for the manufacture of picture-frames, statuettes, and the like, as a substitute for papier-mâché, and that fairly satisfactory results have been obtained. I believe there is a chemical means of reducing wood to the form of pulp, but I have not heard that as yet it has been practically successful. Messrs. Voelter state that the fibre of the wood, on which its value depends, is destroyed by the process, while, by mechanically reducing it, the fibre remains uninjured. The machine by which the above operation is effected may be described as a big, vertical grindstone, against which the wood to be ground is pressed, while a stream of water assists the operation and at the same time keeps the working parts cool. The wood thus ground down is passed through successive sieves until the residue is of the required degree of fineness.

At the Exhibition the mill is driven by three of Messrs. Colla's portable engines, of about 15 or 17 horse power each, two of which are kept running together. It would, however, require the power of all three to work the mill up to its full productive power. The grindstone is of the ordinary description, with a hammer-picked face, the one in the Exhibition being about 4 ft. in diameter, and making from 150 to 180 turns per minute. Around its periphery are

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fixed five boxes, or hoppers, which receive the wood to be ground, and which has been previously cut up into proper lengths by a circular saw. These boxes are fitted with sliding covers, which are gradually forced forward by screws as the stone wears the wood. The amount of feed (which is necessarily very small) is regulated by a governor similar in principle to those which are used in connection with water-wheels. It is driven from the main shaft, and causes an increased or diminished feed to be given, according to the velocity of the stone, and, consequently, the pressure of the wood against it. A simple arrangement permits of the slow motion of the feed-screw being dispensed with, and the cover rapidly withdrawn by means of a rack and pinion, when it is required to renew the charge of wood.

This first process reduces the wood to a mass of pulp and splinters of different degrees of fineness. To separate the larger from the less, the whole, profusely mixed with water, is passed into a trough containing a revolving cylindrical strainer, permitting only of stuff of a certain degree of fineness passing through it. All those pieces which from their coarseness adhere to the outside of the cylinder are thrown away as useless. The pulp then undergoes a similar process again, but the strainer is much finer, and the pieces of wood which it separates are worth being farther dealt with. As they are separated by the action of the revolving strainer they are carried with a stream of water to the centre of the upper of a pair of ordinary horizontal millstones, where they are reduced by grinding to the same condition or quality of fibre as that coming direct from the grindstone. It remains now only to separate the pulp into three degrees of fineness, according to the purpose for which it is intended. This is done by passing it through strainers of various degrees of coarseness, that which separates the very finest pulp having a mesh with 40,000 holes to the square inch. The pulp is then dried partially by the action of the air, and partially by being pressed between rollers, when it is ready for use. If, however, it has to be transported, as a matter of economy the drying process must be completed.

In Germany wood pulp sells for about 36f. per 100 kilos (or nearly 15*s.* per cwt.) In France it is worth 50f. per 100 kilos (or nearly 1*l.* per cwt.). The condition of the matter is air dry—that is, containing some 10 per cent. by weight of water. In Germany rag pulp costs double wood pulp, or 72f. per 100 kilos.

The above figures were given me by Messrs. Voelter and Decker; but I confess I cannot see how such prices can pay

for the expenses I have detailed above, unless power and wood be got for nothing.

In England the Spanish or Espartero grass is much used as a substitute for rags. It appears to have the necessary length of fibre, and can be imported at a price which enables it to be economically used. The supply in those countries where this grass grows is practically inexhaustible, though its cost is much influenced by the locality from which it is procured, as in the countries where it is found means of transport are usually very defective.

BAVARIA.

Kœnig and Bauer (2) are noticeable for the high class of workmanship shown in their presses, which leaves little to be desired in accuracy of fitting or a skilful arrangement of parts. Messrs. Kœnig and Bauer send a considerable number of their presses to Russia and Germany.

Kœnig and Bauer, presses for ordinary and colour printing.

Two printing-presses for general purposes are shown, one of which in design presents no novelty ; the other has the same reciprocating motion for the type-table which has been described in connection with the press of Messrs. Klein in the Prussian section. The inking arrangements are somewhat modified from those generally employed. The ink is taken from the fountain and spread on the type by means of distributing rollers, but the usual inking-plate is substituted by a roller.

There is also a two-colour printing-machine shown, which is the same in principle as those previously described, the impression being completed by two distinct operations, and separate type and inking apparatus is arranged at each side of the impression-cylinder, which latter makes a complete turn and return for each complete operation of printing. The double-colour machine will throw off 1,000 copies per hour, and costs, at Messrs. Kœnig and Bauer's works, near Wurtzburg, 9,000f. (360*l.*); the other press, for journals, costs 7,000f. (280*l.*), and is stated to work up to 1,800 impressions per hour.

