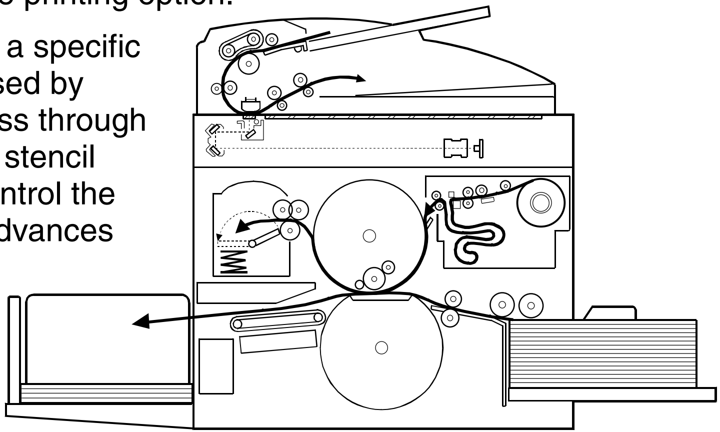
Digital Duplicators

Overview

Digital duplicators are designed to provide inexpensive, large-quantity duplication services. They use digitally-created stencil masters and ink to make prints.

Digital duplicators are a modern adaptation of an older technology. The basic rotary stencil process was developed in the 1930s. Before the electrostatic copy process was introduced, the reproduction of documents in the office was manly done with carbon paper (for about five copies) and stencil duplicators (for larger volumes). While much of this work has been shifted to copiers, digital duplicators still provide a high-volume, inexpensive printing option.

Most printing methods, such as lithography, apply a specific amount of ink to the paper. The stencil process used by digital duplicators, however, requires the ink to pass through the master before it is applied to the paper. While stencil masters are very easy to make—it is difficult to control the amount of ink passed to the paper. Fortunately, advances over the last two decades have made modern Digital duplicators easier to use, while greatly improving their print quality.



Compared to photocopiers, the printing speed from a single original is much faster. The *C235* supports 5 different printing speeds, ranging from 60 sheets/minute to 120 sheets/minute. Most digital duplicators can also use a variety of ink colors. On the other hand, the setup time for each original is longer, and digital duplicators tend to require more-complex mechanical components to handle tasks like ejecting old masters and wrapping new masters around the drum.

While many digital duplicators are marketed towards schools, small government offices, and anyone who needs inexpensive, high-volume printing, the high quality machines can even handle some of the work usually done by offset printers.

Duplicating Process

1. Master Ejecting: ↓	Ejects the used master wrapped around the drum into the master eject box.
2. Scanning: ↓	Scans the original image with the CCD through the mirrors and the lens.
3. Master Feeding: ↓	Converts the image signal read by the CCD into digital signals and sends them to the thermal head to write the image on the master. The master then wraps around the drum.
4. Paper Feeding: ↓	Sends paper to the drum section.
5. Printing: ↓	Presses the paper fed from the paper feed section against the drum. This transfers ink to the paper through the drum screen and the master.
6. Paper Delivering:	Peels off the printed paper with the exit pawls and air knife, and ejects the paper onto the paper delivery table.

Master Ejecting

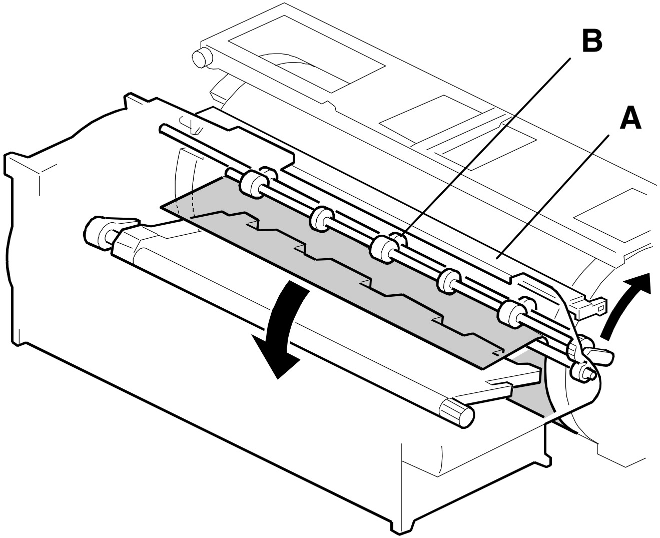
To keep the ink from drying, the master remains wrapped around the drum. Therefore, the first step in the duplicating process is to eject the old master.

