STEEL CASTINGS HANDBOOK

SUPPLEMENT 4

DRAFTING PRACTICES FOR CASTINGS

STEEL FOUNDERS'
SOCIETY OF AMERICA

STEEL CASTINGS HANDBOOK SUPPLEMENTS

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Steel Castings Handbook
Supplement 4

Drafting Practices

Preface

This supplement is recommended as a guide when making drawings of parts to be manufactured by the steel casting process. A steel casting is a part produced to the desired form by filling a pre-shaped mold cavity with molten steel. The casting process is a direct method of producing parts to their final form and has three major attributes:

1. Design flexibility
2. Metallurgical versatility and quality
3. Economic benefits

No casting has commercial value unless the part as drawn can be made in the foundry and at a cost that will allow its effective and economical use. Therefore the casting drawing must be understood completely by both the patternmaker, who makes the pattern of the object to be cast, and the foundryman who produces the steel casting to the shape, dimensions, tolerances and material required. The draftsman should know what information is required by the patternmaker and the foundryman to translate the drawing into a metal casting.

Contents

MACHINE AND CASTING DRAWINGS

A finished machine drawing is an engineering drawing of a part which describes the final shape of the part to be made. The machine drawing typically relates to the machining operations which might be required to obtain the finished part.

A casting drawing refers to an engineering part to be produced as a casting. This casting drawing contains all the information required for the foundry operations involved; it provides a stock allowance for machining (if machining is required), draft to facilitate removal of the pattern from the mold as indicated in Chapter 5,* radii and fillets that enhance the castability of the part, etc.

To develop the best rigging for the production of the part, i.e. the best number, type, and size of risers and ingates, the foundry personnel need to know the final part configuration and target points for layout. For instance, they need to know how much and where machining is involved, whether and where holes are to be drilled, etc. It is for these reasons that many foundries prefer to receive a single set of drawings, which combine the functions of machine drawing and casting drawing. Figure 1 illustrates such a drawing for a "center plate" where the cast contours are indicated by solid lines, and the machined outline by broken lines. The metal to be removed in the machining process is referred to as machine stock allowance.