AUSTRIA

shows next to no machinery in class 59, her exhibits being confined principally to accessories belonging to different branches of the paper and printing trades. M. Weiss (12), however, is the sole exhibitor of rags in the Exhibition; he has contributed some samples of compressed rags. The duty of 2 fl. per Zoll. cwt. makes it possible to export only the highest quality of material, and, owing to the competition

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with Russia, Italy, and the Levant, the exportation from Austria is not large.

Spain and other Countries.

Spain has, according to the catalogue, five exhibitors, which an even diligent search failed to discover.

Italy has in like manner six, of which two only were to be found.

Turkey has one by name, Cheik Ali Mehmed, which I looked for, as I was anxious to see what contribution to printing a Syrian village could produce. I did not, however, get more than a verbal description of M. Mehmed's stamps, and the official who gave it to me seemed to think I had missed little in not seeing the originals.

There is nothing further shown in class 59 worth noticing till we come to the

United States,

who have nominally eight exhibitors, of whom several are absent.

Sweet's matrix compositor.

Sweet (3).—This machine represents the most promising invention in connection with printing which is shown in the Exhibition, and if the mechanical difficulties still remaining can be overcome, and the machines stand a practical test in the printer's hands, I see no reason why a revolution in printing should not be made, since the use of this system is more rapid than the ordinary one, and it dispenses with the cumbersome and costly founts of type hitherto necessary. The object to be obtained is the same as that aimed at by M. Flamm (86) in the French section; but the means by which it is effected is different.

It will be well first to get clearly an idea of the principle of this extremely ingenious machine, which is as follows:—The platen attached to the matrix is carried under a wheel containing the type, the depression of any one of which stamps the matrix; this wheel is kept continually revolving, but can be stopped in any position by raising certain pins in a corresponding wheel below, which pins are in relation with the keyboard of a sort of piano, whose notes would correspond with the different letters; hence the depression of a note raises the corresponding pin and stops the type wheel in such a position that the proper type is over the matrix, when the depression of the stamp forms the impression.

Having, I hope, got an idea of the principle, the reader will now readily follow a more detailed description:—

The machine in appearance is like a harmonium with two rows of keys and four separate ones, above which latter are

the spaces. Of course any number of keys may be used, corresponding to the number of types required. Above the keyboard is a fluted or grooved roller, which, on being turned, moves forward the form carrying the platen and matrix. There is on the left side of the machine an arc, on which is shown the amount which the roller has turned, and, consequently, the position of the platen. Behind the machine is a circular disc, near the periphery of which are inserted a number of pins, one corresponding to each key, and which, in their normal position, are flush with the top of the plate, but are raised by the depression of different keys. Above this disc is an axle springing from its centre, which carries, first, the real type-wheel; and, second, the apparatus for causing the type in it to make an impression. Beneath the type-wheel, and on the same axis, is an arm which sweeps round just above the lower disc, and which, when no pins are raised, runs continuously round, being driven by a band from a small pulley, which may be turned by the foot, or in any other convenient manner. Attached also to the arm is a lever, whose duty it is to push the pins back in their places after they have done their work of stopping the arm. After the rotation of the arm is arrested, the pulley on the axle continues to travel on, and the result of its motion is the depression of the hammer by which the types are forced on to the matrix. This is effected as follows:—The pulley which drives the axle is partially loose on it, and carries a piece of metal which is in front of an inclined plane, which latter is made one with the type-wheel; the piece of metal is in connexion with the lever working the hammer by which the type is depressed. When both the piece of metal and the wheel are running together no effect is produced on the hammer; but when the latter is arrested, the former mounts the inclined plane and puts the hammer in action. Attached to the hammer is a small catch, which, after the type has been replaced, brings it back to its original position.

In connexion with each note of the keyboard is a pawl which takes into the teeth of the roller described above; and the act of raising the key, which is performed by the arm of the type-wheel, causes this pawl to turn the roller round, and so advance the form containing the platen, with which it is in connection.

The divisions of the teeth of the roller, and its connexion with the form, are such that one tooth corresponds to an advance of 1-64th of an inch of the form. The pawls attached to the keys are arranged so that they are depressed more or less according to the width of the letter to be printed—thus, for a w, six teeth; while for an i, only three are taken. An

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arc is attached to the lever at the side of the roller, which serves to show the exact position in the line which the types are printing.

