blankets. The paper next passes on to the printing cylinders *T, T',* on which the printing surface—not composed of movable types but of stereo plates—is fixed, and to the impression cylinders *I, Ï.* The printing cylinders contain each the plate in curvilinear shape, constituting the forme for one side of the paper. The web is led between the printing and the impression cylinders, as shown by the dotted line. After being printed on one side by *T,* it travels round *I* and receives an impression on the other side from *T',* thus being “perfected.” It then passes on to the cutting cylinders *K, K,* one of which has a serrated knife, which enters the paper, and on the application of tension divides the web, causing the peculiar saw-like edge seen in copies of journals printed on rotary machines. The paper is next carried in over tapes to the point where the complete severance takes place. Soon after they encounter a pendulous frame, which delivers them in two piles on to the tables *x*, *x,* whence they are removed. There is an ink supply trough *a,* which is connected with the distributing rollers by a revolving metal roller *b.* The distributing rollers of metal are marked *f, g, h, i,* and the rollers which ink the forme, made of the ordinary composition, are marked *k, k.*

The average rate of speed of the Walter press is 12,000 per hour, the sheets being printed on both sides. In this apparatus every­thing is automatic : there is self-feeding and self-delivery, the web of paper at one end being transformed into properly printed single sheets at the other. The machine requires only one man to super­intend its general working, including the replacing of the web when printed and the removal of the successive piles of sheets. In respect of speed, if the perfecting machine is to the hand-press as 32 to 1, the rotary will be to the hand-press as 96 to 1. The Walter press, requiring a space of only about 14 feet by 5, is not more remarkable for its speed and economy than for its simplicity of construction and its compactness. And the same remark applies to several other machines, such as the Victory, the Hoe, and the Prestonian, which have since come into use. Their general appear­ance is that of a collection of small cylinders or rollers, through which the paper seems to fly at railway speed, issuing forth in two descending torrents of sheets accurately cut into lengths. Without such machinery the prodigious issues of some of the morning journals would not be possible. One daily paper averages a circu­lation of more than a quarter of a million. This enormous number of sheets are printed in about four hours, owing to the type matter being stereotyped and placed on several presses.

Printing from webs of paper instead of single sheets will probably be adopted in the future for all newspapers and even books of large circulation. Hand-feeding is limited by the ability of the operator to lay the sheets on the feeding-board with the necessary accuracy. One chief obstacle to the more general adoption of rotary printing is the expense of stereotyping the type formes. Although a machine has been constructed in which movable types can be placed round the periphery of an impressing cylinder, it cannot compete with the Walter and other presses using stereo plates. The problem of printing directly from flat formes of ordinary types, as well as from stereotypes, with paper supplied in the roll, is one that may be commended to engineers. The saving in stereotyping in many cases would be very considerable ; but, even where this is not an object, the readiness and ease with which the type could be manipulated would ensure for such an apparatus admission into offices where the large rotaries of the present day are inadmissible. It would also enable illustrated journals to be printed from the web. The pictures introduced into some of our daily journals are very rude when compared with those in periodicals printed on flat­bed machines. This is owing partly to the distortion that arises when the cast from a flat block is accommodated to a curved sur­face, partly to the fact that stereotyping does not give the fine and delicate reproduction that electrotyping supplies, and partly to the imperfect inking powers of the machines. Quite recently a plan has been patented whereby curved electrotypes of pictures can be fastened to blank or depressed portions of an ordinary curved stereo plate ; but the method is not always practicable. With a flat-bed machine the forme to be printed from might be of a com­posite kind,—partly movable types, partly stereotype, and partly electrotype. One difficulty of constructing a web printing machine with a flat bed is that of turning the sheet so that it may be printed almost simultaneously on both sides. It would have to be reversed by the continued rotary movement of the cylinder. This, however, is quite within the limits of practicability, and experiments are now being made to devise a machine with this feature.

