Fig. 2.01 Standard pattern plate. Overall dimensions for different DISAMATIC molding machines.

<table>
<thead>
<tr>
<th></th>
<th>2013/A</th>
<th>2013/B</th>
<th>2120/30/A</th>
<th>2120/30/B</th>
<th>2120/30/C</th>
<th>2070/A</th>
<th>2070/B</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>600 mm (23.6&quot;)</td>
<td>650 mm (25.6&quot;)</td>
<td>730 mm (28.7&quot;)</td>
<td>775 mm (30.5&quot;)</td>
<td>850 mm (33.5&quot;)</td>
<td>950 mm (37.4&quot;)</td>
<td>950 mm (37.4&quot;)</td>
</tr>
<tr>
<td>B</td>
<td>480 mm (18.9&quot;)</td>
<td>535 mm (21.0&quot;)</td>
<td>600 mm (23.6&quot;)</td>
<td>660 mm (25.5&quot;)</td>
<td>700 mm (27.5&quot;)</td>
<td>800 mm (31.5&quot;)</td>
<td>800 mm (31.5&quot;)</td>
</tr>
<tr>
<td>C</td>
<td>20 mm (0.79&quot;)</td>
<td>20 mm (0.79&quot;)</td>
<td>25 mm (1.0&quot;)</td>
<td>25 mm (1.0&quot;)</td>
<td>25 mm (1.0&quot;)</td>
<td>25 mm (1.0&quot;)</td>
<td>25 mm (1.0&quot;)</td>
</tr>
</tbody>
</table>

Fig. 2.02 2013 DMM. STANDARD PATTERN PLATES (Assembly sketches)

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Pattern Plates and Patterns

In terms of quality, a DISAMATIC molding line must correspond to the advantages offered by a DISAMATIC molding machine. As we use to say: castings will never be better than the pattern. The purpose of using the DISAMATIC is to produce casting with the following properties:

- minimum shifting of parts
- minimum dimensional tolerances
- fine surface finish
- minimum application of cores
- minimum production cost
- high productivity

All the above properties are directly dependent upon the quality of the pattern equipment. Therefore, this section deals with our recommendations and advice concerning pattern equipment.

PATTERN-PLATE MATERIALS

Pattern plates for DISAMATIC molding machines are usually made of cast iron. Steel, resin and aluminum plates may also be used. In order to save weight on thick pattern plates, aluminum with an outer frame of steel may be used. When using aluminum and resin as pattern-plate material, allowances on plate width and length should be different from those applying to iron plates. This is due to the fact that the heat expansion coefficients are different for iron and aluminum.

On the other hand, thick pattern plates should be of cast construction. They may be solid, or they may be recessed on the rear side to reduce weight.

Another method very often used for thick pattern plates consists in employing a frame/rib bolster structure, which is filled up with gypsum or resin.

STANDARD PATTERN PLATES  Overall Dimensions (see Fig. 2.01)

Four lock screws (a) and two guide bushings (b) are mounted at the back of the 2013 standard plate. The bottom edge of the plate is completed with a nylon scraper strip (c), which prevents sand build-up under the pattern plate. The scraper is held fixed by a brass strip (d) (Fig. 2.02). The plate is provided with four bolts (e) on its back side for being handled by the Quick Pattern Change arrangement (QPC).

In addition to the lock screws (a), guide bushings (b), and scraper strip (c), the 2070 standard plate has three nylon side strips (e), which pre-
Fig. 2.03 2120 and 2130 DMS.

Fig. 2.04 2070 DMM.
vent damage to the plate edge, and a rail (f), which enables a rolling movement of the plate during pattern plate change, as well as facilitating storage and handling (Fig. 2.04).

The pattern plate for the 2070 machine has four lock screws (a), scraper (b) held by the brass strip (d), and two side strips (e) for protection. On the top of the 2070 plate there is a nylon protecting strip. The steel rail on the back is used for rolling the plate into the machine and out of it during pattern plate change. The guiding system is somewhat different from that of the 2013 DMM, since the plate is provided with two guide pins (b) fitting the guide bushings in the squeeze plates of the machine (Fig. 2.04).

CASSETTE SYSTEMS

When the production program consists of short series or situations requiring quick conversion of existing patterns into DISAMATIC patterns, a cassette system can be used with advantage. The principle of such a system is based on a permanent frame made of steel or gray iron, whose overall dimensions correspond to the standard plate dimensions. Patterns mounted on exchangeable base plates are screwed into the frame. The inside area of the frame can be utilized by one exchangeable pattern plate (full format - 1/1), two halves (½ format), or even smaller units, depending upon requirements. For cassette system examples, see Figs. 2.09, 2.10, 2.11, 2.12 and 2.13.

PATTERN PLATE UTILIZATION

Summary of Pattern Plate Utilization

When preparing a new pattern plate set, the following aspects should be considered:

1) Utilization of the surface area
   a) coverage of the pattern plate area by the pattern and gating system must not exceed 60%. The machines provided with the Mold Side Supports (MSS) should be able to run with a higher utilization if the sand properties and quality of molding materials allows it.
   b) The distance between the pattern and the upper (A), side (B) and bottom (C) edge of the plate must correspond with the figures in the table.
Fig. 2.05 Example of thick pattern plate bolster frame using frame/rib construction for 2013 DMS.

Fig. 2.06 Example of thick pattern plate bolster frame using frame/rib construction for 2120/2130 DMS.
Fig. 2.07 Example of thick pattern plate bolster frame using frame/rib construction, for 2070 DMM.

Fig. 2.08 A high pattern plate bolster frame built together of two standard pattern plates.
Fig. 2.09 Example of a 2070 DMM cassette system with a full size cassette insert plate made of polyurethane.

Fig. 2.10 Example of a cassette system for 2013 DMM within the field of malleable iron pipe fittings. Two halves of the pattern plate (aluminum) mounted on the gray iron base plate.

Fig. 2.11 Standard 2130 DMS cassette system.
Fig. 2.12 Example of a cassette system for 2013 DMM.

Fig. 2.13 Example of a cassette system for 2070. Cassette frame, built of steel around a standard 2070 pattern plate of gray iron.
Fig. 2.14 This mold has contained a casting, the pattern of which covered approx. 60% of the total area of the pattern plate (2070).

Fig. 2.15 Utilization of surface area.
2) Utilization of thickness

a) Maximum permissible overall thickness of both patterns.

b) Maximum permissible thickness of thick pattern plate, if required, on counter-pressure side.

c) Maximum permissible thickness of pattern on the counter-pressure plate, so that the pattern remains within the involute curve.

d) Maximum permissible thickness of pattern on counter-pressure plate, without causing pattern top to collide with the injection slot.

e) Maximum permissible thickness of the pattern on the squeeze plate, without causing pattern top to collide with the injection slot.

f) Maximum permissible pattern height on the counter-pressure plate, so that the top of the pattern clears the front edge of the molding chamber after maximum draw of the counter-pressure plate, just before the swing operation.

Utilization of Surface Area

The degree of pattern-plate surface area utilization is restricted by the basic sand features:

(1) Thermal, static, and dynamic sand stability.

(2) Stability and pressure deformation while molds are being conveyed forward.

Plate area covered by the pattern and the gating system should not exceed 60% of the total plate area (Fig. 2.14).

Many factors influence these features, but the strongest criterion for high-quality castings is sand stability until solidification is complete, as well as pressure deformation. Factors determining sand stability during solidification for side and bottom walls include total pattern height and wall thickness. The tables on Fig. 2.16 and 2.17 give guidelines for determination of the safety distances on the pattern plates (see also Fig. 2.15).
### Fig. 2.16 The following table should be used as a guide only for 2070, 2120/A/C and 2130/A/C.

| CASTING WALL THICKNESS | MODUL OF SOLIDIFICATION | TOTAL PATTERN HEIGHT (without pattern plates) | TOP EDGE "A" | SIDE EDGES "B" | BOTTOM EDGE "C"
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>in.</td>
<td>cm</td>
<td>mm</td>
<td>in.</td>
<td>mm</td>
</tr>
<tr>
<td>0-10</td>
<td>0-0.4</td>
<td>0-0.5</td>
<td>0-0.2</td>
<td>0-30</td>
<td>0-1.2</td>
</tr>
<tr>
<td>30-60</td>
<td>1.2-2.4</td>
<td></td>
<td></td>
<td>60-80</td>
<td>2.4-3.2</td>
</tr>
<tr>
<td>60-100</td>
<td>2.4-3.9</td>
<td></td>
<td></td>
<td>80-120</td>
<td>3.9-4.7</td>
</tr>
<tr>
<td>100-200</td>
<td>3.9-7.9</td>
<td></td>
<td></td>
<td>100-120</td>
<td>3.9-4.7</td>
</tr>
<tr>
<td>200-300</td>
<td>7.9-11.8</td>
<td></td>
<td></td>
<td>100-120</td>
<td>3.9-4.7</td>
</tr>
<tr>
<td>300-400</td>
<td>11.8-15.8</td>
<td></td>
<td></td>
<td>120-140</td>
<td>4.7-5.5</td>
</tr>
</tbody>
</table>

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Fig. 2.17 The following table should be used as a guide only for 2013, 2120/B and 2130/B.
Fig. 2.18 Mold Thickness for Different Molding Machine Models.

Fig. 2.19 Schematic presentation of counterpressure plate swinging operation.
Utilization of Mold Thickness

Maximum pattern-plate plus pattern thickness is given by the maximum chamber depths of the individual types of machines. This means that if thicker plates plus patterns than the maximum thickness are fitted on the machine, then the patterns will get damaged due to collision during the squeeze operation.