On the conclusion of a line this lever is replaced by hand to its original position, corresponding to the commencement of a fresh one; it is necessary also that a lateral movement of advancement be given to the platen, so that a fresh portion be presented to the action of the type after each line is completed; and this is effected at the same time that the whole form is moved by the side lever. The bottom of the platen is scored with inclined groves, which are taken into by a small stud fixed in the frame of the machine, and which are so arranged that the said stud takes a fresh groove each time the whole form is retired, the distances apart of the grooves correspond to the widths apart of the lines of the printing. I hope, on considering the above explanation, the action of the machine will be readily apparent. The compositor, sitting in front of the machine, keeps the type-wheel in motion with his foot, at the same time that, reading the manuscript, he successively puts down the keys corresponding to the letters, when the following actions result:—The type-wheel is arrested in such a position that the type corresponding to the key struck is over the matrix; the pulley, continuing its motion, causes the piece of iron above described to mount the inclined plane and depress the type, stamping the matrix, after which the pin raised is depressed, allowing the arm to continue its motion, and at the same time replacing the key, and thereby turning the fluted cylinder, and so advancing the form a distance corresponding to the width of the letter.

In correcting, the matrix is passed again under the type-wheel and the correction made. When the stereotype is cast, of course, a double word is the result, but the superfluities may be readily cut away; and, though the inventor does not pretend that a perfect substitutton is the result, yet the alteration is always quite legible. In some cases, where the letters happen to be similar, the correction would hardly be noticed. The machine exhibited is the first that has been made, hence it is reasonable to suppose that subsequeut attempts will give much better results. With this one forty-five characters per minute have been actually printed, the limit of speed of the machine being sixty, though this rate in practice has never been reached, owing to want of skilled manipulation. The limiting rate of sixty characters per minute cannot with this machine be passed, as the parts would not then have time to perform their functions properly. The inventor hopes, however, with another machine to eventually

double that speed, or to reach the speed at which it is possible for the hand to depress the keys. The price of the machine is such that when any large amount of printing has to be done, its cost, more or less, becomes no serious consideration.

The machine exhibited is not adapted for newspapers; but it is obvious that with a little modification it can be adapted readily to all kinds of printing. It would appear likely that the principle of this system—namely, doing away with movable type and stamping the matrix at once—is one which, at any rate, in some way or another, will succeed; and, since it renders unnecessary the costly founts of type necessary by the old system, will reduce the cost of printing.

Printing-presses for light work, by Degener and Weiler.

Degener and Weiler (4) exhibit presses which are specially adapted for printing on a small scale and for hand-presses. The easy motion which they have, and the simple arrangement, are well worth notice. I believe this adaptation of parts is original. The press consists of two parts, which are connected by a hinge, one part carries the platen, and the other the type, to which is attached the inking-table. These two parts are doubled together like a book at each action of the press; but as the points about which they move are situated some distance below them, it results that a gradual and easy motion is given; and as the platen and the type approach each other, their speed is arrested with a corresponding increase of power. The centre about which the platen-table turns is fixed; but the centre of the type-table has a reciprocating motion given to it by a connecting rod from a toothed wheel turning on the said centre. When the impression is being taken and the press is closed, both parts are vertically together.

The course described by the type-table is sufficient to bring the type and the inking-table successively under the the inking-rollers, the axle of which latter slides in a groove, so that it can accommodate itself to the requirements of the former.

In the smaller size of machine the ink is supplied to the table by hand; but in the larger ones a regular ink-ductor is provided, which at each revolution of the machine comes into connexion with the inking-table, an automatic arrangement causing this latter gradually to turn round, so as to ensure an equable distribution of the ink. To the smaller sizes, especially adapted for printing cards and circulars, a sort of self-acting clip is attached to the platen, which delivers the cards, after they are printed, into a tray beneath the machine. Under these circumstances, 2,500 impressions may be made per hour. The price of the lesser

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press shown is 34*l.*, and that of the larger one, with ink-fountain, 80*l.*

Welsh (7) shows a clever little machine for dressing type, which it does by planing, in place of the ordinary method of grinding. The types having been set up, are made to pass between cutters, which at once reduces their sides to a true surface.

Mr. Welsh also exhibits a compositor's type-case, which is divided in a way different from that ordinarily in use, and the inventor states that the system facilitates considerably the labour of the compositor.