When the start key is pressed, the drum rotates from the home position to the master eject position. Then the drum master clamper (A) opens.

Master pick-up rollers (B) grab the leading edge of the master, and remove the master from the drum. The master is ejected.

Once the master is fed completely into the master eject box, a pressure plate compresses the master into the box.

After ejecting, the drum rotates into the master making position.



Scanning

Scanning and image processing for digital duplicators is basically the same as other digital processes. Older machines tended to use a pass-through scanner, where the image was moved past a stationary *CCD* or *CIS*. This is the same method commonly used by fax machines—in fact, the duplicators often used the same components as the fax line. Newer machines tend to use a book scanner—the type of scanner used on a copier. Again, the components are identical to those used by the digital copiers.

For example, the *C231* and the *A265* use identical scanners.

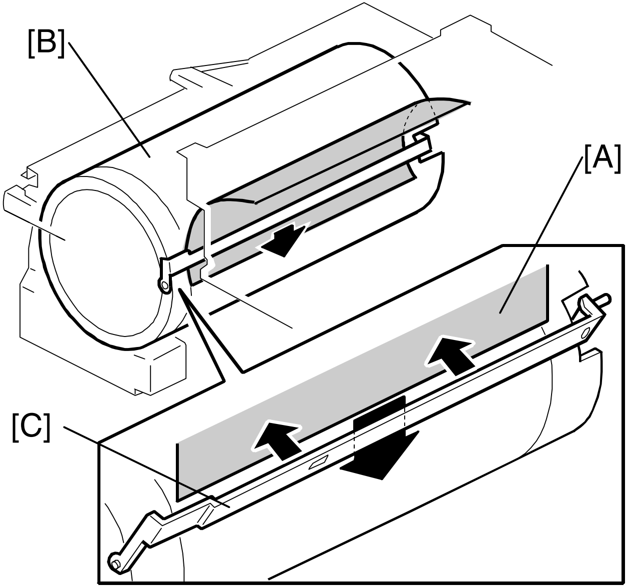
See *Digital Scanning* for more information.

Master Feeding

The masters are made from a low-fiber content paper coated by a thin layer of heat-sensitive film. The paper is fed from a roll to the thermal head. Here, image data from the CCD is burned into the film, creating the new master.

The master is then fed to the drum. Once the drum rotates into the master feed position, the master clamper opens, and the leading edge of the master is fed under the clamper. The clamper then closes on the leading edge.

The new master is wrapped around the drum, as it slowly rotates. When the master making process is finished, the master feed motor turns off, and the cutter activates. After the master is cut, the drum rotates again to wrap the remaining portion around the drum.



A: Master
B: Drum
C: Clamper

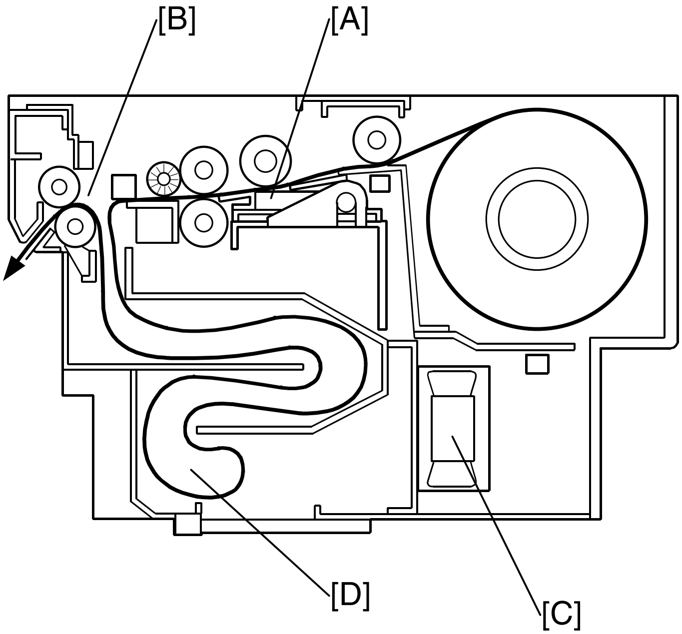
Master Buffering

As the master passes the thermal head, the thermal head burns the image data into the thermal head. In an unbuffered machine, the master is transported directly to the drum. As the image is created, it is immediately clamped onto and wrapped around the drum.

