SEMINAR REPORT

on

INSERT MOLDING

Presented

by

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SYNOPSIS

Insert molding technology was in use for from a long time .Many types of inserts are available as standards now a days which can be selected and implemented easily. Molded in inserts is the only method to obtain a durable, high quality, method of assembly for parts subjected to frequent assembly and a variety of geometries can be used. By using insert molding a wide variety of complex geometries can be obtained. Any parts can be assembled and reassembled any number of times by using metal inserts for male and female threads.

Insert molding is also called molded in inserts. A process by which components such as pins, studs, terminals, fasteners may be molded on a part to eliminate the cost of post molding .Considerable stresses can be set up in such thermoplastic parts .To relieve those stresses allow parts to cool slowly during cooling and provide for even cooling or annealing after molding.

In this seminar I have tried to give a brief introduction about the process ,the various types of inserts available, location and loading of these inserts, the design considerations and their standards, its advantages and disadvantages .This gives the reader a brief idea about the do’s and don’ts and things to be taken care of while planning for the insert molding process. Hence, this report is only a modest attempt to introduce the reader to this technology and help him in appreciating the immense opportunities this technology has to offer.

ACKNOWLEDGEMENTS

I take this opportunity to express my sincere thanks to **Dr. N. Ramani, Principal, School Of PG Studies**, for his valuable guidance throughout. His involvement, guidance and suggestions have contributed a great part in successful completion of this report

I dedicate this seminar report to my father **Late Mr. T.P.Babu**

I also wish to thank all of my friends and colleagues for their help in many ways in the preparation and completion of this report

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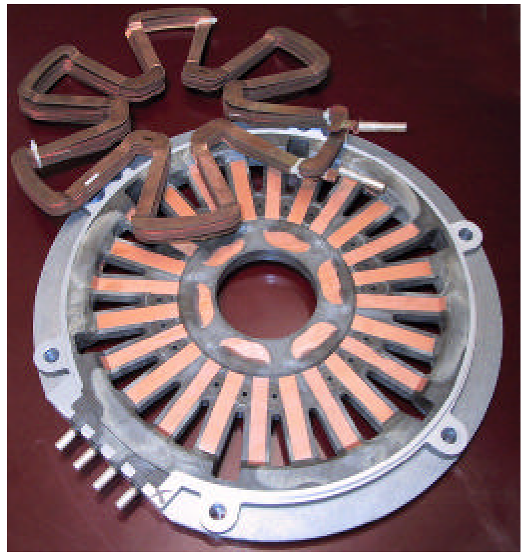
CHAPTER-1

INTRODUCTION

1, INTRODUCTION



Insert molding minimizes the post molding operations which increases productivity and improves strength and life of the component. It allows the assembly and disassembly of parts any number of times.

Insert molding is also called molded inserts. A process by which components such as pins, studs, terminals, fasteners may be molded on a part to eliminate the cost of post molding .Considerable stresses can be set up in such thermoplastic parts .To relieve those stresses allow parts to cool slowly during cooling and provide for even cooling or annealing after molding.

If the insert is larger and molding is smaller, for E.g. Molding on a little portion of a large sheet metal part, it is called Over molding .Even injection molded parts can be used as inserts E.g. Key of typewriter

The operator has to load the inserts after each cycle .Fool proofing is needed to avoid faulty insertion and missing of inserts. Preheating of inserts will reduce the defects like chilling, weld lines, short fill etc

CHAPTER-2

TYPES OF INSERTS

2, TYPES OF INSERT

The main classifications of inserts are

2,1 Blind and open female threads.

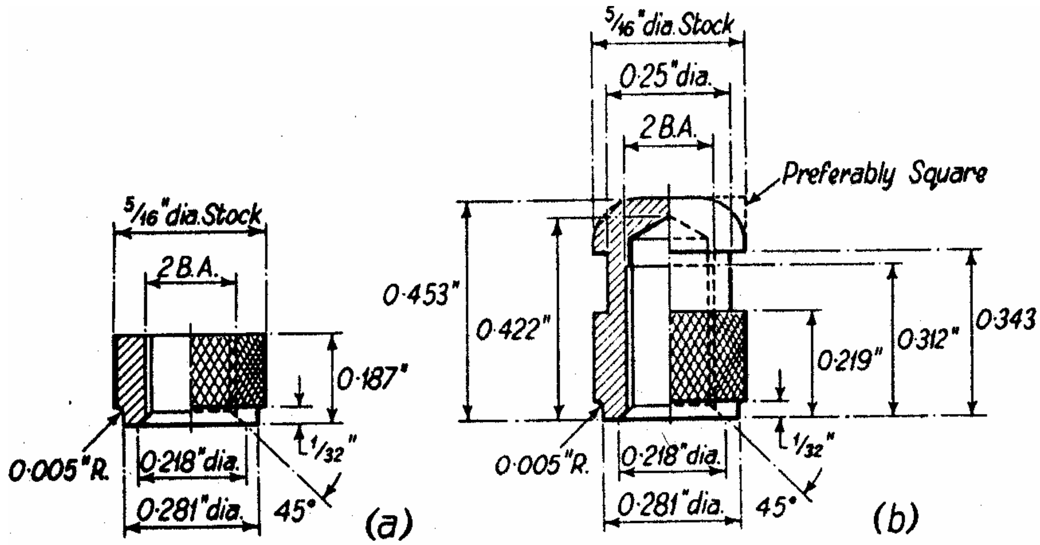


Fig. 7.1. Metal Inserts: (a) Through Insert; (b) Blind Insert.

These are blind or open. The open type of insert is generally used where the thread must run right through the molding. The insert is, therefore, clamped between the opposite faces of the tool and hence should be given just sufficient nip between the tool faces to prevent flash without distorting the insert. An interference of about 0.002 in. is usually sufficient.