Though eight exhibitors are down in the catalogue, only the above three are to be found in the American section of class 59.

GREAT BRITAIN.

Bryan, Donkin, & Co.'s exhibit of parts of paper making apparatus.

Messrs. Bryan, Donkin, & Co. (4) exhibit apparatus in connexion with the manufacture of paper by machinery. There is nothing shown which is very new, but the machines are extremely well made, and no pains are spared by this firm to turn out their machinery perfect, not only in workmanship, but in design and arrangement of the smallest details.

A rag-cutter is shown. The rags are fed into the machine by an endless band, which delivers them to a knife having a reciprocating motion given to it by a crank on the flywheel shaft. The knife consists of a single blade, with three others at right angles working on a block of iron, and cutting the rags into small squares. A strainer is also shown in which the motion for shaking has been very nicely worked out, the result being that the whole strainer has an equable shaking motion instead of, as is usually the case, receiving a vertical motion by means of a cam at one end of the strainer, the other being fixed, whence the motion has died out before the pulp passes over the lip of the strainer to the paper-machine.

A cylinder, cut after the fashion of a strainer, is also shown, which has been made out of a single sheet of copper, in a very simple and ingenious manner: the plate being taken of a suitable size and thickness, is bent to a circle, and, having been put in a lathe, is scored with parallel lines half through its thickness; it is then taken out and bent at right angles to its former direction, and, being again put in the lathe, is similarly scored; the result being that, where the lines intersect each other, the metal is completely cut through, and an even series of holes produced.

Morel's system of electrotype.

Morel (6) shows samples of electrotype as applied to obtaining facsimiles of both type work and engravings; the

letters are clearly formed and will give, no doubt, a good impression. I have not been able to glean information sufficient to have a very satisfactory notion of the merits of the process, so shall quote Mr. Morel's own words on the subject. He says: "I have arrived, by successive improvements, at such a state of perfection that I am able to furnish facsimiles of forms of type as quickly and nearly as cheaply as by the common stereotype process, thus rendering electrotypes available for the ordinary purposes of printing where stereotypes are used. The durability of electrotype is so great that more than a million copies can be taken from one plate, so that books, and especially illustrated works, can now be produced more rapidly and much more cheaply than formerly. The process consists first in moulding the form in beeswax, instead of gutta-percha. The beeswax is then inserted in a metal frame, and the system of rendering it conductible is such that in a few hours a shell of copper is obtained sufficiently thick to be finished; this shell of copper is then thickened by a process so rapid that a sheet of sixteen pages can be obtained in a few hours. The *Art-Journal*, with its supplement, the *Bow Bells*, and several periodicals are printed from my electrotypes."

The above description does not state the way in which the beeswax is made conductible, nor the manner which is adopted for finishing the electrotype by fastening on a backing of another metal, and so rendering it fit for the printer's hands.

The Patent Printing Surface Company (7) show two machines, which have for their object to print on irregular surfaces, such as the curved face of a powder canister.

The press is described as a pneumatic machine for printing from vulcanised india-rubber printing blocks.

A cushion of air is introduced under the block, thus raising up its surface; and, being elastic, it permits of the printing surface adapting itself to an irregular shape. The air is introduced by means of a small pump, worked by hand. The machines were not at work, nor was there any attendant from whom I could obtain specific information; hence I cannot say what results may, in practice, have been obtained.

Steam calender, Robinson.

Mr. Robinson (9) shows a complete machine for glazing, by direct pressure, calico, silk, satin, or cotton goods. It will also glaze paper; but the rolls attached to the machine shown are not adapted for that particular purpose.

The machine consists of four cylinders, placed one above the other, with their axles in a vertical line, and supported by two strong standards. The rolls are of hard metal, every alternate one being covered with paper, and the higher of the

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two uncovered ones is provided with means by which steam can be introduced to heat it. The upper rolls are approached or withdrawn from each other by means of screw tackle, which is worked by hand from above, the lower roll being acted on by means of a right and left handed screw, which serves to draw up or let down a lever, which supports the bearings of the roll. Attached to the main driving-wheel is a pulley, which carries a strap, driving a roller on which the goods are wound after having been glazed. The machine is driven by a pair of diagonal high-pressure engines, each of 6-horse power nominal. They are fitted with the ordinary eccentrics and slide valves, and their connecting rods at right angles to each other catch hold of a single crank. The framework of the engines appeared to be decidedly light.