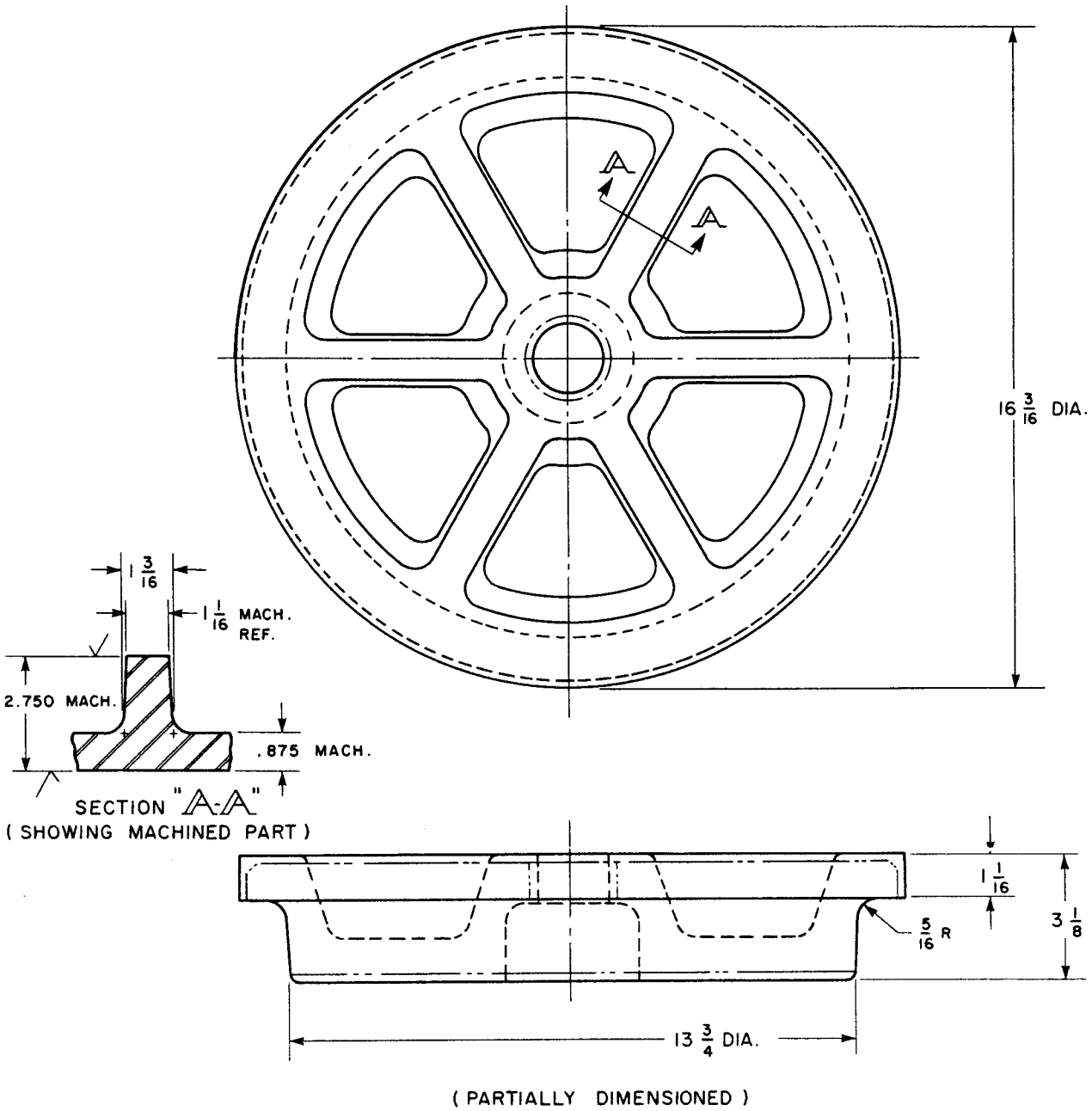

Fig. 1 Combined casting and machine drawing of a "center plate," solid lines indicate the cast part, and broken lines the machined dimensions (dimensions in inches, conversion: 1 in. = 25.4 mm).

* *Refers to Steel Castings Handbook—5th Edition.*

For this casting the center hole, the top and bottom flange surfaces, the edge chamfer, and the outer edge are to be machined.

An alternate approach to combining the machine and casting drawing is to provide a machine drawing, as well as a casting drawing. Figures 2 and 3 are examples of a casting drawing and a machine drawing, respectively, of the longitudinal section of a valve casting. The casting drawing reflects the information required by the foundry to produce a pattern. The particular section shown in Figure 2 is, of course, only one of several sections and views required; it incorporates the as-cast dimensions of the external and internal valve configuration, fillet radii, and pads to improve feeding characteristics of the casting. Note that the dimensions provide for machining stock, as is evident upon comparison with the machine drawing in Figure 3. This machine drawing does not include casting dimensions, except when required for reference; it illustrates the location of drilled holes, machined diameters, datum lines or surfaces, and other characteristics to produce a complete part.

In the third alternative, when only one drawing is provided, most foundries prefer to receive the machine drawing and to specify the amount of finish stock that is to be added. This approach, especially that involving a casting drawing only, has disadvantages and ultimately may give rise to misunderstandings, production delays, extra cost due to repair, extra machining, handling of the part—all of which can be minimized, or even eliminated, by observing the recommended approach discussed earlier.

Independent of whether combined or separate casting and machine drawings are provided, the following points should be observed:

1. The drawing should be specific on size, shape, and material.
2. Draft and dimensions on radii and fillets should be optional for the foundry unless precluded by specific requirements such as interference between mating parts.
3. Drawings should be current, legible, and clear.

Drawings should always be made to scale and the scale clearly noted. Full size drawings are preferable.