The limitation of pattern plate plus pattern on the counter-pressure plate is defined by a curve described during the upswing. (Fig. 2.19).

All patterns located inside the curve traced by the involute will clear the upper edge of the molding chamber during the upswing of the counter-pressure plate, but if these limits are utilized in practice, the pattern will be exposed to direct influence during the sand shot.

Another limitation is imposed by the sand injection slot. A pattern which is under the sand injection slot during sand injection, will be exposed to wear due to "sand blowing". Whether one wants to employ so large a pattern that it will be under the slot, will therefore depend on the pattern material and the desired pattern life.

Maximum Draw of Counter-pressure Plate

There is one more pattern height limit which concerns patterns placed on the counter-pressure plate. This is maximum draw of the plate before it starts to swing. This is important due to the fact that it is difficult to change a pattern plate when the top of the pattern is not completely free of the front of the molding chamber.

Mold Delivery Point Too Far Away

When the thickness of the pattern plate on the squeeze side increases, the delivery point of the last mold shifts forwards. At some stage, the delivery point can be so far away that the maximum stroke of the Core Setter is not sufficiently long to deliver the core to the mold.

When producing cored castings, this is one of the pattern plate thickness limitations on the squeeze side.

Determination of Minimum Chamber Depth

Optimum chamber depth must be calculated for each new set of pattern plates used on 2013. (2070 and 2120/2130 calculate and adjust the chamber depth automatically on the basis of pattern height figures entered in the microcomputer of the machine).

In order to better understand the chamber depth calculation method, molding sand blown into the molding chamber should be considered in two states:

Before the squeezing and after the squeezing operation.
Fig. 2.20  Basic dimensions of mold before and after squeezing.

Fig. 2.21  Total pattern and pattern-plate heights for various configurations of patterns and pattern plates, when $S = 70$ mm and with 25% sand compression. (All dimensions in mm).
Compressibility \( (K) \) of the sand (mold thickness reduction in per cent before and after the squeezing operation) is normally approx. 25% (when blow pressure = 3 \( \text{kp/cm}^2 \) (43 psi), mold squeeze pressure = 10 \( \text{kp/cm}^2 \) (143 psi) and sand compactability = 40%). Chamber depth can be calculated by using the following designations (see Fig. 2.20).

\[ A = \text{thickness of pattern plate on the swing side} \]

\[ B = \text{thickness of pattern plate on the squeeze side} \]

\[ C = \text{minimum possible chamber depth. A certain pattern set can be produced with} \]

\[ F = \text{distance between pattern plates in the molding chamber before squeezing} \]

\[ K = \text{compressibility of the sand (approx. 0.25)} \]

\[ P = \text{pattern height on the swing side} \]

\[ Q = \text{pattern height on the squeeze side} \]

\[ S = \text{minimum distance between mold cavities to ensure good mold stability and to avoid metal breakthrough from one mold cavity to another, 70 mm (2.8\text{"}))} \]

\[ T = \text{necessary mold thickness} \]

The minimum possible chamber depth can be expressed as:

\[ C = F + (A + B) \]  \hspace{1cm} (1)

\[ F = \frac{T}{1 - K} = \frac{T}{0.75} \]  \hspace{1cm} (2)

and

\[ T = P + Q + S \]  \hspace{1cm} (3)

If we insert (3) in (2) and (2) in (1), the chamber depth can be expressed as:

\[ C = \frac{P + Q + S}{0.75} + (A + B) \]  \hspace{1cm} (4)

Consequently, the suggested sequence of calculation of the minimum chamber depth will be:

**STEP 1:** Total plate thickness: \( A + B \)

**STEP 2:** Total pattern height (without plates): \( P + Q \)

**STEP 3:** Necessary mold thickness: \( T = (P + Q) + S \)
Fig. 2.22 When the mold parting line is shifted, the mold thickness $T_1$ is not always equal to the mold pitch $T$.

Fig. 2.23 Chamber depth $C$ set smaller than indicated by table. Squeeze-plate movement without crash pins: Patterns will collide and be damaged. Squeeze-plate movement with crash pins: Movement is stopped by pin-to-pin collision.
STEP 4: Necessary separation between pattern plates before squeezing operation

\[ F = \frac{T}{0.75} \]

STEP 5: Minimum calculated chamber depth to be selected:

\[ C = F + (A + B) \]

STEP 6: Minimum Chamber Depth to be Set on the Machine

The example on Fig. 2.21 shows a way of chamber depth determination for 2013/A for three different pattern plate types.

When adjusting the molding chamber depth to the required value, this value for the 2013 DMM can be read directly on the molding chamber depth meter.

The 2120, 2130 and 2070 DMM sets the chamber depth automatically, and a special safety device prevents the possibility of pattern plate collision.

NOTE: When using shifted parting line terms: molding thickness \( T_1 \) is not equal to the mold pitch \( T \) (see Fig. 2.22), but in this section we are only talking of mold thickness \( T_1 \).

In many cases it is even advisable to increase the chamber depth beyond the calculated minimum values. For example, it is always good practice to choose the chamber depth large enough, so that patterns do not project under the injection slot in the molding-chamber top plate. The reason why pattern plates collide when a chamber depth smaller than the indicated minimum depth is employed, is that the squeeze plate will always travel through the chamber during the squeeze operation, both when there is sand in it and when there is no sand in it. If the molding chamber is full of sand, the squeeze operation will be terminated by the resistance offered by the sand against the movement of the squeeze plate. When there is no sand in the molding chamber, the squeeze plate will travel over a distance \( S \), called the safety stroke. The safety stroke is proportional to the chamber depth \( C \), and its length will always exceed the squeeze-plate travel during the maximum obtainable compression of a mold in the chamber. Hence, the chamber depth \( C \) must always be chosen sufficiently large to ensure that the distance \( X \) (see Fig. 2.23) will in all cases exceed the length of the safety stroke \( S \).

Should it prove necessary to use a chamber depth smaller than the minimum value calculated, precautions should be taken when manufacturing the pattern equipment to prevent any damage that might occur, should the pattern plates collide. This should be done by providing a minimum of two crash pins on each pattern plate, each crash pin being of course aligned with one on the opposite pattern plate (Fig. 2.23).

These pins are made of steel and should not be tapered, with a minimum diameter of 25 mm (1") and of sufficient length to protrude beyond the highest point of the pattern.
Fig. 2.24 Dimensions around the molding chamber of a 2013/A DISAMATIC.
<table>
<thead>
<tr>
<th>Formula</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>F = C - (A + B)</td>
<td>430</td>
</tr>
<tr>
<td>T = F × 0.75</td>
<td>322</td>
</tr>
<tr>
<td>P + Q = T - S</td>
<td>252</td>
</tr>
<tr>
<td>A + B</td>
<td>292</td>
</tr>
</tbody>
</table>

Maximum permissible thickness of pattern on counter pressure plate, including pattern plate, without causing pattern to collide with the sand injection slot.

- A = 20
- P = 137

Maximum permissible thickness of pattern on squeeze plate, including pattern plate, without causing the pattern to collide with the sand injection slot.

- B = 20
- Q = 243

Maximum permissible thickness of pattern plate on counter pressure side and pattern on squeeze side, due to swing involute. See fig. 2.24.

- A = 92
- F = C - (A + B) = 358
- T = F × 0.75 = 268
- Q = T - S = 198

Maximum permissible thickness of pattern plate on squeeze side and pattern on counter pressure side.

- B = 155
- P = 150

P ≥ B - min. 5

2013 A

Fig. 2.25 Total maximum pattern and pattern-plate heights for various configurations of patterns and pattern plates. Calculations based on S = 70 mm, sand compressibility 25% and with max. chamber depth 470 mm. (All dimensions in mm).

If your pattern height exceeds the above values, please contact DISA.

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Fig. 2.26 Dimensions around the molding chamber of a 2013/B DISAMATIC.
**Maximum permissible overall thickness of both patterns, including pattern plates. (In case of two positive patterns)**

\[
egin{align*}
F &= C - (A + B) = 430 \\
T &= F \times 0.75 = 322 \\
P + Q &= T - S = 252 \\
A + B &= 40 \rightarrow 292
\end{align*}
\]

**Maximum permissible thickness of pattern on counter pressure plate, including pattern plate, without causing pattern to collide with the sand injection slot.**

\[
\begin{align*}
A &= 20 \rightarrow 157 \\
P &= 137 \rightarrow 157
\end{align*}
\]

**Maximum permissible thickness of pattern on squeeze plate, including pattern plate, without causing the pattern to collide with the sand injection slot.**

\[
\begin{align*}
B &= 20 \\
Q &= 243 \rightarrow 263
\end{align*}
\]

**Maximum permissible thickness of pattern plate on counter pressure side and pattern on squeeze side, due to swing involute. See fig. 2.26.**

\[
\begin{align*}
A &= 45 \\
F &= C - (A + B) = 405 \\
T &= F \times 0.75 = 304 \\
Q &= T - S = 234
\end{align*}
\]

**Maximum permissible thickness of pattern plate on squeeze side and pattern on counter pressure side.**

\[
\begin{align*}
B &= 155 \\
P &= 150 \\
P &\geq B - \text{min.} \ 5
\end{align*}
\]

Fig. 2.27 Total maximum pattern and pattern-plate heights for various configurations of patterns and pattern plates. Calculations based on \(S = 70\) mm, sand compressability 25% and with max. chamber depth 470 mm. (All dimensions in mm).

If your pattern height exceeds the above values, please contact DISA.