This process can take a significant amount of time, especially for higher-resolution printers. Also, the process does not begin until the old master has been completely ejected, and the drum has rotated into the master making position.

In order to improve the first print speed, many of the higher-end duplicators buffer the master, allowing them to start creating a new master while the old master is being ejected. Old master creation and master ejection begin at almost the same time.

In master buffering, the new master is fed until the leading edge is past the master feed control rollers. The master feed control rollers then stop. The master vacuum fans activate, drawing air down the master buffer duct.



A: Thermal Head
B: Master Feed Control Rollers
C: Master Vacuum Fans
D: Master Buffer Duct

As the master is created, the slack is drawn into the master buffer duct. When the drum rotates into the master creation position, the master feed control rollers activate again. The leading edge is clamped onto the drum, and the master is fed out and wrapped around the drum.

Paper Feeding

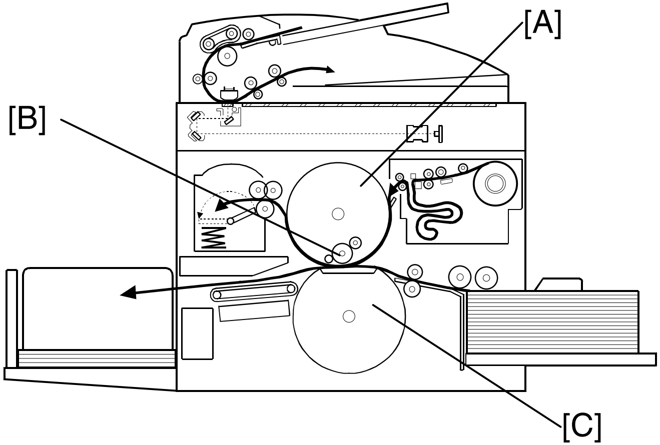
Digital duplicators use standard paper handling processes. See *Paper Feed* for more information.

Printing

There are two variations on the printing process. One uses a pressure roller, the other uses a pressure cylinder. The basic procedure, however, is similar.

As the paper is fed, the pressure roller (or pressure cylinder) presses it against the drum.

The drum itself consists of a cloth screen over a metal screen. The ink pump supplies ink from the ink cartridge into the drum through the drum shaft. The ink roller and doctor roller spread the ink evenly over the screen. Ink seeps through the master where the film has been burnt away, transferring the image to the paper.



A: Drum
B: Ink Roller
C: Pressure Cylinder

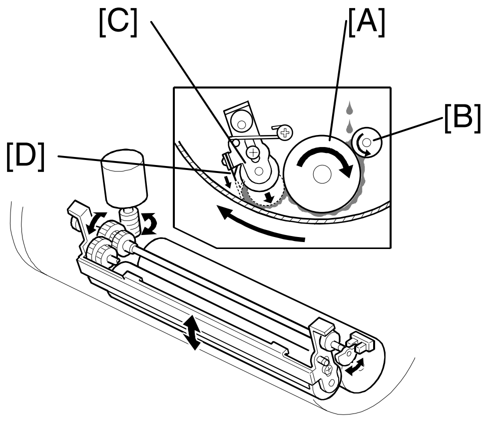
The pressure roller is a smaller roller, held against the drum by tension springs. It is attached to a cam system, so it can disengage from the drum, and allow the master clamper to pass.

The pressure cylinder is a much larger roller—it is the same diameter as the drum. The pressure cylinder and the drum rotate in synch. The cylinder has a slot which the clamper fits into as it rotates through the printing nip. This allows the clamper to pass through without disengaging the cylinder from the drum. So, while the cylinder takes up more space, it also simplifies the mechanical design.

Finally, on some of the higher-end machines, a drum idling roller has been added. This enables the Quality Start mode—ensuring that the first print has enough ink, even if the machine has not been used in a long time. When Quality Start mode is selected, the drum idling roller is lowered against the drum, providing ink onto the screen and master before printing begins. Note: there must be a master on the drum—if there is no master, this procedure is skipped.