Normally, blind holes are formed with blind inserts as shown at (b) in the Fig. above, the insert being molded part way into the thickness or depth of the molding or boss. This allows the carrier thread to be an easy fit without danger of flash penetration. The common domed head of the insert is preferably made more square, with only a small radius, since this decreases the thickness of molding above the insert and hence the possibility of sinking. However, a completely sharp edge should be avoided, to prevent stress concentration.

The inserts themselves are inserted in the molding tool, mounted upon carriers. The latter are special pins made of hardened nickel- chromium steel, and threaded at one end to receive the insert.

Two complete sets of carriers are made for each mould, so that a further set of inserts can be assembled to the spare set of carriers during a press cycle in preparation for the next cycle. When the press opens and the molding is extracted, the carrier is ejected, the carriers being placed in the line of draw. The fresh set of carriers, together with their assembled inserts, is then rapidly placed in the tool and the next cycle commenced The carriers still attached to the finished molding are then unscrewed, usually by means of, a fast unscrewing jig, using the square head provided on the shank of the carrier.

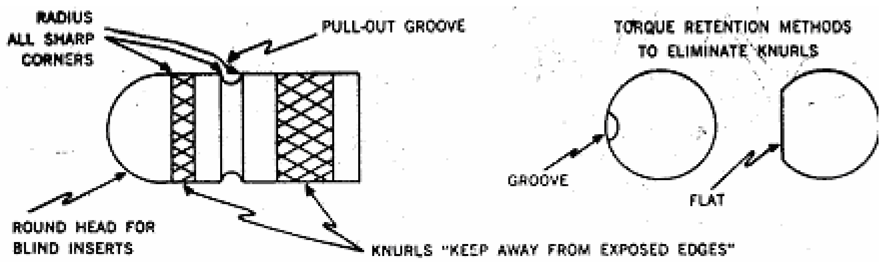


FIG. 7.56 Recommended form of a blind insert for thermoplastics. All sharp corners must be removed for high voltage application inserts.

Two complete sets of carriers are made for each mould, so that a further set of inserts can be assembled to the spare set of carriers during a press cycle in preparation for the next cycle. When the press opens and the molding is extracted, the carrier is ejected, the carriers being placed in the line of draw. The fresh set of carriers, together with their assembled inserts, is then rapidly placed in the tool and the next cycle commenced

2,2 Female Plain-hole inserts.

These inserts may be open or blind, and both types are basically the same as the threaded variety except that a plain hole replaces the threaded hole. If the insert is large and is to be placed in an accessible position on the male tool or in a shallow cavity, no carrier need be employed since it has only to be placed on the pin without any screwing. If, however, the inserts are small or the cavity deep, loading of the inserts into the tool is facilitated if they are first assembled to carriers, since the carriers are easier to handle and position than the inserts only. The carriers are identical with those employed for threaded inserts,

Except that the thread is replaced by a plain diameter. This can be made a push fit to hold the insert, and if desired a spring retainer may also be included. Caution should be exercised that the flow pattern of the plastics material within the tool does not tend to lift the insert off its carrier.

2,3 Male Inserts

These are much less commonly employed than female inserts, but arc occasionally required. A typical threaded male insert is shown in Fig. 7.5, and similar plain inserts are also used. Carriers are used under the same conditions as for female inserts. However, in place of the threaded or plain pin on the carrier, the male carrier has a threaded or plain hole to take the insert shank. For many threaded male inserts, the hole in the carrier is made plain, the diameter being that of the outside dimension of the thread, i.e. the major diameter.

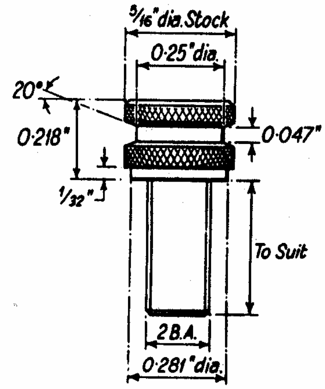


Fig. 7.5. Standard 2 B.A. Male Threaded Insert.

The close fit thus produced and the fact that the shoulder of the insert seals off against the head of the carrier substantially prevent the entry of flash. If full prevention of flash is necessary, then the hole in the carrier is also threaded to engage the insert thread.