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Fig. 2.28 Dimensions around the molding chamber of a 2120/2130/A DISAMATIC.
Maximum permissible overall thickness of both patterns, including pattern plates.
(In case of two positive patterns)

\[
\begin{align*}
F &= C - (A + B) = 623 \\
T &= F \times 0.75 = 467 \\
P + Q &= T - S = 397 \\
A + B &= 50 \rightarrow 447
\end{align*}
\]

Maximum permissible thickness of pattern on swingable squeeze plate, including pattern plate, without causing pattern to collide with the sand injection slot.

\[
\begin{align*}
A &= 25 \rightarrow 240 \\
P &= 215 \rightarrow 240
\end{align*}
\]

Maximum permissible thickness of pattern on squeeze plate, including pattern plate, without causing the pattern to collide with the sand injection slot.

\[
\begin{align*}
B &= 25 \rightarrow 378 \\
Q &= 353 \rightarrow 378
\end{align*}
\]

Maximum permissible thickness of pattern plate on swingable squeeze side and pattern on squeeze side, due to swing involute. See fig. 2.28

\[
\begin{align*}
A &= 240 \\
F &= C - (A + B) = 408 \\
T &= F \times 0.75 = 306 \\
Q &= T - S = 236
\end{align*}
\]

Maximum permissible thickness of pattern plate on squeeze side and pattern on swingable squeeze side.

\[
\begin{align*}
B &= 220 \\
P &= 215 \geq B - \text{min. 5}
\end{align*}
\]

Fig. 2.29 Total maximum pattern and pattern-plate heights for various configurations of patterns and pattern plates. Calculations based on \( S = 70 \) mm, sand compressability 25% and with max. chamber depth 673 mm. (All dimensions in mm).

If your pattern height exceeds the above values, please contact DISA.

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Fig. 2.30 Dimensions around the molding chamber of a 2120/2130/B DISAMATIC.
Maximum permissible overall thickness of both patterns, including pattern plates.
(In case of two positive patterns)

\[
F = C - (A + B) = 623 \\
T = F \times 0.75 = 467 \\
P + Q = T - S = 397 \\
A + B = 50 \rightarrow 447
\]

Maximum permissible thickness of pattern on swingable squeeze plate, including pattern plate, without causing pattern to collide with the sand injection slot.

\[
A = 25 \rightarrow 240 \\
P = 215 \rightarrow 240
\]

Maximum permissible thickness of pattern on squeeze plate, including pattern plate, without causing the pattern to collide with the sand injection slot.

\[
B = 25 \rightarrow 378 \\
Q = 353 \rightarrow 378
\]

Maximum permissible thickness of pattern plate on swingable squeeze side and pattern on squeeze side, due to swing involute. See fig. 2.30

\[
A = 240 \\
F = C - (A + B) = 408 \\
T = F \times 0.75 = 306 \\
Q = T - S = 236
\]

Maximum permissible thickness of pattern plate on squeeze side and pattern on swingable squeeze side.

\[
B = 220 \\
P = 215 \\
P \geq B - \text{min. 5}
\]

2120/2130 B

Fig. 2.31 Total maximum pattern and pattern-plate heights for various configurations of patterns and pattern plates. Calculations based on S = 70 mm, sand compressability 25\% and with max. chamber depth 673 mm. (All dimensions in mm).

If your pattern height exceeds the above values, please contact DISA.

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Fig. 2.32 Dimensions around the molding chamber of a 2120/2130/C DISAMATIC.
Maximum permissible overall thickness of both patterns, including pattern plates. (In case of two positive patterns)

\[ F = C - (A + B) = 623 \]
\[ T = F \times 0.75 = 467 \]
\[ P + Q = T - S = 397 \]
\[ A + B = 50 \to 447 \]

Maximum permissible thickness of pattern on swingable squeeze plate, including pattern plate, without causing pattern to collide with the sand injection slot.

\[ A = 25 \to 240 \]
\[ P = 215 \]

Maximum permissible thickness of pattern on squeeze plate, including pattern plate, without causing the pattern to collide with the sand injection slot.

\[ B = 25 \]
\[ Q = 353 \to 378 \]

Maximum permissible thickness of pattern plate on swingable squeeze side and pattern on squeeze side, due to swing involute. See fig. 2.32

\[ A = 240 \]
\[ F = C - (A + B) = 408 \]
\[ T = F \times 0.75 = 306 \]
\[ Q = T - S = 236 \]

Maximum permissible thickness of pattern plate on squeeze side and pattern on swingable squeeze side.

\[ B = 220 \]
\[ P = 215 \]
\[ P \geq B - \min 5 \]

2120/2130 C

Fig. 2.33 Total maximum pattern and pattern-plate heights for various configurations of patterns and pattern plates. Calculations based on \( S = 70 \) mm, sand compressibility 25% and with max. chamber depth 573 mm. (All dimensions in mm).

If your pattern height exceeds the above values, please contact DISA.

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Fig. 2.34 Dimensions around the molding chamber of a 2070/A DISAMATIC.
Maximum permissible overall thickness of both patterns, including pattern plates. (In case of two positive patterns)

\[
\begin{align*}
F &= C - (A + B) = 734 \\
T &= F \times 0.75 = 550 \\
P - Q &= T - S = 480 \\
A + B &= 50 \rightarrow 530
\end{align*}
\]

Maximum permissible thickness of pattern on swingable squeeze plate, including pattern plate, without causing pattern to collide with the sand injection slot.

\[
\begin{align*}
A &= 25 \rightarrow 300 \\
P &= 275
\end{align*}
\]

Maximum permissible thickness of pattern on squeeze plate, including pattern plate, without causing the pattern to collide with the sand injection slot.

\[
\begin{align*}
B &= 25 \rightarrow 391.5 \\
Q &= 366.5
\end{align*}
\]

Maximum permissible thickness of pattern plate on swingable squeeze side and pattern on squeeze side, due to swing involute. See fig. 2.34

\[
\begin{align*}
A &= 240 \\
F &= C - (A + B) = 519 \\
T &= F \times 0.75 = 389 \\
Q &= T - S = 319
\end{align*}
\]

Maximum permissible thickness of pattern plate on squeeze side and pattern on swingable squeeze side.

\[
\begin{align*}
B &= 280 \\
P &= 275 \\
P &\geq B - \text{min. 5}
\end{align*}
\]

Fig. 2.35 Total maximum pattern and pattern-plate heights for various configurations of patterns and pattern plates. Calculations based on \(S = 70\) mm, sand compressability 25% and with max. chamber depth 784 mm. (All dimensions in mm).

If your pattern height exceeds the above values, please contact DISA.

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Fig. 2.36 Dimensions around the molding chamber of a 2070/B/620 DISAMATIC
Maximum permissible overall thickness of both patterns, including pattern plates. (In case of two positive patterns)

\[
\begin{align*}
F &= C - (A + B) = 799 \\
T &= F \times 0.75 = 600 \\
P + Q &= T - S = 530 \\
A + B &= 50 \rightarrow 580
\end{align*}
\]

Maximum permissible thickness of pattern on swingable squeeze plate, including pattern plate, without causing pattern to collide with the sand injection slot.

\[
\begin{align*}
A &= 25 \rightarrow 300 \\
P &= 275
\end{align*}
\]

Maximum permissible thickness of pattern on squeeze plate, including pattern plate, without causing the pattern to collide with the sand injection slot.

\[
\begin{align*}
B &= 25 \rightarrow 456.5 \\
Q &= 431.1
\end{align*}
\]

Maximum permissible thickness of pattern plate on swingable squeeze side and pattern on squeeze side, due to swing involute. See fig. 2.36

\[
\begin{align*}
A &= 212 \\
F &= C - (A + B) = 612 \\
T &= F \times 0.75 = 459 \\
Q &= T - S = 389
\end{align*}
\]

Maximum permissible thickness of pattern plate on squeeze side and pattern on swingable squeeze side.

\[
\begin{align*}
B &= 280 \\
P &= 275 \\
P &= B - \text{min. 5}
\end{align*}
\]

Fig. 2.37 Total maximum pattern and pattern-plate heights for various configurations of patterns and pattern plates. Calculations based on \( S = 70 \) mm, sand compressability 25% and with max. chamber depth 949 mm. (All dimensions in mm).

If your pattern height exceeds the above values, please contact DISA.

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Fig. 2.38 Copy milling masters and the Master core for a differential case casting.
Fig. 2.39 This set of patterns is used for production of a heavy truck brake drum with a protruding green sand core.
PATTERN DESIGN

Pattern Construction

The making of pattern plates requires the utmost care. It is definitely poor economy to save on pattern costs at the expense of fettling. Such a policy will seriously slow down the rate of production, and the time required for fettling will be considerably longer. Also, the quality will suffer. On the other hand, the size of a job has decisive influence on the choice of pattern material and on pattern construction.

Metal patterns are still considered to ensure a long life, and especially full-machined patterns are very accurate in terms of dimensions.

Synthetic resins, however, are today used to a continually increasing extent as pattern material in spite of their shorter life. A clear advantage of the resin patterns is the fast reproducibility and the relatively low costs of material and of production, compared with metal patterns. A combination of metal and resins is successfully employed both for designing pattern plates and for the patterns themselves.

The examples shown below cover various solutions of pattern design for DISAMATIC machines.

Pattern Plate Material Selection

Besides the length of the run, the choice of pattern material should be influenced by pattern heights, location of the patterns on the plate, the geometry of the pattern, and whether the pattern will be placed on the squeeze or the counter-pressure side. Blow pressure, molding sand type, pattern temperature can also be significant factors in determining pattern material, and hence pattern wear and pattern life. The figures below must therefore be subject to reservations, but they will nevertheless give a fair indication of what to choose.