Some Idling rollers also include a quality blade to scrape excess ink off the inside of the metal screen.

The drum idling roller disengages before printing begins. Actual printing proceeds as previously described.



A: Ink Roller
B: Doctor Roller
C: Drum Idling Roller
D: Quality Blade

Paper Delivery

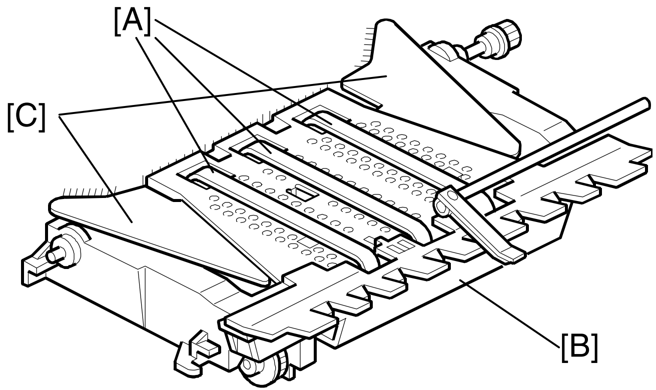
Paper separation takes place shortly after the leading edge passes the nip between the pressure roller and the drum. Since this is a wet process, the paper has a tendency to stick to the drum. Most machines use both air knifes and exit pawls to separate the paper. Like the pressure roller, the exit pawls are also placed on cams. They disengage from the drum to allow the master clamper to pass.

Once separated, the paper is fed into the delivery tray.

Since the ink is still wet, paper transport must be handled without smearing the ink. On older machines, two rollers were used to transport the paper. Each roller's position was carefully adjusted according to the paper size and the paper's position on the paper table. The rollers had to catch the paper within the 5mm margin along its edges.

Newer machines use a combination of rubber belts and a vacuum fan to transport the paper. The vacuum draws the paper down, holding the sheet to the belts.

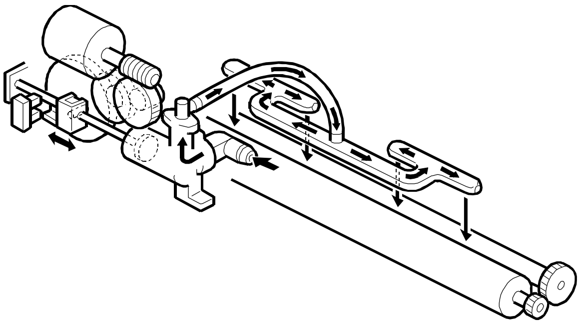
Finally, the paper guide wings lift the side of the paper as it leaves the delivery unit. This stiffens the paper so that the leading edge will not sag and brush against the sheets already on the delivery table. Again, this prevents the ink on freshly printed sheets from smearing as the paper is stacked.



A: Rubber Belts
B: Vacuum Fan
C: Wings

Ink Supply Control

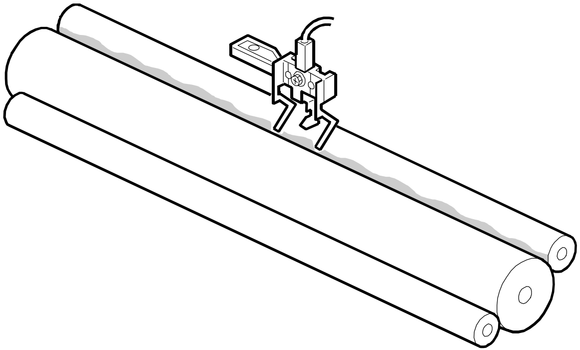
Overview



Ink is pumped from the ink cartridge to the ink roller. The ink travels through the drum shaft. Holes in the shaft drop the ink onto the ink roller.

The ink on the ink roller is squeezed by the doctor roller, spreading it into an even thickness. While printing, the pressure roller pushes paper, master, and the screens against the ink roller. Ink seeps through the holes in the screens and master, and is applied to the paper.

Ink Level Detection



The ink detection pins work like the electrodes of a capacitor. The capacitance between the pins is measured. This capacitance varies depending on how much ink is touching the pins. Based on the capacitance, the ink motor is turned on and off. This way, the machine maintains a consistent level of ink on the roller.