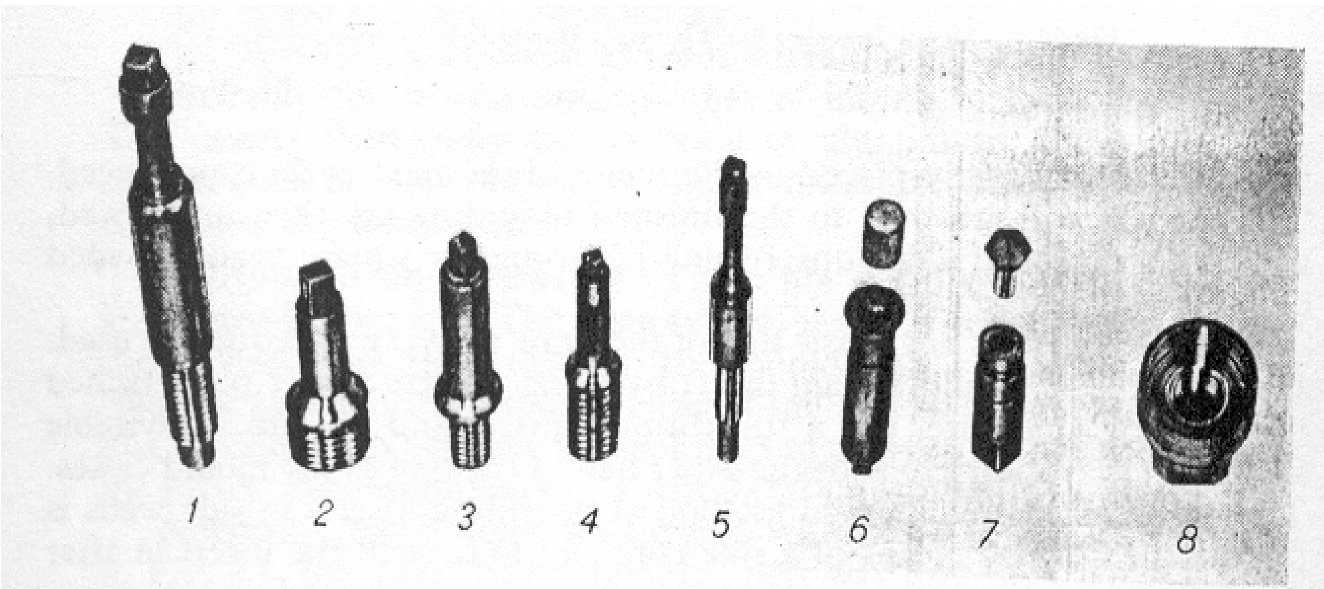


Fig. 7.6. Carrier Pins for Inserts and Moulded Thread Pins: 1. Pin to produce Male Moulded Thread and Boss, with Parallel Seating; 2. Carrier for Male Insert with Circlip Location and Parallel Seating (Only the Bottom of the Thread Carrier Hole is threaded to minimize Time in screwing Insert in and out); 3. Carrier for Blind-threaded Female Insert with Circlip Location and Valve Seating (Note the Short Length of Screw Engagement to minimize Time in screwing Insert on and off); 4. Valve-seated Threaded Pin to produce Female Moulded Threads and Two Parallel Bores, with Spring-wire Location (Note the Turned-down Portion on Locating Length to provide Relief on this Length); 5. Valve-seated Threaded Pin to produce Female Moulded Thread, with Spring-wire Location; 6. Valve-seated Threaded Pin to Produce Female Moulded Thread, without Spring Location; 7. Carrier for Full Through-threaded Female Insert, with Valve Seating; 8. Threaded Pin with Valve Seat and Spring-wire Location to produce Female Moulded Threads and Two Parallel Bores (Note the Turned-down Portion on the Locating Length to provide Relief).

2,4 Plate-type Inserts.

It is occasionally necessary to mould in metal tabs, plates or strips as inserts. An example is given below. This indicates the molding-in of a metal tag into a knob. Such an insert generally requires the use of splits for loading, either in a completely split tool, or locally split portion as illustrated.

Metal parts intended as inserts must be produced to close tolerances, as otherwise the molding material will penetrate down the sides, or the insert will not enter the tool. A maximum tolerance of 50 microns is quite usual.

Similarly, the inserts must be straight, flat and free of burrs. They are generally produced as metal stampings, so that apart from die wear, accuracy is reasonably assured. If there is any doubt about the final size of the insert, it is preferable to delay cutting the locating recesses in the mould until actual samples are available.

Whatever the form of insert, it is essential that the form of location in the splits will prevent movement in any direction, when under the influence of plastics flow and pressure. This positive location can be seen in the illustration, and the use of the dowel to prevent forward motion of the insert, in preference to attempting to locate on the radius of the insert neck, should be noted.

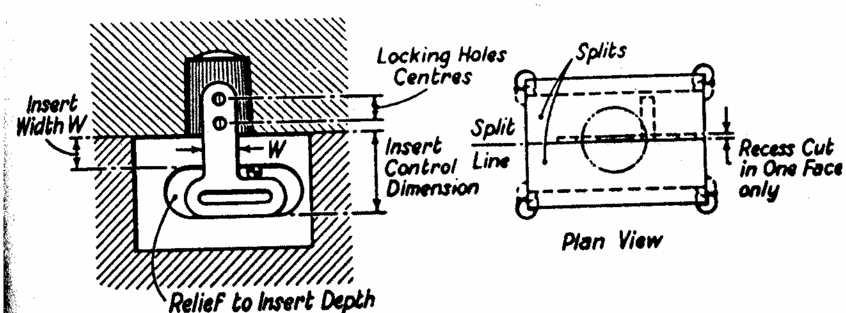


Fig. 7.7. Moulding of Plate Type Insert.

The recess to receive the insert is invariably cut into one face only, and the width and depth at the molding face must be a close fit to minimize flash. The length of the closely fitting portion of the recess should if possible be at least as long as the insert is wide. However, if it is made too long, imperfections in the insert may prevent it from lying flush.

Means of locking the insert into the molding must be provided, since shrinkage alone may not be sufficient. One common method is shown in the illustration, where holes are stamped through the metal. The plastics material flows through these holes and thus locks the insert in position. These holes should be set as far apart as possible, to achieve maximum rigidity.

2,5 Wire-type Inserts.

In many electrical moldings, small wires have to be molded in as inserts. These may be single straight wires for use as terminals, or may be bent forms. For the former, the length of unsupported wire left projecting into the mould must be kept small, since the pressure of incoming plastics material will readily bend any excessive length. Such wires are generally keyed into the molding by the provision of a flattened spade end on the wire.