<table>
<thead>
<tr>
<th>PATTERNS OR PATTERN PLATE MATERIALS</th>
<th>LIFE (NUMBER OF BLOWS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft plaster</td>
<td>100 - 500</td>
</tr>
<tr>
<td>Hard wood</td>
<td>500 - 1,000</td>
</tr>
<tr>
<td>Hard plaster</td>
<td>1,000 - 5,000</td>
</tr>
<tr>
<td>Plastic plaster</td>
<td>2,000 - 10,000</td>
</tr>
<tr>
<td>Epoxy resin</td>
<td>5,000 - 50,000</td>
</tr>
<tr>
<td>Polyurethane resin</td>
<td>20,000 - 60,000</td>
</tr>
<tr>
<td>Aluminum alloys</td>
<td>20,000 - 60,000</td>
</tr>
<tr>
<td>Copper alloys</td>
<td>40,000 - 60,000</td>
</tr>
<tr>
<td>Gray cast iron</td>
<td>200,000 - 300,000</td>
</tr>
<tr>
<td>Low-alloy steel</td>
<td>300,000 - 500,000</td>
</tr>
</tbody>
</table>

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Fig. 2.40  Gray iron patterns, fully machined, bolted to a standard iron plate.

Fig. 2.41  Standard gray iron pattern plate with fully machined brass patterns.
Fig. 2.42 Gray iron pattern plate with patterns cast of polyurethane resin around an aluminum insert.

Fig. 2.43 Polyurethane resin pattern plate surface cast together with pattern. Backing material inside is a foamy epoxy resin.
Fig. 2.44 Integrated pattern plate cast in solid polyurethane.
Coating of metallic patterns with nickel or chromium results in a further life increase, not only because of an increase of hardness, but also because the patterns can be dismantled from the plate and recoated when the coating layer has worn through.

A discussion of the numerous different alloys suitable for patterns would prove very lengthy. We could, however, point to a few of them:

(a) Aluminum alloy containing 4% Cu and 3% Si.

(b) Bronze alloy containing 2% Ni and 0.3% Si.

(c) Beryllium bronze containing approx. 2% Be (should be treated so that high surface hardness is obtained).

(d) Red brass No. 5 containing 85% Cu, 5% tin, 5% lead, 5% zinc, and max. 2% Ni.

(e) Zinc alloys containing 91-92% zinc, 5% Al, and 3-3.5% Cu. Although more difficult to cast than aluminum alloys, they are frequently used for patterns and are particularly suited for permanent-mold casting. This alloy is known commercially as "kirksite".

For long production runs we recommend cast iron patterns for molding in the DISMATIC. The relatively moderate additional cost will be recovered through the increased life.

Pattern Production Technique

The technique generally used for the production of a series of metal patterns consists of first making a master pattern in wood or resin. Where small patterns are required, the master copy pattern can be made to a larger scale, say 2:1 or more, in order to minimize the dimensional inaccuracies of the completed pattern.

Thereafter, two alternatives exist:

(1) Making all patterns on a copying machine, on the basis of the master pattern.

(2) Making a mold in which the pattern is cast.

If the master pattern is made to a scale of 1:1, copies of it can be cast in light-alloy metal in molds made of special sand (Petro Bond) or plaster/gypsum cement. If cast-iron or steel patterns are required, molds can be made of ceramic materials (aluminum-oxide or zirconiumoxide powder, using ethylene silicate as binder) or conventional claybonded sand. After the joint surfaces have been machined and finished, the patterns are assembled in pairs and the locator holes drilled. Then one pattern half is positioned on the plate, which is then drilled via the pattern locator holes. The next step is to assemble the two plates front to front, using pattern plate locator pins, and to drill the second plate through the holes in the first plate. This method ensures that both pattern halves always correspond with each other when mounted on the plates.
Fig. 2.45 Different pattern plate and pattern construction methods.

Fig. 2.46 Graphical representation of pattern draft.
When resin patterns are to be produced, a master pattern should be made of resin or wood. Then a negative of the pattern can easily be cast in a synthetic resin. The negative is a basis for further operations. The patterns can be cast in it separately and then be mounted on the pattern plate. In that case some metal parts (bushings, grids) can be cast into the resin plate to ensure mounting of standard pattern plate parts, like scraper strips, lock screws, rails, etc.

Generally, the following pattern and pattern plate construction methods can be employed (Fig. 2.45).

METHOD 1: Patterns of metal or resin, bolted on the metal plate, either standard or a thick one. The patterns can be cast and polished manually or machined.

METHOD 2: Similar to Method 1, but the patterns are indented in the pattern plate and bolted to it. The patterns can be of metal or resin.

METHOD 3: The patterns are surface-cast of resin on a core roughly corresponding to the final pattern shape. The core can be cast of metal or of foam resin. In both cases, the core insert is prepared in advance, and a negative of the final pattern shape is fixed on the insert. The void between the core and the negative surface is subsequently cast in between. The pattern can be cast directly in a metal plate (a) or later bolted in as an indented pattern.

METHOD 4: The patterns are cast in their negative directly in the pattern plate.

METHOD 5: Pattern and pattern plate cast in one piece of resin over a negative. The plate has a frame of cast iron and some bushings of steel at the rear.

METHOD 6: Pattern and pattern plate cast in one piece over a negative. A grid of cast iron is cast in for higher rigidity, for lower thermal movement of the resin, and for mounting standard pattern plate parts.

METHOD 7: Pattern and pattern plate surface cast of wear-resistant resin and inside backing core, either metallic or cast of foam resin. Metal bushings cast into the rear for lock screw mounting.

Pattern Draft
Minimum pattern draft generally depends on pattern height. But many other factors, such as pattern material, surface finish, pattern shape, sand quality and squeeze pressure influence the draft very strongly. On the opposite page is shown a graph of pattern draft recommended by DISA (Fig. 2.46).

Depending on pattern, sand quality and machine settings, it will often be possible to use less outside draft than shown in Figs. 2.47, 2.48 and 2.49.
Fig. 2.47  a) The correct draft ensures lift-off without tearing.
   b) The draft may be reduced by pulling a fillet around the pattern.

Fig. 2.48 Especially turned patterns can often cause sand tear-off, since the draft at the parting line is 0°. This can be helped by applying a fillet R 2-3 mm (0.08-0.12”). Normally a fillet of 0.5-1 mm (0.02-0.04”) will be sufficient.

Fig. 2.49 Sometimes the casting manufacturer accepts a slight increase of the draft at the parting line, which solves the problem of sand tear-off.

Fig. 2.50 Guide pin has no draft and should be min. ø25 (1”).

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A pattern on the counter-pressure plate often requires less draft than the one on the squeeze plate.

**Pattern Guiding in the Mold**

Mounting of guide pins on the pattern plate provides a more accurate pattern-mold separation during the very first stage of pattern stripping. The more accurate the separation, the less sand tear-off tendency.

The number and location of guide pins depend on the complexity of pattern and area situation on the plate. Fig. 2.50 shows the shape of a recommended guide pin.

The guide pins must be fixed tightly, perpendicularly to the pattern plate. If the guide pins are longer than the total pattern height, they will also protect patterns which may collide in the molding chamber if the chamber depth setting for instance is incorrect. See also Fig. 2.23 (Minimum Chamber Depth Calculation).

**Lift-off Devices**

A rubber ball in the bottom of a deep concave pattern part can help to push green sand molds out during stripping by delivering back the energy which was accumulated in it during squeezing (Fig. 2.51).

If an impression-less top of the green sand mold is required after mold assembly, a convex rubber lifter can be employed. Air holes must be provided under the lifter as shown on Fig. 2.52. The softness, surface area and thickness of the rubber ball or lifter depend on the pressure that will be exercised on the part of the pattern question during the squeezing operation. In turn, the pressure depends on machine settings, depth of pattern, and surface finish of pattern.

**Pattern Venting**

In order to avoid vacuum formation in the deep patterns during lift-off and in order to ensure proper air evacuation during the sand-blow operation, air vents can be mounted in the bottom of problematically deep patterns. Figs. 2.53 and 2.54 show the vents and how to install them.

It is essential to connect the air vent with the ambient atmosphere by drilling a hole through the pattern plate behind the air vent and to provide a groove on the rear of the pattern plates so that the groove connects the vent with the nearest venting groove in the heating plate of the molding machine as shown on Figs. 2.56, 57, 59, 60, 61, and 2.62.

It is uneconomical to save on production and maintenance of pattern equipment at the expense of casting quality. Such a policy will seriously slow down the rate of production, increase the rejection rate, and the time required for casting cleaning will be considerably longer.

Pattern equipment must therefore fulfill several dimensional requirements to ensure full utilization of a well-adjusted molding machine.
Fig. 2.51 Rubber ball as energy accumulator during squeezing and stripping. Beside the casting after pouring.

Fig. 2.52 Rubber lifter accumulates energy during squeezing, which helps push the sand out of the pattern without leaving any impression on the mold.
Fig. 2.53 Air venting of deep patterns.

Fig. 2.54 It is important to ensure connection between the venting valve in the pattern plate and the venting groove in heating plate of the machine.

Fig. 2.55 Different types of air vents
a) Slot vents  b) Mesh vents  c) Self-cleaning vents.
Fig. 2.56 2013/A. Venting grooves on heater plates.

Fig. 2.57 2013/B. Venting grooves on heater plates.
Fig. 2.59 2120/2130/B. Pattern venting grooves on heater plates. The black areas only are contact areas between heater plate and pattern plate.
Fig. 2.60 2120/2130/C Pattern venting grooves on heater plates. The black areas only are contact areas between heater plate and pattern plate.