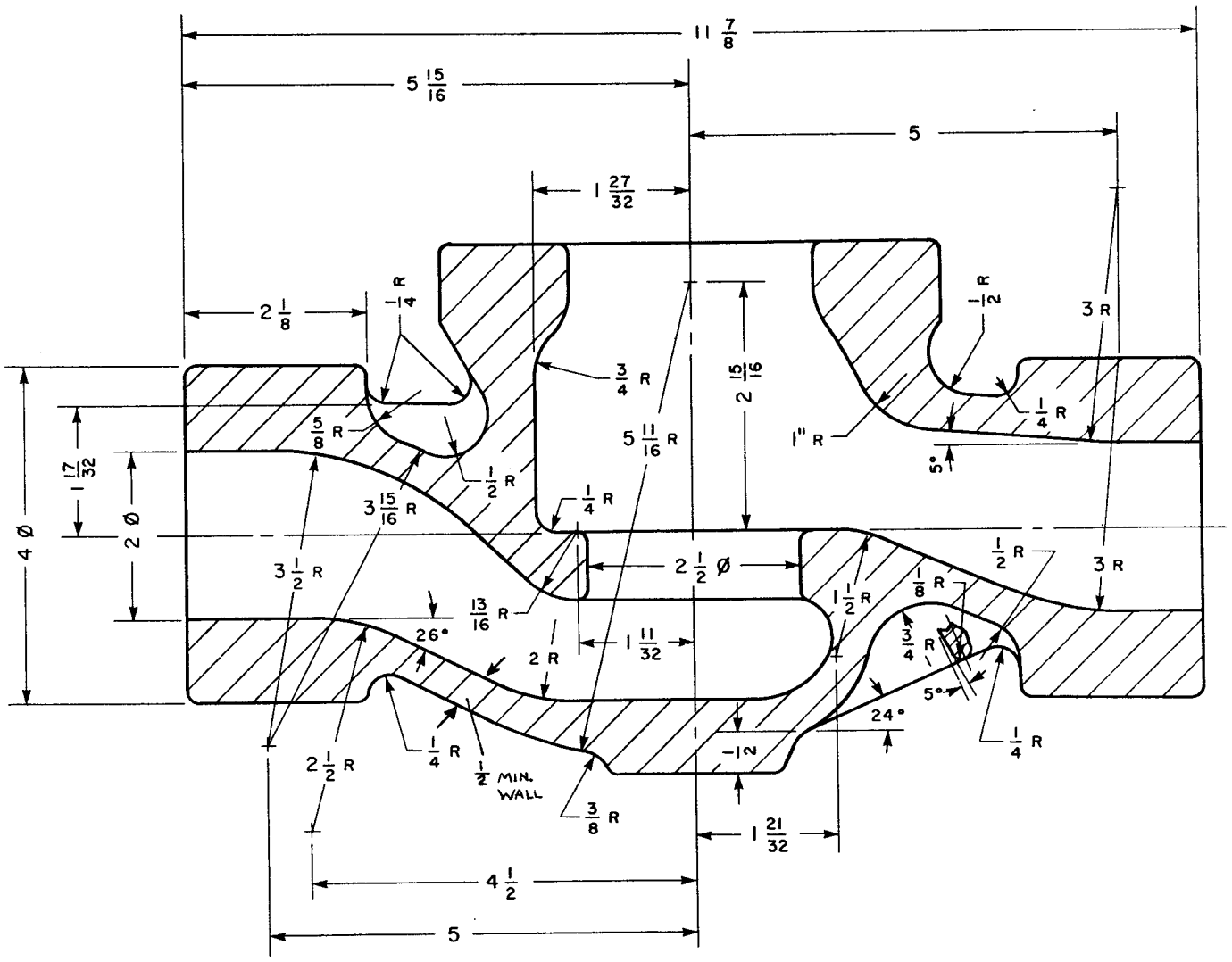

Fig. 2 Casting drawing of section through valve (dimensions in inches, conversion: 1 in. = 25.4 mm).

Drawings that are not to scale can result in distorted impressions of what a casting will really look like and should therefore be avoided. Distorted impressions can also arise when a single drawing is used to represent several similar parts, by showing certain dimensions being changed, such as bore size, length, or wall thickness. This practice should be avoided even though it decreases drafting time somewhat.

MACHINING AND TOOLING REFERENCES

Good drafting practice will employ the use of datum planes and target points (also called tooling points). Figure 4 illustrates the basic concept of datum planes. The three points A_1, A_2, and A_3, fix the location of plane A, two points and perpendicularity to plane A establish plane B. For plane C, it is only necessary to have one point and perpendicularity to planes A and B. A practical illustration of this concept is given in Figure 5.