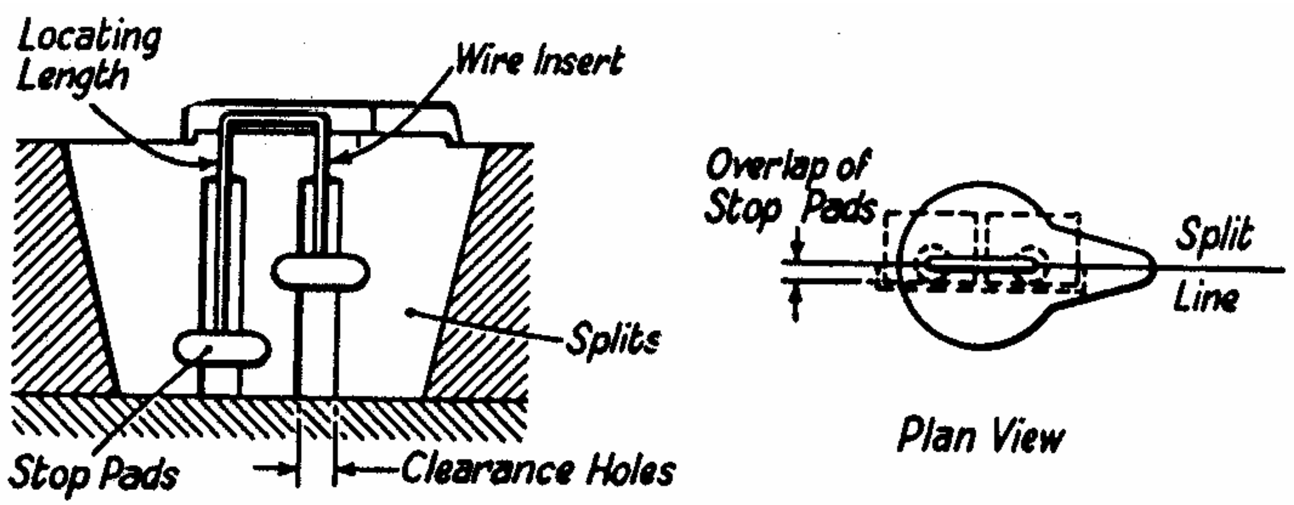


Fig. 7.8. Moulding of Wire Type Insert.

In the case of bent wires, it is essential that both ends of the wire are held in the tool. This is necessary to maintain control of the position and direction of the wire; if one end is not required, it can be cut off after molding. The molding of a bent-wire insert is indicated in Figure above. If the wires are produced free of flattening or burrs at the ends, they may be inserted direct into locating holes drilled in the tool; however, the possibility of flash entry and blockage should be considered. This is seldom the case, however, and to obviate the difficulty, they are generally loaded into splits. Since the wire diameter is generally of close tolerance, the locating hole can be held to between +0.50in. and -0.00 mm., but the length of the locating portion should not exceed 0.64mm., since other wise frictional resistance set up against ejection, from flash, may be excessive.

The wires are located for depth by means of stop pads. In the case of splits, these must overlap the split line to ensure that the wires locate on a firm face. If the pads were divided at the split line, the wires might pass over the edge and become trapped between them, and out of position

2,6 Preform Inserts.

In some instances it is convenient to produce an insert in a plastics material and then to include this insert in the main molding. Such inserts may be plain or threaded, and either produced in a separate mould or in a separate cavity in the main mould, the inserts so produced being molded into the main molding during the next cycle.
Perform inserts are used:

(a) To reduce the bulk of the molding. In the case of thick sections, the resulting excessive shrinkage can cause objectionable sink marks, such sinking occurring either on the face of the molding or in the bore of a hole. By using a preform, the section thickness to be produced on the final molding can be reduced.

(b) In the case of threaded holes, it may be desirable to produce the thread in a tougher material than that being used for the main molding. These performs may either be molded already threaded, or produced with a plain hole for use with a self-tapping screw on final assembly. Preforms are normally used where bosses are to be included on the main molding for the direct attachment of screws. Their use resolves the difficulty of bosses bursting due to insufficient wall thickness yet causing sinking if their thickness is increased. It is not uncommon to design the tool with a boss of adequate strength and to adopt a preform only if this is proved necessary on sampling. This does mean, however, that the design and estimating of the job is carried out with this eventually in mind. The preforms are mounted in the main tool either on fixed pins (plain hole preforms), or on carrier pins as other inserts.

With performs for use with standard screws or self-tapping screws, these can be molded in various lengths on stock multi-impression tools. For self-tapping screws, proved hole sizes must be used to ensure that maximum thread is engaged without the danger of bursting the boss. Preforms are normally produced with a plain exterior without serrations or knurl. They are bonded on the second molding by the melting of the outer skin, which thus welds the preform to the main molding. It therefore follows that, in general, the material used for the preform should have a lower melting point than that used for the main molding, but should be compatible with it. However, in practice, the same material used for the main moldings is often used for the preform

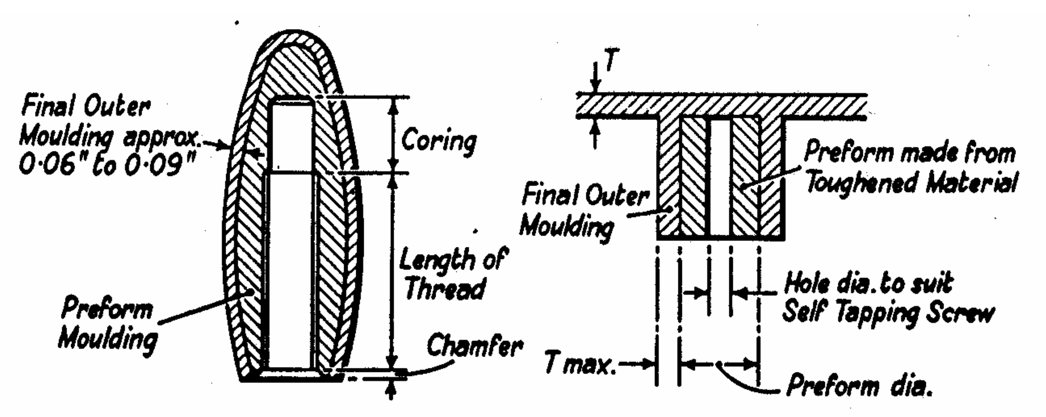


Fig. 7.9. [*Left*] Use of Preform in Handle Moulding. Fig. 7.10. [*Right*] Use of Preform in Moulded Boss.