Fig. 2.61 2070/A. Venting grooves on heater plates.

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Fig. 2.62 2070/B. Venting grooves on heater plates.
Fig. 2.63 Flexible guiding of the pattern plates on the machine ensures one-direction extension, due to the thermal expansion of the plates.

Fig. 2.64 Patterns are dimensioned from the left guide on the counter-pressure plate and from the right on the squeeze plate.
Pattern Location on the Pattern Plate

The patterns on either pattern plate must be accurately placed. Shifted patterns cause mismatch defects of the casting and make it impossible to set cores accurately into the mould impression.

Pattern plates are guided in the base planes of the molding machines by means of guide pins and guide bushings.

One of the guides is always fixed, and the other is shaped so that pattern plate movements caused by heat expansion are possible (Fig. 2.64). The location of the patterns on the plate must always be determined from the fixed guide of the plates.

Therefore, as soon as it can be determined which pattern will be mounted on the counterpressure side and which on the squeeze side, it is at the same time determined from which guide the pattern's location will be marked (facing the plates):

- for the plate on the counterpressure side: from the left guide.
- for the plate on the squeeze side: from the right guide, looking at the pattern plate layout.

The table below shows the guidelines for pattern location tolerances on the plate.

Nominal Dimension

<table>
<thead>
<tr>
<th>From (mm)</th>
<th>To (mm)</th>
<th>Tolerances (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>150</td>
<td>+0.035</td>
</tr>
<tr>
<td>150</td>
<td>300</td>
<td>+0.045</td>
</tr>
<tr>
<td>300</td>
<td>450</td>
<td>+0.055</td>
</tr>
<tr>
<td>450</td>
<td>600</td>
<td>+0.065</td>
</tr>
<tr>
<td>600</td>
<td>750</td>
<td>+0.075</td>
</tr>
<tr>
<td>750</td>
<td>900</td>
<td>+0.085</td>
</tr>
</tbody>
</table>

Pattern Plate Guide Pins and Bushings

Pattern plate guide pins and bushings must not be worn down. Worn bushings or pins will immediately cause dimensional inaccuracies of the casting. For this reason, the guide pins and bushings must be controlled regularly for wear and replaced, if necessary.

Guide bushing (pin) distance is one of the important characteristics of each type of pattern plate.

Figs. 2.65, 2.66 and 2.67 show the proper distance for all three sizes of DISAMATIC's.
Fig. 2.65 2013 DMW. Pattern plate guide pins, their diameter and distance.

Fig. 2.66 2120/2130. Pattern plate guide pins, their diameter and distance.
Fig. 2.67 2070 DMM. Pattern plate guide pins, their diameter and distance.
Fig. 2.68 Plane parallelism of the standard plate may not exceed 0.1 mm (0.004").

Fig. 2.69 Non-plane parallel pattern plates will produce untransportable and inaccurate mold string.

Fig. 2.70 Make sure that there is the correct distance between the lock screws and the rear of the pattern plate by verifying that the screws are tightened.

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Plane Parallelism

Both sides of the standard pattern plate must be plane parallel, meaning that parallelism deviation on the longest dimension of the plate may not exceed 0.1 mm (0.004") (see Fig. 2.68). Plane parallelism error will cause production of unparallel molds as shown on Fig. 2.69.

Lock Screws

Screws for fixing pattern plates must be screwed all the way home. This ensures that the distance between the screw head and the rear of the cassette corresponds to the travel of the pneumatic pattern plate locks (Fig. 2.70). However, it should be possible to loosen the lock screws manually by simply using a wrench. A pattern plate with loosened lock screws will be locked incorrectly in the heater plate of the molding machine (Fig. 2.71), causing non-parallelism of the closing surfaces of the mold. This may result in dimensional errors in the castings, fin formation and mold smash-up during transport.

Scraper Strip

The scraper strip must be flush with the rear edge of the groove in the lower edge of the pattern plate. A shifted or deformed scraper strip (fig. 2.72) may cause sand build-up on the other side of the pattern plate. This will lead to poor lift-off and increased wear of the chamber bottom plate.

Side Strips

A defective edge strip applied in a 3070 MM may cause formation of sand casts in the parting line of the mold. This applies in particular to impact marks on the edge strips (Fig. 2.73). The sand cast, which is an exact impression of the impact mark from the edge strip, will break off during mold stripping or mold close-up and fall into the mold cavity, thus causing sand inclusion in the casting. If several well-compressed sand casts are formed in the edge strips, this may make mold closure difficult, which in turn may cause dimensional inaccuracy in the casting, and in extreme cases lead to fin formation on the casting.

Pouring Cup Wear Plates

The cup is provided with a replaceable wear plate. The plate is intended to ensure

- that the upper surface of the cup is without draw. This is important to avoid formation of a sand fillet (Fig. 2.74), which may cause sand inclusion in the casting by falling into the mold cavity;

- that the pouring cup is protected against unnecessary wear during the sand shot and plate handling.

Impact marks on the wear plate of the cup described in connection with control of edge strips may also cause formation of sand fins that may drop into the mold cavity (see also Fig. 2.74).
Fig. 2.71 A pattern plate with incorrect lock screw distance or dirt on the back surface causes non-parallel mold parting lines.

Fig. 2.72 Typical scraper strip fault.  Fig. 2.73 Typical edge strip defect.

Fig. 2.74 Pouring cup wear plate and typical faults in it.
CONTROL OF THE PATTERNS

Pattern Defects
All pattern defects, like impact marks and parts breaking off the mold, must be repaired immediately upon being discovered.

Pattern Plate Draft
Patterns must be regularly checked for pattern draft after repair jobs and changes.

Air Vents and Rubber Lifters
Air vents can only function as intended if they are not blocked up. Therefore, they must be cleaned regularly. Defective rubber lifters may lead to counterdraft.

Molding Machine Adjustments
Even patterns of the best quality can produce castings with a high rejection rate if the molding machine is not properly adjusted. The following adjustment and check must be undertaken regularly:

1) Check parallelism between the heater planes of the squeeze plate and the counterpressure plate.

2) Check adjustment of the guide bushings and guide brackets on the plates of the molding machine and core setter console, both laterally and vertically.

3) Check adjustment of the squeeze plate vertically as well as horizontally.

4) Check main bearings of the counterpressure plate for correct alignment with the squeeze plate.

5) Check level of the rail plate and bottom plate of the molding machine related to AMC or PMC.

6) Check perpendicularity of the core setter or combi setter related to the symmetry line of the machine.

Pattern Plate Checking and Drilling
For procedures for drilling and dimensional control of the pattern plates, as well as pattern plates parts list with the DISA code numbers, refer to the respective DISA publications.
Core Setter Mask

The core setter mask on the core setter serves to accurately place the cores in the mold cavity and to ensure repeatability of core setting in each mold produced. The close tolerance within which the cores for a DISAMATIC operate can only be fully utilized with the accuracy of the pattern equipment, including the core setter mask.

CORE MASK DESIGN

Normally, the core mask represents the impression of the counter-pressure plate pattern. The cores held by means of vacuum in this impression may be set in the squeeze plate impression produced in the mold. Therefore, in connection with the making of the core mask, it should be decided which of the pattern plates to place on the counter-pressure plate (swing plate), the core mask being a reversed copy of this plate. The core locators holding it in the mold must therefore be placed on the pattern of the squeeze plate and the locators holding the core in the mask on the counter-pressure plate pattern.

Already at an early stage, the following must be defined:

- how the core will be placed in the mask in order to be stable;
- where to choose the core pushing surfaces, which are mask/core contact surfaces, to ensure that the core will be pushed safely into the mold with uniform force to obtain the proper core setting pressure;
- how to ensure that core deformation during the pushing into the mold will not cause the core to be jammed in the mask;
- where to place the vacuum holes of sufficient diameter and number so that their location matches a point on the core which ensures:
  - a sufficient suction surface to retain the core in the mask;
  - a sufficient sealing between the mask and the core suction surface.

STANDARD CORE MASK FRAMES

The core mask is normally cast of epoxy resin in specially designed standard core mask frames.

The standard core mask frames are cast of aluminum. Their inside shape enables the resin, which the core cavity is cast of, to remain stable in the frame after curing. The frame has four holes for fixing screws located in the frame. The mask is bolted on the core setter console from the front (2013 DMMs). The 2070 DMM core mask is provided with four lock screws at the rear, which secure the mask to the core setter console by means of automatic locks. Like the pattern plates in the molding ma-
Fig. 2.75 2013/A. Standard core setter mask frame of two thicknesses. A = 70 mm (2.76") and A = 130 mm (5.1").

Fig. 2.76 2013/B. Standard core setter mask frame of two thicknesses. A = 70 mm (2.76") and A = 130 mm (5.17").

Fig. 2.77 2120/2130/B. Core mask mounting back plate. Mask thickness is step-less variable from 90 mm (3.5") to 210 mm (8.3").
chines, the mask is guided by a pair of guide pins in the core-setter console. One of the guides is round and fixed, and the other is elongated. All the dimensions on the core mask will therefore be defined from the fixed guide. Figs. 2.75, 2.76, 2.80 and 2.81 show standard core mask frames of various thicknesses for the different DISAMATIC models.

Masks for Combi Setters of the 2120/2130 DMS have another design. Their thickness is variable stepless within the limits described later and are made as solid resin blocks mounted on Aluminum back plates provided with retaining studs, similar to the ones on the pattern plates. The plate is shown on Fig. 2.79. The Core Setter for the 2120/2130 DMS requires a slightly different back plate, see Figs. 2.77 and 2.78. However, the same solid resin block used for the combi setter mask can be applied for the core setter mask.