Ink End Condition

As soon as the capacitance indicates that the ink level is getting low, the ink pump activates. If the capacitance does not change within a specified time, the CPU stops the printing process and turns on the Ink End Indicator. For example, the *C235* waits 40 seconds after the pump activates.

Thermal Head Control

Overview

The thermal head is a row of heating elements—one element per pixel. The thermal heating elements melt the over-coating and polyester film layers of the master, according to the image data sent by the CCD.

The power supply PCB applies power (VHD) to the thermal heating elements. The applied voltage varies from one head to the next, since the average resistance of each element varies. When the thermal head or power supply PCB are replaced, the applied voltage must be set to match the value specified for that particular head.

When creating a new master, the amount of energy sent to the head is controlled by varying the length of time during which power is applied. This is adjusted depending on the thermal head's current temperature. If the temperature is higher, the time will be shorter. The time setting is calculated when the Start key is pressed. It is kept throughout the entire master making process.

See *Thermal Head* for more information.

Thermal Head Protection

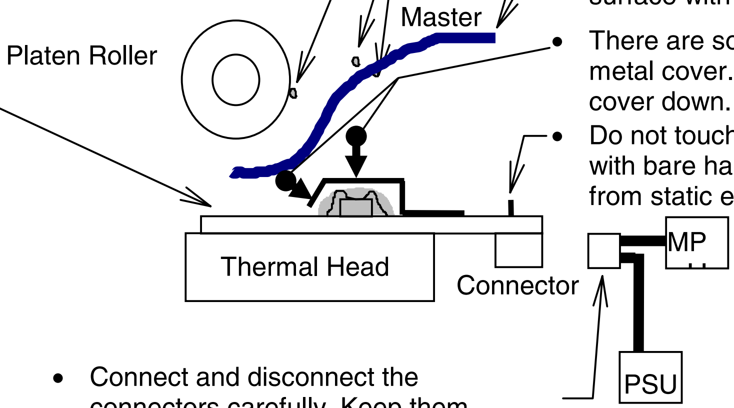
To prevent the thermal head from overheating when continuously processing a solid image, a thermistor in the thermal head is used to monitor the unit's temperature. The CPU checks for any unusual conditions when the Start key is pressed.

Special Handling

Pay attention to the following when servicing the thermal head.

- Do not touch the surface with bare hands. If this occurs, clean the surface with alcohol.
- Do not damage the heating elements.

- Remove any foreign materials from the platen roller.
- Remove foreign materials.
- Do not touch the master film surface with bare hands.
- There are some ICs inside the metal cover. Do not push the cover down.
- Do not touch the connector terminals with bare hands, to prevent damage from static electricity.



- Connect and disconnect the connectors carefully. Keep them horizontal and firmly reconnect them.
- Adjust the voltage supplied to match the specified value for the thermal head.

Digital Duplicator Specific Specifications

There are several specifications specific to digital duplicators. The following are some of the more noteworthy specifications, and can be useful when comparing the capabilities of two different machines.

Master Processing Time

This is the amount of time it takes to create a new master. All other things being equal, this is largely a function of the machine’s resolution. A 600 dpi machine will have a much longer master processing time than a 400 dpi machine. However, machines that buffer the master will have a much shorter master processing time than those that do not—regardless of resolution.

Run Length Per Master

This is the number of prints that can be made from a single master. If you need more copies than this, the machine will need to process the job in batches, creating a master for each batch.

Master Roll Yield

This lists the number of masters that can be created from one roll.

Master Eject Box Capacity

This lists the number of masters that can be created before the master eject box needs emptying.

Ink Recommended Maximum Storage Period

Duplicator ink has a limited shelf life. For example, the gradual evaporation of water from the ink will cause it to become overly viscous, reducing its quality. Other elements also contribute to a slow reduction in ink quality.

Printing Speeds

This is the sheet-per-minute speed from a single master. It does not take into account any master processing time. Unlike copiers, digital duplicators often have several different speed settings. Lower speeds allow higher density prints. The greater the density of ink on the page, the greater the likelihood of wrapping jams. The slower speeds help to compensate.

Since there is a direct trade-off between print quality and speed, several options are provided. The customer can select a speed appropriate to their needs.