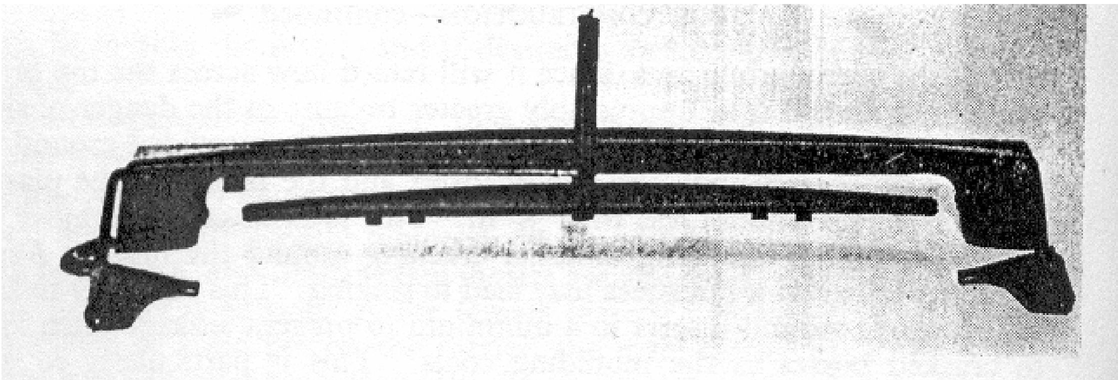


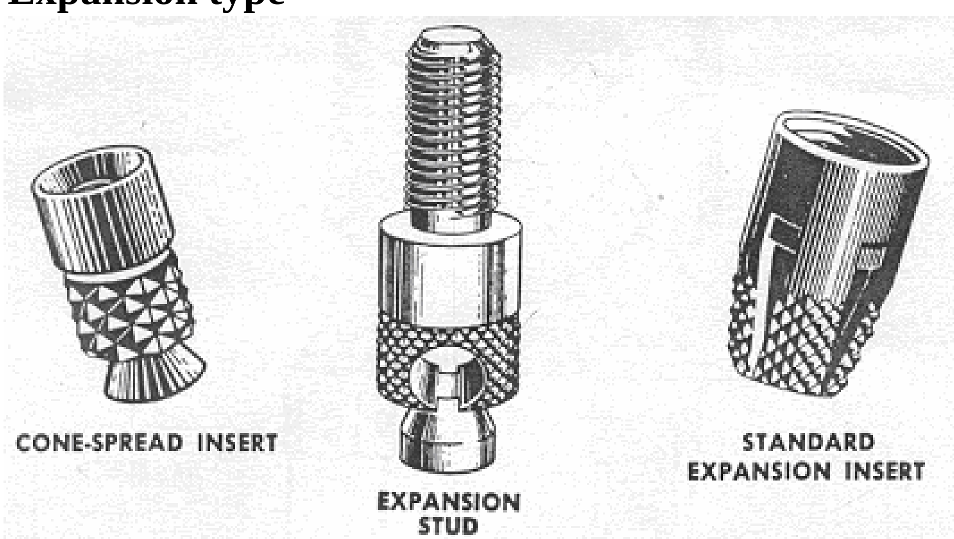
Fig. 7.10A. Hand and Cover Moulding in ABS Material produced on a Four-ounce Press. The Tool used has One Impression of the Handle gated at one End, and one Impression of Cover edge-gated at the Centre. Due to the Heavy Section of the Handle Ends, the Component is moulded with Preforms at these Points. The Preforms used are shown lying in the Foreground and are Moulded separately in Another Tool. [*Courtesy: Ekco Plastics Ltd.*]

The use of preform to reduce the bulk of two handle moldings is indicated in Fig. 7.9 and 7.1 OA. The application of a preform to reduce the final molding thickness of a boss (and thus to eliminate sinking in the front face of the molding) is illustrated in Fig. 7.10. In such a case, the preform might be produced in toughened polystyrene while the main molding might be in unmodified styrene.

2,7 Post Molding Inserts

The product designer has another option when considering the use of threaded inserts in a molded part- that of installing the inserts after molding. There are two basic insert types:

2,7,1 Expansion type



Generally internal threads that are inserted into a molded hole(s) when the molded part is cold. When the internal thread becomes activated with a male screw, the outer shell expands and becomes locked in place

2,7,2 Force fit

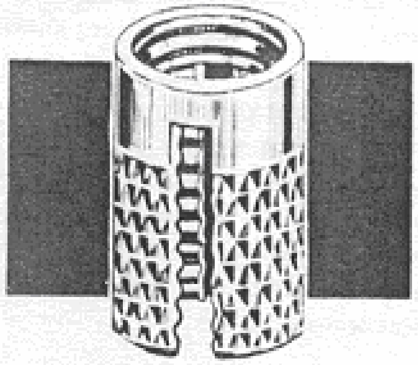


FIG. 7,59 Diamond knurled insert is designed to be pressed into molded parts after molding. (*Courtesy Boots Aircraft Nut Div., Norwalk, Conn.*)