**STANDARD CORE SETTER MASK THICKNESS (mm, in):**

<table>
<thead>
<tr>
<th></th>
<th>2120/2130</th>
<th>2070</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STEPLESS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70 (2.76&quot;)</td>
<td>90 (3.5&quot;)</td>
<td>100 (3.9&quot;)</td>
</tr>
<tr>
<td>130 (5.12&quot;)</td>
<td>210 (8.3&quot;)</td>
<td>250 (9.8&quot;)</td>
</tr>
</tbody>
</table>

The aluminum standard frame (2013, 2070 DMM) supplied by DISA will generally be employed as frame material.

**CORE MASK MATERIALS**

The resin cast into the standard aluminum frame or back plate normally consists of two layers:

- 1-2 mm (0.04-0.08") surface coat, wear-resistant material
- backing layer of foam expanding material filling the frame up to the rear face.

Fig. 2.83 shows a cross-section of a typical core mask:

A) Cast in Al-frame.
B) Mounted on Al-back plate.

Fig. 2.84 shows examples of the core mask materials. It is advisable to contact the local supplier of the resin materials used in order to get proper guidance on their preparation, use or possible substitute materials.
Fig. 2.78 2120/2130/C. Core mask mounting back plate. Mask thickness is stepless variable from 90 mm (3.5") to 210 mm (8.3").

Fig. 2.79 2120/2130/C. Combi setter mask frame. Mask thickness is stepless variable from 90 mm (3.5") to 210 mm (8.3").

Fig. 2.80 2070/A. Standard core setter core mask frame of two thicknesses: A = 100 mm (3.9") and A = 250 mm (9.8").
Fig. 2.81 2070/B/620. Standard core setter core mask frame of two thicknesses: 
$A = 100 \text{ mm (3.9"')}$ and $A = 250 \text{ mm (9.8"')}$. 

Fig. 2.82 A heavy core package in a DISAMATIC 2013 core mask.
1 - 2 mm (0.04 - 0.08") of surface coat material (wear resistant)

Foam expanding resin

Vacuum suction hole

Aluminium std. core mask frame

Aluminium back plate

Fig. 2.83 Cross-section through a typical core mask A = Cast into the Al frame (2013, 2070 DMM) B = mounted on Al back plate (2120/2130 DMS)

RESINS FOR MASK MANUFACTURING

POLYURETHANE RESIN VERSION

Release agent: QZ 11 or 13
Surface coat: Gelcoat 581/920
100:40
Backings mix: 545/974/Armospheres
100:80:300

SADOCAST

EPOXY RESIN VERSION

Release agent: QZ 11 B
Surface coat: SW 404/HY 404
(2 layers)
100:9
Coupling layer: ARALDIT LV 569/HY2959
100:14
or Glass fiber HEXEL
EPO 648/648 (100:20)
Backing mix: Expandable foam
ARALDIT CW 2215/HL/DY 050
100:20:1

Fig. 2.84 Examples of core mask materials.
CORE MASK PRODUCTION

The core mask manufacturing process varies depending on the model of the DISAMATIC machine. Basically there are two methods:

1. Frame cast masks used for 2013 and 2070 DMM (see examples Fig. 2.85, 2.86 and 2.87).
2. Back plate based masks applied on 2120/2130 DMM (see examples Fig. 2.88 and 2.89).

For detailed description of the mask manufacturing methods, see DISA publication.

Vacuum Holes

The number and size of the vacuum holes in the core setter mask depend on:

- location of holes in relation to the core;
- total number of cores in the mask;
- weight and size of the core;
- vacuum tightness between core and mask.

Normally, vacuum holes of 5-12 mm (0.2-0.5") diameter are sufficient. It is advisable to start with the holes of smaller size and gradually increase hole diameter, if necessary, during the practical core holding test at the core setter.

The holes should preferably be drilled (Fig. 2.91).

- where the cores adhere well to the core mask surface;
- where a possibility of increasing the suction surface exists due to insufficient holding force;
- at the top of a single core where holding force is greatest.

It is of great importance that as few vacuum holes as possible are drilled. The leakage at the holes decrease the vacuum, and thus the holding force.

NB: It is the suction area, and not the vacuum hole area, that holds the core in the mask (see Fig. 2.91), however, the diameter of the holes must be sufficient to assure the proper passage of the air.

Dressing the Core Mask

A ready cast core mask must sometimes be equipped with some extra parts improving the core holding or the core setting operation.

Distance Piece:

Sometimes it is necessary to mount a distance piece for contact between the core and the mask, either to ensure better support of the core, or
Fig. 2.85 Back side of a core setter mask for 2013 DMM. The frame is provided with two guide bushings for fixing screws in the corners.

Fig. 2.86 Core setter mask for 2013/B DMM.
to drill vacuum holes where it would normally be impossible because of lack of core/mask contact (Fig. 2.92).

The distance piece can be made of resin or metal, and either screwed or glued onto the mask, or simply cast into it.

Sealing of the Core Suction Area:
Sometimes it is necessary to obtain better sealing between the core and the mask or to increase the suction area to obtain better core holding force. This can be the case with very heavy cores or cores where the location of the suction area is unfavourable because of core geometry. In such cases, various rubber rings can be mounted around the vacuum holes. We strongly recommend the so-called V-rings (lip rings) used normally for dirt protection of rotating axles in machine design. An example of such a solution is shown on Fig. 2.93 for a core mask intended for a large engine block joint core package. The mounting principle is shown on Fig. 2.94.

Soft rubber seals may be applied when an irregularly-shaped suction area must be sealed (see Fig. 2.95).

Auxiliary Holding Devices:
Some very heavy cores or cores with a shifted center of gravity require additional holding security in the mask. It is relatively easy to mount pneumatic cylinders holding the core mechanically or as a back-up for the traditional vacuum holding system for the 2070 DMM and 2120/2130 DMS.

The holding device can easily be connected to the control system of the molding machines so that the holding will automatically release the core when the vacuum is released, meaning when core setting pressure is obtained.

The release of the vacuum can at any time be switched to the compressed air and this way several other ways of core holding can be applied. Fig. 2.96 shows an engine block core package mask where an air cylinder is acting as an auxiliary holding device to the vacuum method.

Fig. 2.97 and 2.98 show core masks where exclusively pneumatic clamps are used for retaining for the heavy cores. Fig. 2.99 and 2.100 demonstrate application of rubber expanders (inflatable hoses) which successfully can replace the traditional methods of core retaining. This method requires the cores provided with the holes and an air hose system cast into the mask as shown on Fig. 2.101.

The auxiliary holding devices will be recommended especially for heavier cores set with the combi setter for the 2120/2130 DMS. If the cores are transported on the pallets, the pallet/core mask transfer requires from the mask to be able to hold the core hanging in the "upside-down" position (see Fig. 2.102).
Fig. 2.87 Back side of a core setter mask for 2070 DMM. The frame is provided with two guide bushings and four fixing screws.

Fig. 2.88 Resin block mask for 2120/2130 DMM mounted on the back plate. Good solution for foundries running various short series jobs.
Miscellaneous Auxiliaries:

Some cores positioned in the mask need additional support, which cannot be obtained by casting the direct impression of the counterpressure plate alone. In such cases the supporting devices can be bolted or cast into the finished core mask. As an example, Fig. 2.103 shows a hub core.

The core is supported by the metal ring, which is produced separately and glued onto the mask.

Even the highly wear-resistant resin coat on the mask surface can be worn down after some tens of thousands of core setting operations, since the sand core is highly abrasive.

In such cases, steel plates may be cast into the areas of the mask/core contact surface most exposed to wear (see Fig. 2.104).
Fig. 2.89 Maximum sealing between the mask and the core must be obtained.

Fig. 2.90 Location of the gravity center of the core must be taken into consideration for correct placing of vacuum holes.

Fig. 2.91 The core holding force may be increased by increasing the suction area (increase of the sealed core/mask contact area).
Fig. 2.92 Distance piece between core and mask.

Fig. 2.93 Rubber sealing rings increase suction area and improve contact between core and mask (2070 DMM).
Fig. 2.94  Principle of rubber lip-rings for better sealing of the cores in the core setter mask. A—Unloaded, B—Loaded.

Fig. 2.95  Foam rubber seals the core/mask contact even when the suction area is not regularly round (2013).
Fig. 2.96 Pneumatically controlled device for holding the extremely difficult cores in the mask (2070).

Fig. 2.97 Heavy cores can be held in the mask by means of pneumatic retainers activated and deactivated by the usual vacuum controls of the molding machine (example of a 2130 mask).
Fig. 2.98 Complex engine block core package held in the mask by pneumatic retainers (2130).

Fig. 2.99 Inflatable core retainers (expanders) A: Expander and its fixing socket B: Core with holes for the expanders.
Fig. 2.100  A) Expander cast into the mask  B) Sketch of non inflated expander in the core  C) Inflated expander inside the core

Fig. 2.101  The core holding expanders are placed in the core locator areas and the air pipe manifold located inside the mask casting frame before the mask manufacturing (2130).
Fig. 2.102 Core transfer from transport pallet to the combi setter core mask requires firm hold of the core in horizontal position.
Fig. 2.103 The protruding core is supported by a metal ring machined out separately and fitted to the core mask.

Fig. 2.104 Core locator cavity in a core mask is most exposed to wear. This one is protected by stainless steel stripes cast in.
Fig. 2.105 Maximum permissible core height for 2013/A using 2043 CSE.
NOTE: Maximum permissible plate thickness on squeeze plate when using
2043 CSE: 150 mm (5.9\textquotedbl{}).

Fig. 2.106 2013/A. Dimensions around core setting area limiting maximum core
heights.