The use of tooling or datum points will serve as the basis of casting layout for the foundryman, inspector, and machinist. The size and location of these target points should be marked clearly on the drawing, and should be the same for the foundryman and the machinist. One cannot overstress the importance of common points for layout in the foundry and customer's inspection. Layouts started at different origins may result in different layout results. With specific, predetermined points as origins, agreement is more readily reached on the results of layout inspections.

Raised datum targets can be cast onto the part for jigging for subsequent machining. Such reference points should not be in a position where they must be ground, burned, etc. in the cleaning operation.

TOLERANCES

Tolerances on the drawing should conform to the latest Steel Founders' Society of America tolerance guidelines as indicated in Chapter 13.* These tolerances take into account the size, shape, and weight of the casting as well as the type of pattern equipment to be used.

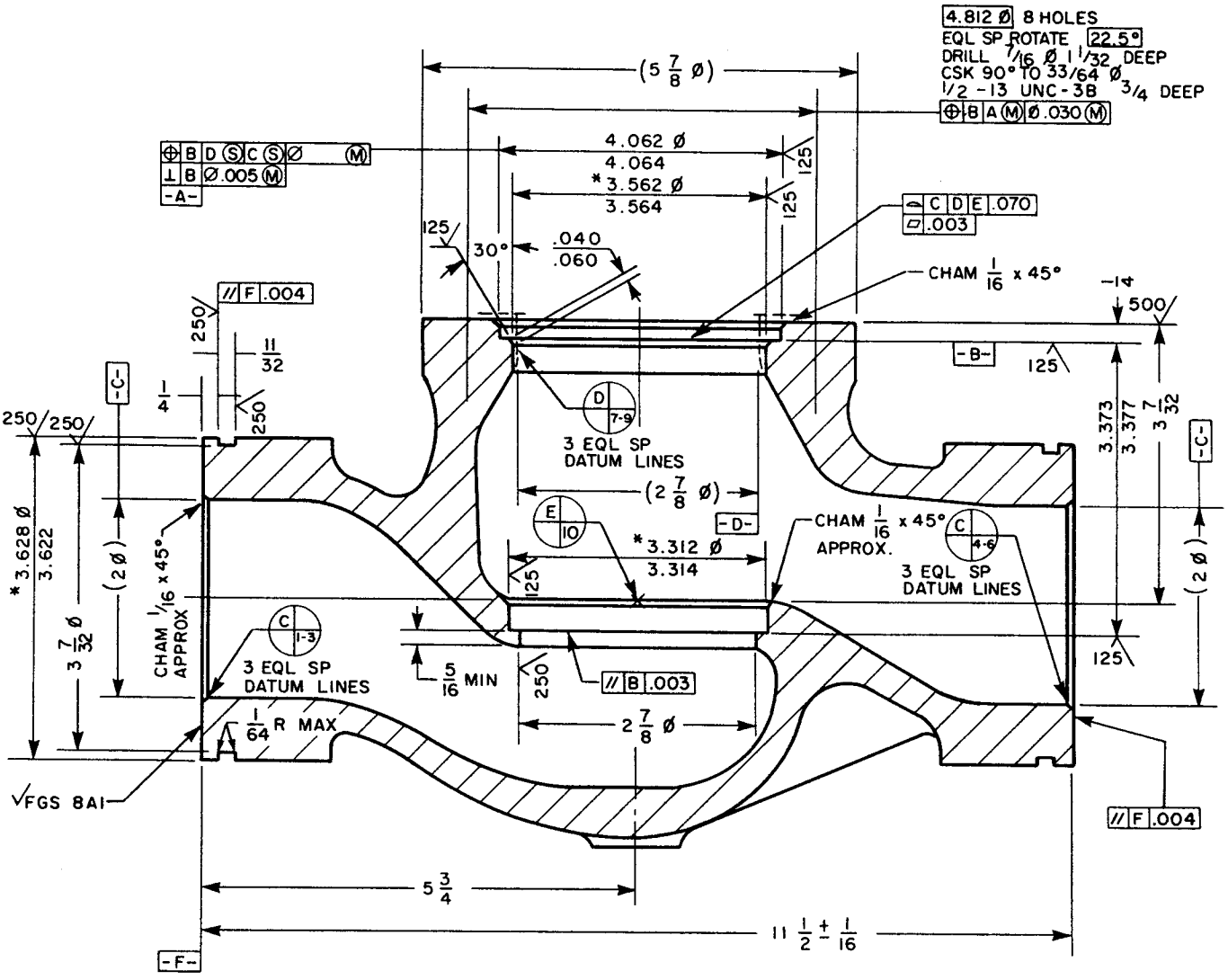

Fig. 3 Machine drawing for valve in Fig. 2 (dimensions in inches, conversion: 1 in. = 25.4 mm).

* *Refers to Steel Castings Handbook—5th Edition.*

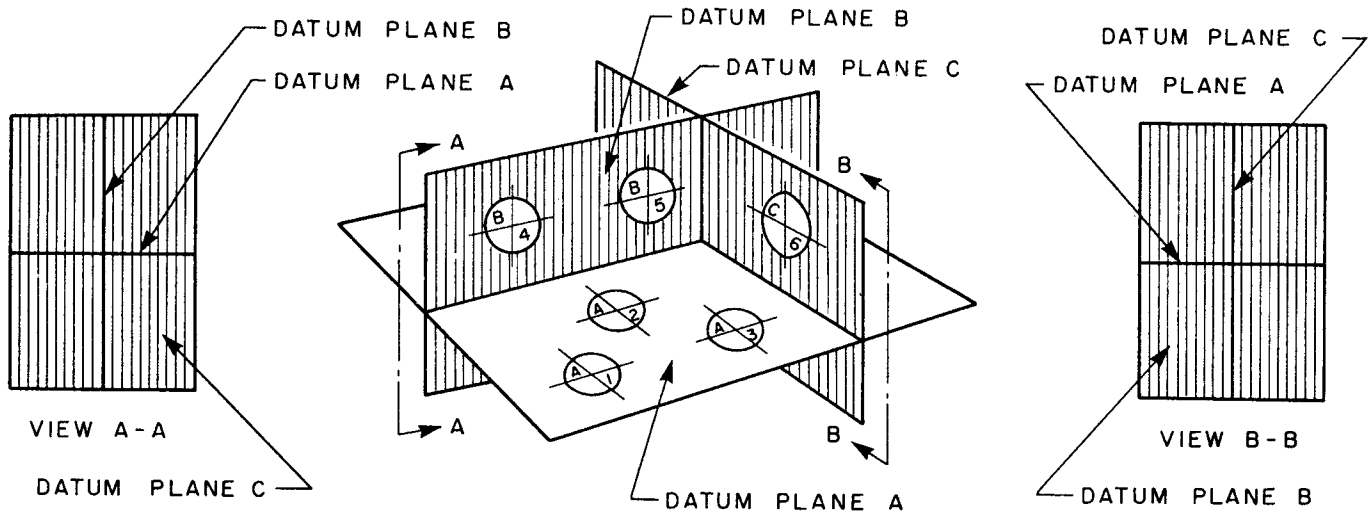

Fig. 4 Schematic illustration of perpendicular relations among the three datum planes (1).

Requirements for parallelism, concentricity, and perpendicularity, plus minimum wallsection should be noted. Compromises on requirements that conflict with foundry capabilities should be negotiated before production begins.

It is also strongly recommended that Chapter 5*on Manufacturing Considerations in Design be studied thoroughly before design of a part is begun. Naturally, the drafting practice should conform to the practice set forth in the American National Standards Drafting Manual Y-14 (2).