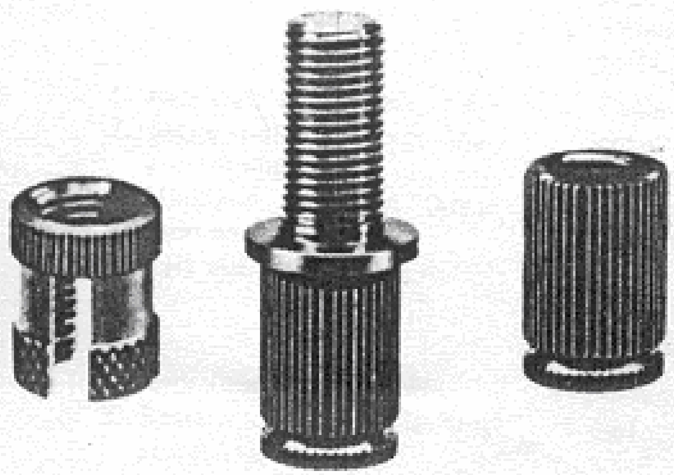


FIG. 7.60 These inserts are pressed into molded or drilled holes; the collapsing end locks the piece in place. (*Courtesy Fastener Products, Inc., Southport, Conn.*)

Male or female threaded inserts with external spiral knurls that can be force. Fitted into a molded hole(s) as soon as the Part is removed from the hot mold. With this force fitting method, the molded part is removed from the mold and immediately positioned into a fixture containing the inserts, which are aligned with their mating holes is the molded part. The inserts are pressed into the part, and, as the part cools, it shrinks onto the inserts, securely anchoring them in place.

2,7,3 Self threading inserts:

A self threading insert is a metal insert that has internal machine threads, and an external self threading thread configuration. Like self threading screws the external thread configuration can have either a thread cutting or thread forming geometry. Self threading inserts tap or form threads as they are driven into a molded or drilled pilot hole. Once in place, friction between the plastic material and the insert keep the insert from rotating, while the threads provide pull out resistance. The self threading insert provides a durable set of machine threads for use with a machine screw, or applications where repeated assembly operations are anticipated. The self threading inserts are available in a variety of sizes, having a variety of both internal and external thread configurations

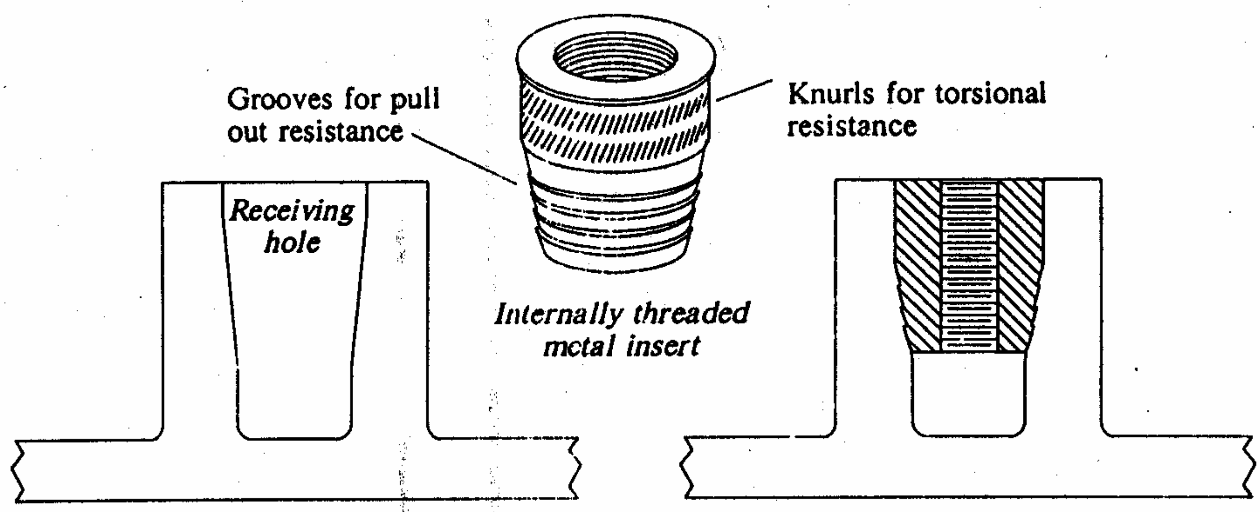


Figure 6.87. **Ultrasonic welding equipment can be used to install specially designed metal inserts into a molded plastic boss.**

Both methods are beneficial in that they eliminate the more costly molded in insert techniques and are always free of flash on the threads. The expansion type can be inserted in a secondary operation, not affecting the molding cycle, whereas the force fitting method can be utilized during the molding cure time.

2,7,4 Ultrasonic insertion:

Ultrasonic welding equipment (described latter in the chapter) can be used to generate the pressure and heat necessary for thermal insertion. The inserts used for the ultrasonic insertion process are generally brass with internal machine threads and a series of axial buttress type flutes for pullout resistance and knurls or vertical slots for torsion resistance as shown in Fig1lres 6.87 and 6.88. The inserts and the slightly undersized receiving holes are generally tapered to facilitate loading, ensure more uniform heat generation due to the scarfing action, facilitate molding, and reduce installation time (generally less than 1.0 second). The interference fit of the hole must provide sufficient material to fill in the various insert undercuts

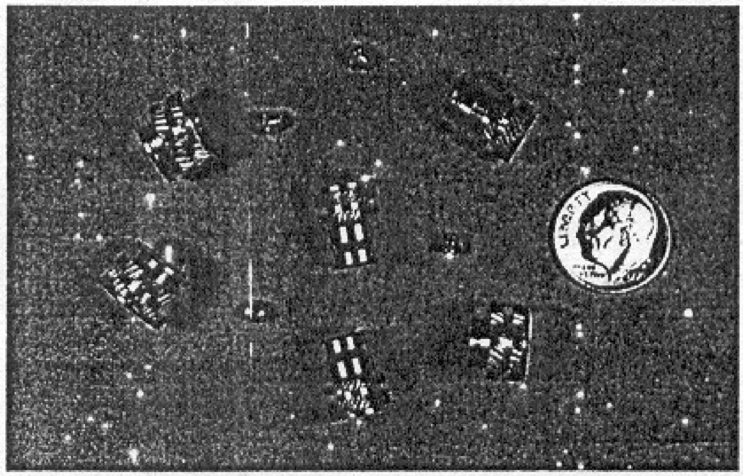


Figure 6.88. Internally threaded brass inserts are available in a wide variety of sizes and shapes for ultrasonic insertion.