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CORE LIMITATIONS

The following dimensions limit the maximum permissible core height:

- core mask thickness
- delivery point of mold face
- position of the mask when aligned with the mold string just before the core inserting stroke
- length of core inserting stroke
- swing convolute of the rear face of the counterpressure plate
- geometry of the protective guard of the core setter

For a more detailed explanation of the core height limitation drawings, the following terms will be used:

G = minimum distance of the core mask core end from base of mask
H = maximum permissible total length of core
L = shift between main and local parting line of pattern (difference between mold thickness and mold pitch)
M = standard core mask thickness
N = height of core outside mask
O = height of core inside mask.

Figs. 2.105, 2.106 show the core height limitation on 2013/A.

Figs. 2.107 and 2.108 show the core height limitation for the 2013/B.

The 2130/2120 DMS operates with any core mask thickness between 145-245 mm.

Figs. 2.109 and 2.110 show the core height limitation on 2120/2130/A
Figs. 2.111 and 2.112 - - - - - - 2120/2130/B
Figs. 2.113 and 2.114 - - - - - - 2120/2130/C

Core masks for 2013 and 2070 DMMs are available in two standard thicknesses. In most cases the thick mask can be applied for the production of cored castings. However, where possible the thin mask should be used, since it is easier to handle and cheaper to make.

Fig. 2.115, 2.116 and 2.119 show the core height limitation on 2070/A
Fig. 2.120, 2.121 and 2.124 - - - - - - 2070/B/620
Fig. 2.107 Maximum permissible core height for 2013/B using 2043 CSE.
NOTE: Maximum permissible plate thickness on squeeze plate when using 2043. CSE: 150 mm (5.9").

Fig. 2.108 2013/B. Dimensions around core setting area limiting maximum core heights.
For 2070 DMMs there is a possibility to increase the limit of the max. core height protruding out of the mask (N). This can be accomplished by shifting position of the shock absorber on the core setter carrying frame (the brake, which stops the console at the point of the core delivery). See Fig. 2.117, 2.118, 2.122 and 2.123.

The core setters for the DISAMATIC molding machines are designed so that the cores of a size corresponding to the respective mold sizes have a weight which the respective core setters can handle. There are, however, certain maximum values for the total weight of the core setter mask with the cores (see table in Fig. 2.130) which should not be exceeded. An excessive weight will cause increased wear of the core setter.
Fig. 2.109 2120/2130/A. Dimensions relating to core setting.

Core setter mask thickness M | 90 mm | 210 mm
--- | --- | ---
N max. | 210-L | 210-L
O max. | 90 | 210
H max. | 300 | 420

Max. weight of the mask incl. core: 200 kg.

Fig. 2.110 2120/2130/A. Dimensions around core setting area, limiting maximum core heights.
Fig. 2.111 2120/2130/B. Dimensions relating to core setting.

Fig. 2.112 2120/2130/B. Dimensions around core setting area, limiting maximum core heights.

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Core setter mask thickness M | 90 mm | 210 mm
---|---|---
N max. | 210-L | 210-L
O max. | 90 | 210
H max. | 300 | 420

Max. weight of the mask incl. core: 200 kg.

Fig. 2.113 2120/2130/C. Dimensions relating to core setting.

90 mm mask front after core setting stroke. 210 mm mask front after core setting stroke.

Mold delivery area.

Convolute of rear face of swingable squeeze plate.

Front of chamber top plate

Rear face of all core masks before max. core setting stroke.

Fig. 2.114 2120/2130/C. Dimensions around core setting area, limiting maximum core heights.

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Fig. 2.115 2070/A. Dimensions relating to core setting with a standard 100 mm core mask and with the system in normal operation.

<table>
<thead>
<tr>
<th>Core mask height M</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>N max.</td>
<td>250-L</td>
</tr>
<tr>
<td>O max.</td>
<td>90</td>
</tr>
</tbody>
</table>

2070 A

Fig. 2.116 2070/A. Dimensions relating to core setting with a standard 250 mm core mask and the system in normal operation.

<table>
<thead>
<tr>
<th>Core mask height M</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>N max.</td>
<td>250-L</td>
</tr>
<tr>
<td>O max.</td>
<td>240</td>
</tr>
</tbody>
</table>

2070 A
Fig. 2.117 2070/A. By shifting the position of a shock absorber on the Core Setter it becomes possible to make full use of the entire stroke of the Core Setter (300 mm).

Fig. 2.118 2070/A. Also in this case it is possible to increase N to max. 290 mm by shifting the position of the shock absorber, with the limitation that the thickness of the pattern plate on the squeeze plate (B) must be not less than 65 mm.

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**Fig. 2.119  2070/A.** Dimensions around core setting area, limiting maximum core heights.

**Fig. 2.120  2070/B/620.** Dimensions relating to core setting with a standard 100 mm core mask and with the system in normal operation.

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Fig. 2.121 2070/B/620. Dimensions relating to core setting with a standard 250 mm core mask and the system in normal operation.

Fig. 2.122 2070/B/620. By shifting the position of a shock absorber on the Core Setter it becomes possible to make full use of the entire stroke of the Core Setter (300 mm).
Fig. 2.123 2070/B/620. Also in this case it is possible to increase \( N \) to max. 290 mm by shifting the position of the shock absorber, with the limitation that the thickness of the pattern plate on the squeeze plate (B) must be not less than 65 mm.

Fig. 2.124 2070/B/620. Dimensions around core setting area, limiting maximum core heights.
Fig. 2.125 A core mask for DISAMATIC 2013 producing ductile iron safety parts.

Fig. 2.126 The core setter mask for DISAMATIC 2013 transferring a heavy core assembly.

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Fig. 2.127 The core setter masks for this DISAMATIC 2070 are divided into two halves for a better product flexibility: any combination of two different cored castings can be produced in the same mold.

Fig. 2.128 A double engine block core in the DISAMATIC 2070 core setter mask.
Fig. 2.129 Core setter mask of a DISAMATIC 2070 accomplishing its back stroke after setting the core in the mold.

<table>
<thead>
<tr>
<th>Type of Machine</th>
<th>Rate (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013 A</td>
<td>50</td>
</tr>
<tr>
<td>2013 B</td>
<td>50</td>
</tr>
<tr>
<td>2120/2130</td>
<td>200</td>
</tr>
<tr>
<td>2070 A</td>
<td>250</td>
</tr>
<tr>
<td>2070 B</td>
<td>250</td>
</tr>
</tbody>
</table>

Fig. 2.130 Limitation of the total weight of the core mask with cores.
Cores

Almost all types of sand cores (cold-box, hot-box, shell, SO₂, CO₂, etc.) may be used with the DISAMATIC.

Mass production of cored high-quality castings requires not only a proper design of the core on the core-setter mask side, but also that the design of the mold side of the core ensures safe and repeated setting of the core into the mold.

If the shape of the core itself does not permit holding the core in the core-setter mask or the mold, core locators must be used for this purpose. Normally, a distinction is made between the following kinds of locators:

- Fixing locators, holding the core in the mold (normally not used on the core mask side, since the core is held in the mask by means of vacuum).

- Auxiliary locators, positioning, indexing, or supporting the core in the mold and the core-setter mask.
Fig. 2.131 When the core is inserted in the mold, the clamping surfaces of the locator keep the core in position by crush fit (1) and prevents the core from tilting out (2).

Fig. 2.132 Properly designed core in its mold and core-setter mask.
PRINCIPLES OF CORE LOCATING

The core locators are intended to retain the core in the mold by means of the clamping surfaces and to support it against tilting out of the mold by means of the supporting surfaces (see fig. 2.131). In other words, those locators are holding the core in the mold and therefore are called the fixing locators.

In order to prevent the core movement in the vertical plane, it is often necessary to apply an auxiliary locator on the other end of the core, called positioning locator (fig. 2.131).

Core/Mold fit

In order to be sure that the core will be fixed and positioned properly in the mold, the tolerances on the various surfaces of the locators between the core and the mold cavity (pattern) must be determined properly.

There are generally three types of fits applied:

1) crush fit where the core dimension is slightly bigger than that in the mold print

2) size-to-size fit, where the dimension on the core is the same as the one of the mold print (naturally within the pattern-, core box- and core production tolerances)

3) loose fit, where there is a clearance between the core and the mold print.

Fig. 2.132 shows on one of the typically designed cores the fits normally applied:

Fit "X" - the clamping surfaces of the fixing locator usually have a crush fit

Fit "Y" - the supporting surfaces of the fixing locator will have a size-to-size fit

Fit "W" - the surfaces restricting the core setting movement are fitted size-to-size

Fit "U" - a loose fit (clearance) is needed on the front face of the fixing locator in a case when the core being inserted should scratch-off some loose sand from the mold print surfaces of the fixing locator

Fit "V" - the core is fixed in the mold in a "hanging" position. Therefore a clearance on the bottom surface of the core is necessary to prevent core jamming in the mold.

Further in this section some more typical core examples and the fits applied are shown.
Fig. 2.133 Size of crush fit on clamping surfaces of the core locator is different for light and smaller core (1) and heavy joint core package cores (2).

Fig. 2.134 For a joined core, the total tolerance is the sum of tolerances obtainable for the single cores.

Fig. 2.135 Core dimensions within the same half-part of the core box can have closer tolerances than dimensions crossing the core-box parting line.
The size of the crush fit on the surfaces of the locator depends on many factors, such as:

- general core allowances in the foundry in question
- core production method
- size and weight of the core
- complexity of the core (single core or joint core package, see Fig. 2.133).