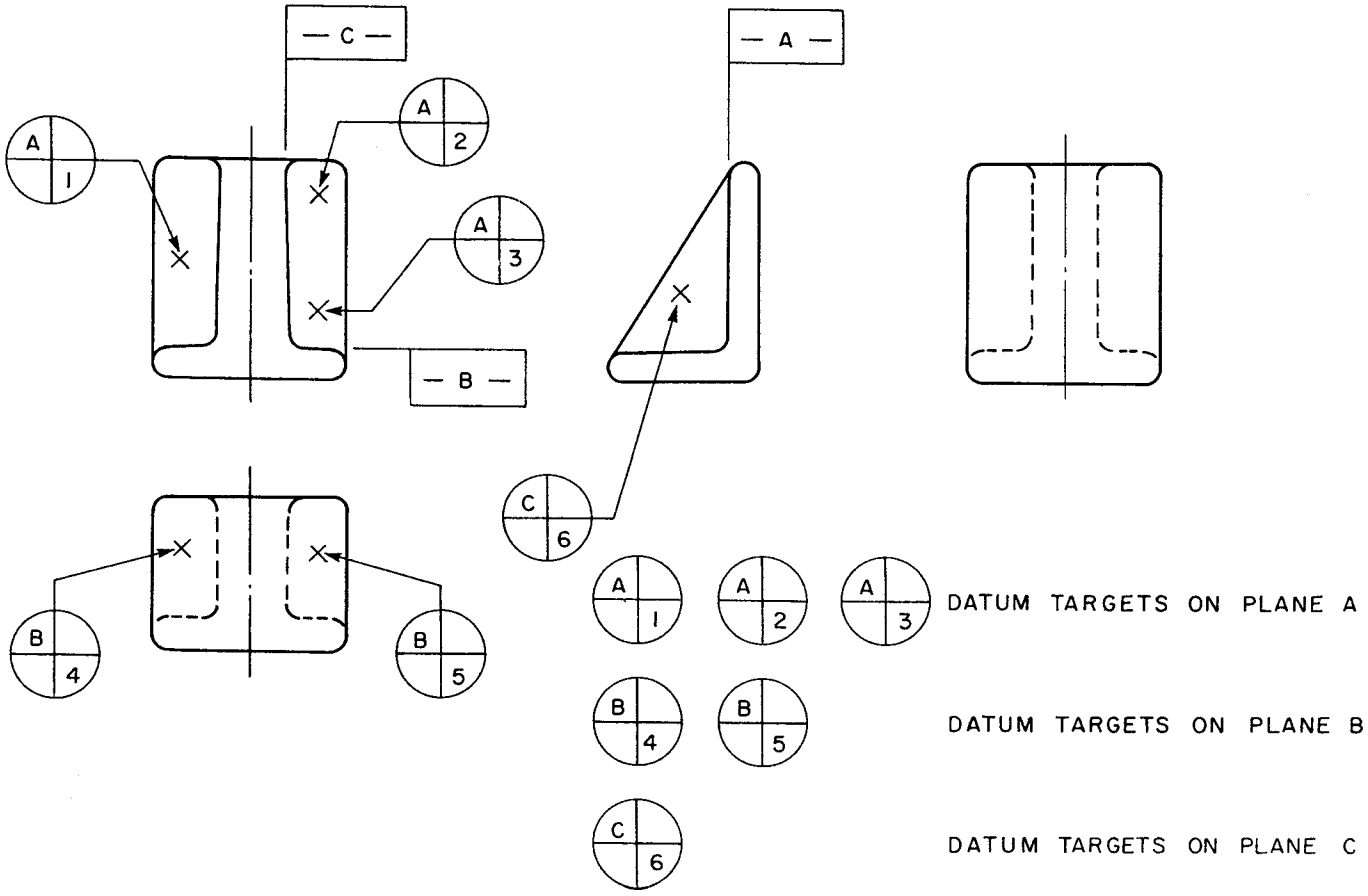

Fig. 5 Illustration of establishing datum planes for a casting, using a datum target system (1).