The price of the machine is as follows:—Machine 310*l.*; engine, 120*l.*; driving-wheels, 22*l.*; or together 452*l.* The two latter items may be dispensed with when other power is available.

Messrs. Stones (10) show a collection, which is second to none in the Exhibition, of wove wire, in the many ways in which it is employed by papermakers, maltsters, millers, confectioners, &c.

The dandy rolls and moulds for producing watermarks in paper are especially well turned out.

ENGLISH COLONIES.

Canada is the only one of our colonies that contributes to class 59. The catalogue states that she sends four exhibitors, but only two are present.

Boissonault (1) shows a type-box where metal wedges are used for securing the type.

Julien (2) exhibits an ingenious press for printing addresses. The machine is designed for use in connection with a newspaper office where a great number of the same addresses are daily required. The apparatus consists of a long type-box, in which are placed side by side the addresses; this box receives a step-by-step motion onwards as each address is printed; the impression is made by a stamp to which a vertical motion is given by means of a single connecting rod and crank driven from a pulley at the side of the machine. The idea of the machine is good, but the way in which it has been carried out, and the workmanship, would hardly satisfy an English mechanic.

I have no doubt, however, that it can do good work, and possibly its price may be very low.

I have now been tolerably closely through class 59, and, though there is much required to make the review a perfect

one, notice has been drawn to everything at all worthy of study.

Concluding remarks.

I think the reader will agree with what I stated at the commencement of this report, that the Exhibition of 1867 has failed to produce any very striking novelty in connexion either with the trade of paper making or with the manufacture of presses; at the same time there is evidence that invention is not quite dormant in connexion with these trades.

The French exhibit is by far the most complete, and, indeed, may be said to be the only one in the Exhibition which at all represents the whole class. The sole notable want being a complete paper-making machine, of which France has got no example. With few exceptions, all the machines she shows are really well made, and creditable specimens of both workmanship and design, the fault principally being a too exuberant growth of invention, often making change for no good end, and an evident dislike to simplicity, or perhaps it would be truer to say a want of admiration for it. In many of their best machines there is full recognition of the standard English pattern, and no attempt has been made to improve the copy.

I should say that what *par excellence* the French excel in is their ingenious application of mechanics to small ends; matters in which it may be we could do as well, did we not rather (but hardly wisely) consider them beneath our serious attention.

Thus, it would be difficult to excel the ingenuity with which the various small hand-presses, stamping, envelope-folding machines, &c., have been contrived.

In Prussia, the presses of Klein, Forst, and Bohn, and in Bavaria, those of Kœnig and Bauer, will bear close scrutiny, and are equal in every way to anything in the Exhibition.

Wirtemberg is remarkable for the single exhibit of wood-pulp machinery.

The three exhibits made in America are all originalities, and good ones too.

In the British section there is nothing to condemn, and but little deserving of especial praise. Indeed our exhibits in class 59 are very small. However, it must not for a moment be supposed that our standing or position in this class (or, indeed, speaking of machinery only, in any other) can be gauged by what is now shown in the British section of the Paris Exhibition. The space at the disposal of the Commissioners was so small that many applicants were excluded, and the demands of all reduced. With the above

exceptions, the rest of the world may be said to be nowhere as regards class 59.

In conclusion, I may summarise the exhibits which I think should be specially noticed, and which, if they have been seen, will probably have satisfied those who, though interested in paper-machinery and its belongings, have only had a limited time to devote to its study at the Paris Exhibition of 1867.

Notable exhibits.

FRANCE.—Lecoq (20), small presses for general purposes; Poirier (24), envelope-folding machine, machine for making lucifer-match boxes; Ducommun (31), printing machine for stuffs in colours; Gaiffe (32), electrical engraving-machine; Tulpin (40), drying apparatus and others; Dutartre (69), double-colour printing-press; Flamm (86), matrix printing machine; Derriey (87), machine for numbering bank-notes.

BELGIUM.—Dautrebande and Thiry (1), paper-making machine; Delcambre (2), machines for composing and distributing type.

PRUSSIA.—Klein, Forst, and Bohn (1), printing-presses; Hammel (not in catalogue), machine for printing stuffs in colours.

WIRTEMBERG.—Voelter and Decker (1), wood-pulp machine.

BAVARIA.—Kœnig and Bauer (2), printing-presses.

UNITED STATES.—Sweet (3), matrix compositor; Degener and Weiler (4), small printing-presses.

ENGLAND.—Bryan Donkin, (4), machines used in connection with paper-making; Stones (10), wove wires.