Joined cores can consist of many pieces which are "locked" together without the use of glue. Each core has its production allowance, which depends on the core blower, the quality of the core box, core sand quality, etc. Even if the dimensional tolerance of the single core is ± 0.1 mm, a core package consisting of six single cores can have a tolerance of ± 0.6 mm (Fig. 2.134).

- size of supporting surface in relation to the core size.
- location of the fixing locators in relation to the joint line of the core. The dimension crossing the core joint line is always subject to a greater inaccuracy than a dimension within the same core box part (see Fig. 2.135).

The crush fit "X" on the clamping surfaces of the locators is normally 0.2 ± 0.1 mm for single cores and increases with the complexity of the cores.

Size-to-size fit "Y" on the fixing locators and all auxiliary types of locators, such as positioning, indexing or supporting locators of the order of ± 0.2 mm.

The clearance for the scratched sand normally recommended is 3 - 5 mm.

Anti-jamming spaces between core/mold and core/mask will be between 2 and 3 mm.

Core/Mask fit

As already mentioned in the section on core mask production there should be a clearance between the outer shape of the core and the mask cavity. In other words the core must be able to "float" slightly in the mask in order to guide itself into the mold print with its locator even in the case of a slight machine misadjustments or pattern inaccuracies. The usual size of this clearance is 0.3 ± 0.1 mm.

This value will however be fine adjusted during the production run-in. Fig. 2.132 shows the types of fits normally applied in the core/core mask systems:

- **Fit "Z"**
  - loose fit ensuring the clearance necessary for the guiding of the core in the mold

- **Fit "W"**
  - size-to-size fit for pushing the core into its position in the mold print.
Fig. 2.136 This engine block core is a typical example of a joined core. The 9 cores are joined without the use of glue, and the length of the package varies within +/- 0.6 mm.

Fig. 2.137 Correct (B) and incorrect (A) way of determining core location in the mold.

Fig. 2.138 Triple-fitting core designed with common locators in order to reduce the number of cores per mold.
CORE LOCATOR DESIGN

When designing a core the following important rules must be observed:

- The position of the core must not be defined by too many location points. A core located by double fixing will have a tendency to jam and to be exposed to unnecessary tension (Fig. 2.137). On the other hand the core must be able to be inserted and fixed in the mold repeatably each time a new mold has been produced.

- Minimizing the number of cores to be set per mold in order to keep the cycle time of the machine down and thus to keep a high productivity (Fig. 2.138).

- The way of core fixing in the mask and in the mold must be determined to allow for the fragility of the core or its parts (Fig. 2.139).

- The core design must ensure easy handling and transportation of cores (Fig. 2.140).

Standard Core Locators

The various types of core locators designed by DISA and used in most cases are shown on Figs. 2.141 and 2.143.

Cores requiring particularly high stability in the core-setter mask can be supplied with a locator as shown on Fig. 2.142.

The last locator is suitable for small cores only, for instance the ones shown on Figs. 2.144 and 2.145.

The following can be mentioned about the design of the standard locators:

- the clamping angle for the crush fit is 2°,
- the supporting angle for the size-to-size fit is 5° - 10°,
- the fillets on the corners of the core are always smaller than the corresponding fillets in the mask in order to avoid jamming of the core in the mask.

On Fig. 2.146 a hub core provided with a pin-like core locator is shown. In this case the front face of the locator restricts the core setting stroke and provides space for the sand abraded by the core from the mold print.
Fig. 2.139 The upper core (water jacket) is very fragile, and therefore the way of fixing in the mold and mold must be determined with special care.

Fig. 2.140 This core (A) is difficult to receive from an automatic core blower, to store and to transport because of its weak stud. Properly designed core locators (B) make the core more stable when stored and easier to handle and to transport.
Fig. 2.141 Dimensional tolerances for locator which can be applied in most cases. On this sketch the clamping surfaces are crush-fitted, and the supporting ones are size-to-size. However, for heavier cores an opposite system may be applied.

Fig. 2.142 Dimensional tolerances for locators applied in a case where the core requires higher stability in the core setter mask. On this sketch, the clamping surfaces are crush-fitted and the supporting surfaces are size-to-size. For heavier cores, the opposite fit system may be applied.

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Fig. 2.143 Typical core locator studs for cores for vertically parted molds.

(a) Locator stud on pattern plate

(b) Locator stud on core box

(c) Locator stud on sand core

(d) Locator stud on core mask

\[
\begin{align*}
d &= 0.75D \\
H &= 1.5D \\
D_{(\text{min})} &= 12 \text{ mm (0.47 in)}
\end{align*}
\]

Fig. 2.144 Dimensional tolerances for dowel locator studs used for small cores.
Fig. 2.145 The dowel locator stud can be used with small cores.

Fig. 2.146 There must always be a space in the front face of the core locator for scratched sand. In this way, space is provided for scratched sand, if the core locator face of the core is used as core inserting stroke limiting surface.
Fig. 2.147 A core tray can be used when setting a large number of cores per mold. This will reduce the cycle time of the machine.
A: The core tray is being filled.
B: Cores are transferred from the tray to the core mask.

Fig. 2.148 Brake drum with steel plate insert.
Locating Small Cores

The use of small cores can lead to a situation where the total number of cores exceeds six, which we normally consider the maximum number of cores to be inserted without influencing the cycle time of the molding machine. In such cases, three things can be done in order to reduce the time it takes to locate cores in the core mask:

- A multiple core with common locators can be produced and in this way the number of cores inserted per molding cycle will be reduced (Fig. 2.138).

- A core tray can be produced where the cores can be prelocated (Fig. 2.147).

- A mechanical core-jig transportation system or a robot system can be used.

INSERTS

The core setter can be successfully used for dealing with other parts than cores. Chills, threaded cast-in bushings and other inserts can easily be set into the molds. The principles of locator design are exactly the same as for sand cores; however, a higher weight due to metallic materials in the inserts must be allowed for. Fig. 2.148 illustrates a steel plate insert for a brake drum, inserted in the mold by a core setter.
Fig. 2.149 Normally, an epoxy resin core box for trial will be made first.

Fig. 2.150 After adjustments, if required, a production core is built.
CORE BOX PRODUCTION

The production of core boxes can be divided into three stages:

1. Production of a master pattern of the core. First-class materials must be used for master patterns.

2. Production of a synthetic resin core box for trial runs (Fig. 2.149). During production run-in, the following corrections must be made to the trial core box:

   • changes of core design (dimensions, drafts)
   • changes of location of blow holes
   • changes of air vent location
   • correcting of sealing strips along the core outline at the core-box parting line.

3. Construction of the production core box (Fig. 2.150).

EXAMPLES

The following section shows some typical examples of cores in a mold/core/mask system and outlines the fit relations between the three elements.

The following designations are used:

X - crush fit on fixing locator (core/mold)

Y - size-to-size fit on fixing locators or auxiliary locators

Z - loose fit between the core and outer shape of the core mask cavity

U - loose sand clearance

V - no-contact space between core/mask or core/mold

W - surface restricting core-setting stroke in the mold and core setting force transfer area on the mask.
FITS IN THE MOLD/CORE MASK SYSTEM

1

Relatively light core. The upper, fixing locator is pressed into the mold on the clamping surfaces and the core "hangs" in the mold on its locator. In this way the vertical movement of the core is prevented. The horizontal movement of the core is prevented by the auxiliary lower locator.

2

The core is heavier than the previous one and therefore has to rest on the bottom of the mold cavity with its lower auxiliary locator which also restricts its horizontal movement. The main, upper fixing locator is used for hanging the core and the supporting surfaces of the main locator jam the core in the mold on a crush fit. The clamping surfaces of the fixing locator are fitted size-to-size.

3

A double-casting core designed with one, round fixing locator which crush-fits in the mold. This restricts the vertical core movement. The horizontal movement restriction is achieved by the upper and lower auxiliary locators.
A lightweight core can be located with a dowel fixing locator crush-fitted in the mold for vertical and horizontal movement restriction. The lower auxiliary locator prevents turning the core around the fixing locator.

The core is pressed into the mold on the central, round fixing locator. The upper, indented auxiliary locator indexes the core in the certain well-defined angular position.

The core is pressed into the mold like previously on the central dowel locator. But in this case there is no need for any indexing locator, as the angular position of the core in the casting is arbitrary.
The core is located on the green sand mold with a size-to-size fit. The angular indexing is not necessary.

A hub core is crush-fit located in the mold on its dowel-fixing locator. A ring is installed in the core mask cavity to improve the positioning of the core, which has a tendency to "hang down" in the mask. The front face-of-the fixing locator has to restrict the core setting stroke, for this reason the loose sand space is ring-shaped.

The dowel fixes the core vertically and horizontally with a crush fit. The auxiliary side locators prevent the core from turning around the dowel. The same side locators, together with the upper one, restrict the core-setting stroke in the mold and secure the core-setting force transfer area between the core and the mask.
FITS IN THE MOLD/CORE MASK SYSTEM

10

The upper fixing locator is pressed into the mold with its clamping surfaces and fixes the core vertically. The bar connecting the pipe cores positions the core horizontally.

11

The core is entirely surrounded by the casting. There are three flanges on the mold side and two on the mask side. Locators 1 and 2 locate the core with crush-fit on their round surfaces, horizontally and vertically, respectively. The front faces of locators 1, 2, and 3 restrict the core-setting stroke in the mold and front faces of locators 4 and 5, as well as the distance plate having a thickness equal to the thickness of the casting, assure sufficient mask/core pushing surface.

12

The core is a package core contained in a quadrangle box-like case core. Since the package is heavy, it rests on the bottom of the mold cavity pressed on crush fit to its side faces.