The insert is pushed into the boss using a cold tool which vibrates at low amplitude and ultrasonic frequency, while the plastic part is firmly fixtured. The vibration at the insert / boss wall interface results in friction, which softens the plastic material. As the insert is pressed in by the vibrating horn, molten polymer flows into the undercuts and cools / re solidifies when the vibration stops, locking the insel1 in place. Horns for the ultrasonic insertion process are subject to a great deal of abuse and should be produced from hardened steel or carbide faced titanium, Horns with replaceable tips are recommended for long production runs. The process is significantly faster and more efficient than the conventional thermal insertion method because heat is generated only at the metal / thermoplastic interface where it is needed. The resulting assembly is strong, with a low residual stress value, Shrinkage of the melt film at the insert / polymer interface tends to relieve stress by pulling melt away from the insert during cooling

Insertion depth is an important process parameter. Situations where the insert is driven too far into the boss should be avoided as this reduces the strength of the assembly. As shown in Figure 6.89. Welding control based on position or a positive stop is used to obtain repeatable insert positioning. Ultrasonic insertion is the most commonly used method of post molding insertion. The technique is suitable for all thermoplastics and thermoplastic structural foams. The ultrasonic insertion process can be used to insert a variety of other mechanical fastening hardware such as the threaded stud shown in Figure

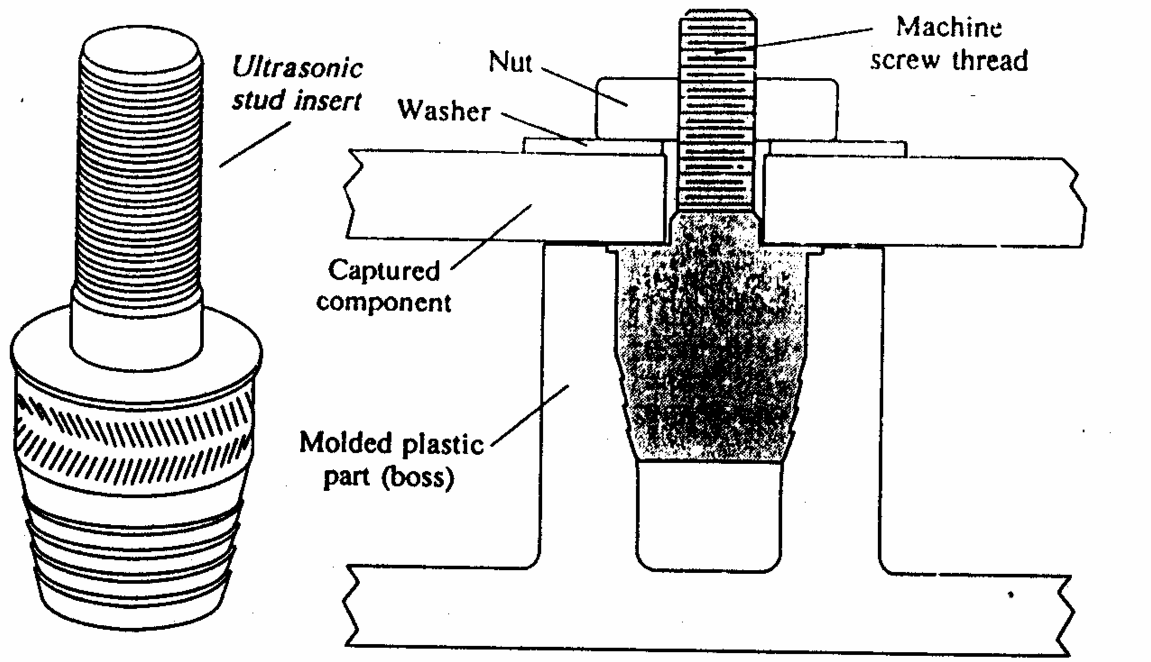


Figure 6.91. **A variety of specialty hardware items can also be ultrasonically inserted, such as this ultrasonically inserted machine screw stud.**

2,8 Other General types

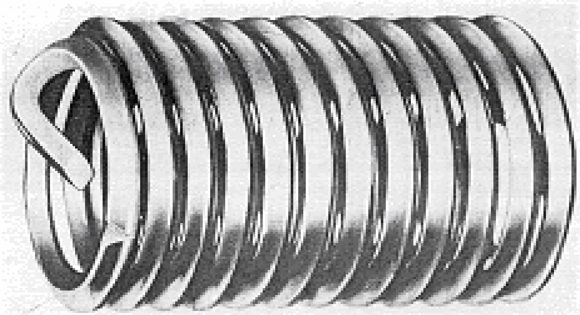
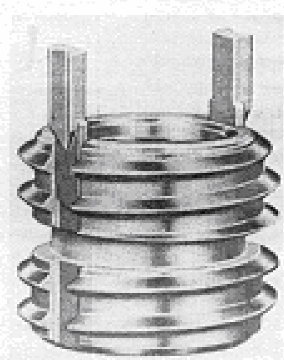