For about three centuries after the invention of printing the formes were inked by leather balls. When machine presses were introduced, their earliest inventor tried to use cylinders covered with leather ; but the plan was most unsatisfactory, until a subse­quent inventor adopted a composition of glue and treacle, which was cast into cylinders having an inner “stock” of metal or wood. For about half a century this composition was used exclusively for both hand and machine presses. Since then glycerin has been in­troduced for roller making. Hansard’s recipe, in use when the 8th edition of the present work was issued, was—glue 4 parts, treacle 12 parts, Paris white 1 part. But a much better composi­tion is now formed of glue 10 parts, sugar 10 parts, and glycerin 12 parts. The glycerin has the property of always keeping the roller moist and soft, while the tendency of glue and treacle is to dry and harden. A glycerin roller lasts much longer than one of glue and treacle.

Printing ink has peculiar qualities. It is required to change from the soft adhesive state in which it is applied to the type to that of a perfectly hard and dry substance after being transferred to the paper. This change of condition must be under control, and when air is excluded the ink should keep in good order any length of time. During its application to the type its solidification should be as slow as possible, and unaccompanied by the emission of any unpleasant or deleterious odour. It ought not to affect the rollers, and, having been applied to the paper, its action should be confined to a very slight penetration, just sufficient to prevent its detach­ment without injuring the surface of the paper. It must dry into a hard, inodorous, and unalterable solid. The ingredients of ink are burnt linseed or other oil, resin, and occasionally soap, with various colouring matters ; that for black ink is usually lamp black, but charcoal and other cheaper materials are occasionally introduced. Ink is removed from types and blocks by detergents, such as potash and pearl ash ; benzine is also well adapted for the purpose.

*Colour Printing.*

The apparatus previously described is intended for monochrome printing, whatever be the shade of the ink. When two colours or more have to be printed in one composition, there must be a separate type forme or separate engraving, and a separate printing, for each. Many attempts have been made to print several colours simultaneously by dividing the trough or manipulating the rollers. All these have been more or less unsuccessful, with the exception of a press invented by Mr W. Conisbee, which prints from type formes in two colours. In construction it is somewhat similar to the ordinary single-cylinder machine, but is provided with two sets of inking apparatus, including ductor, wavers, and inkers, each of which acts totally independent of the rest. The cylinder is placed in the centre of the machine and makes two continuous revolutions, giving an impression for each colour. There are two type formes, each containing only the lines to be worked in one of the colours. These are in two beds adjoining one another, and, the circumference of the cylinder being equal to the length of one bed, one colour is printed by the first revolution and the other by the second. The sheet is thus printed twice without being released from the grippers, whereby perfect register is ensured. The speed is slow, averaging 300 to 400 complete impressions per hour.

The method by which the beautiful coloured supplements issued occasionally with illustrated newspapers are printed may be slightly referred to. A copy of the artist’s painting is first of all made, on a scale regulated by the size of the reproduction. This being sup­plied to the engraver, an outline or key block is made and proofs pulled. It is now necessary to determine the tones of colour to be used,—a process demanding great experience. The key block will, if printed first, afford a guide for the registration of the subse­quent printings ; sometimes, however, that is reserved for a later stage. The colours on which the subsequent printings are done must be of a transparent nature. The blocks are sometimes pro­duced by the typographic etching process, which gives a softness, delicacy, and variety unattainable by the graver. The blending of the colours is the most delicate task the printer has to under­take. A large picture is often printed in ten or more workings, some of them in their turn intensifying and bringing previous colour workings into stronger relief, others giving shape and form to the picture. Almost to the end of the process, however, the picture will want vitality ; its outlines will be hard and bare, or vague and undefined, according to the sequence of the colours. Another working may give grey tones where wanted, and may increase the depth and transparency of various parts. A deep flesh working may have a marked effect on the development ; and, near the close of the series, if the entire colouring is found to be too warm, it may be corrected by over-printing very nearly the whole subject. Chromo-typography has undoubtedly made great strides during the past twenty years, its best results being shown in the coloured prints for illustrated journals. For the production of pictures for commercial and artistic purposes chromo-lithography is generally resorted to on account of its relative economy. In lithography for typographic purposes the line has to be cut and the space on both sides removed so as to leave the line alone to be charged with the ink, or the white space has to be etched away with an acid. The printing of isolated points too is easily effected from a stone, whereas most minute labour is necessary to engrave them. Typographic etching has here, however, been of great assistance. The differences of printing surface caused by the colours are met and overcome by the lithographic stone with great facility, even when the spaces are largest and most uneven ; it is quite the con­trary in regard to typography, wherein the work has to be charged with ink to a greater extent according to its size, and the quantity