* *Refers to Steel Castings Handbook—5th Edition.*

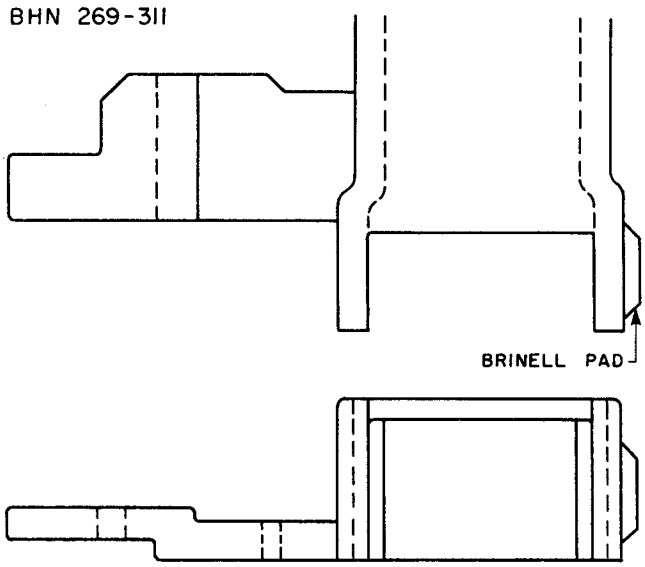

Fig. 6 Notation for hardness test location and hardness range.

MATERIAL AND SPECIAL REQUIREMENTS

Material requirements should employ the use of widely accepted specifications such as those of the American Society for Testing and Materials (ASTM). Such specifications cover almost every type of steel and high alloy, its heat treatment condition, strength level, and special requirements.

If a hardness check is required on a casting, a pad should be specified and located so as to be convenient to both producer and customer. This pad will insure that testing is done in a uniform manner. An example is shown in Figure 6.

If ASTM specifications are referenced, any special testing requirements that may be needed can be specified by using the supplementary requirements of the specification. These cover such things as magnetic particle inspection (MT), penetrant testing (PT), etc. The foundryman is familiar with all these methods of examination, and will help the customer determine his requirements. It is recommended that special nondestructive examination requirements be marked explicitly on the order. If these special requirements apply to all the castings, the requirements and the casting locations to which they pertain should be noted on the drawing as well as the order. It should be noted that it is not sufficient to require a method of inspection without acceptance criteria.

Many times, it is helpful to the foundryman to have special areas noted, for instance dimensionally critical or highly stressed areas, or areas to be hardened by the customer. This information will help the producer

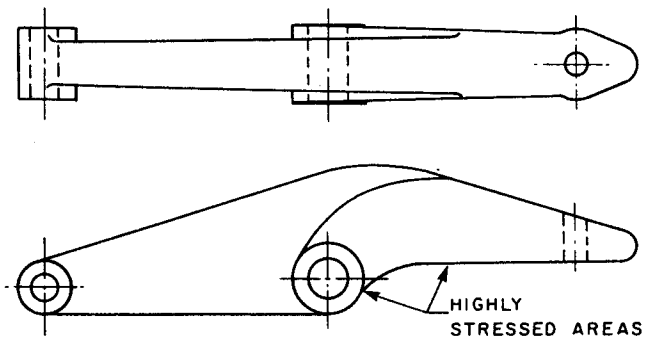

Fig. 7 Designation of highly stressed areas.

in design of pattern equipment and rigging that will produce the best conditions possible in the critical areas. See Figure 7.

Notes which are qualitative rather than quantitative should *not* be on the drawing. Such notes as "the casting should be free of fins, cracks, sand, etc.," are unnecessary since they are a part of all specifications.

Finally, special finish requirements such as paint, galvanize, etc., should be noted on both the drawing and the order as well. Any specifics such as pertinent specifications regarding these finishes should be clearly noted.

CASTING IDENTIFICATION AND LETTERING

The desired location of numbers and letters to be cast onto the surface should be marked on the engineering drawing. The size, shape, and other pertinent information should be indicated. Usually, the foundry will cast its logo in the same area as the pattern number. If it is necessary to metal stamp heat numbers, dates, or serial numbers, the size, shape, and location should be mutually agreed upon and recorded on the drawing. If special stamps such as "low-stress" types are required, this too should be stated.

Drawings produced to these guidelines will help insure good relations between buyer and seller. They will aid in avoiding the pitfalls of misinformation, misinterpretation, or assumed practices. In a word, make the drawings simple, clear, and concise.

REFERENCES

1. *Standards for Aluminum Sand and Permanent Mold Castings,* 7th Ed., Vol. 18, The Aluminum Association, July, 1977.
2. *Drafting Manual Y-14,* American National Standards Institute (ANSI), New York, NY 10018.