FIG. 7.62 Very hard materials such as the laminates, thermosets and ceramoplastics gain maximum thread strength by the installation of precision formed screw thread coils. The coils have a tang that is used for installation and then broken off. Installation is achieved by threading the coil into a tapped hole in the plastics product. (*Courtesy Heli-Coil Products Div., Danbury, Conn.*)

FIG. 7.63 Inserts of this type are available in several styles for thermoplastics and other soft materials. Rotational resistance is achieved by driving the keys down in to the threads of plastics after insertion. (*Courtesy Tridair Industries, Torrance, Calif.*)



2,9 Insert Performance comparison

TABLE 7.10 INSERT PERFORMANCE COMPARISON. *(COURTESY HELICOIL PRODUCTS DIV., DANBURY, CONN.)*

Fastening Method	Advantages	Disadvantages
Self-tapping screws	1. Least expensive 2. Fastest assembly	1. Doubtful holding power 2. Holding power loss after reassembly 3. Chipping and cracking unless tolerances are close 4. Threads easily damaged by improper reassembly
Molded or tapped threads with machine screws	1. Relatively inexpensive screws 2. Better holding power than self-tapping screws 3. Minimum stress in thread forming 4. Easy assembly	1. Drilling and tapping increase cost 2. Not as strong as molded-in or post-mold insert 3. Possible damage from improper screw entry 4. Molded-in threads adds to molding cost
Molded-in inserts	1. Very good holding power 2. Reassembly without holding power loss	1. Adds to molding time and cost 2. Insert missing or misplaced causes part to be rejected
Post-molding inserts for thermoplastics	1. Avoids costs and problems of molded-in or tapped thread types 2. High strength, stress free 3. Useful with smaller bosses and thinner walls, and stress sensitive materials 4. Liberal tolerances 5. Fast installation in a variety of holes	1. Slightly higher initial cost than molded-in or expansion types 2. Requires special (but relatively low cost) equipment 3. Use restricted to thermoplastics

Fastening Method	Advantages	Disadvantages
		3. Cleaning insert of flash increases cost 4. Post molding changes can affect holding power 5. Possibility of mold damage 6. Large inserts need preheating
Post-molding press-in or cement-in inserts	1. No interference with molding operation 2. No cleaning of flash 3. Simple installation without expensive tooling	1. Holding power less than molded-in inserts 2. Doubtful retention of press-in due to close tolerances needed and of cemented-in due to unclean surface 3. Press-in can crack material if tolerances are not held
Post-molding self-tapping inserts	1. Strong holding power 2. Good quality internal thread	1. Higher cost inserts 2. Slowest installation 3. Requires close tolerance control to avoid high driving torque or poor retention 4. Usually restricted to sizes No. 8 through ½"
Post-molding inserts into tapped holes	1. Highest quality internal thread 2. Strongest holding power 3. Can use screw locking feature	1. Highest cost insert 2. Slow installation, with relatively expensive equipment needed for automatic installation
Post-molding expansion type inserts	1. Avoid all extra operation costs associated with molded-in inserts 2. Holding power adequate for most operations 3. Automatic installation at speeds to 60/min.	1. Automatic equipment required for fast installation 2. Strength exceeded by self-tapping post molding inserts

CHAPTER-3

DESIGN CONSIDERATIONS

3, DESIGN CONSIDERATIONS FOR INSERT MOLDING

3,1 General

3,1,1 Decreases the thickness of molding above the insert and hence the possibility of sinking

3,1,2 Completely sharp edge should be avoided, to prevent stress concentration.

3,1,3 The inserts themselves are of brass or aluminum, these metals being chosen both to resist corrosion and to minimize damage when the tool closes on a displaced insert.

3,1,4 Caution should be exercised that the flow pattern of the plastics material within the tool does not tend to lift the insert off its carrier.

3,1,5 Methods to prevent material from filling the thread

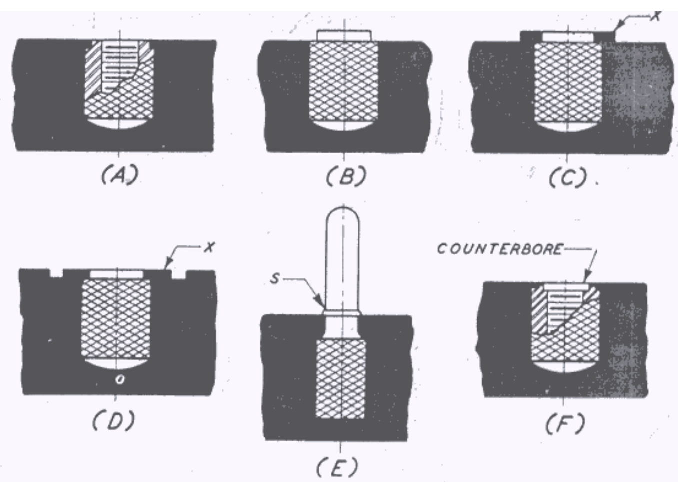


FIG. 7.52 Several methods which prevent material from filling thread. Compound flows easily over end of insert (A) into threaded portion and insert must be retapped after molding. Insert shoulder enters mold pin (B) to prevent compound from flowing into insert. (This is the best construction.) Compound hardens quickly at thin sections "x" (C, D) stopping flow of compound over end of inserts and into thread. Squeeze ring "s" is crushed (E) when rod type insert is driven into mold insert pin thus sealing compound from exterior surface of insert. Internal counterbore (F) also prevents compound from entering thread. The mold pin fits the counterbore and inside diameter of the threaded section.

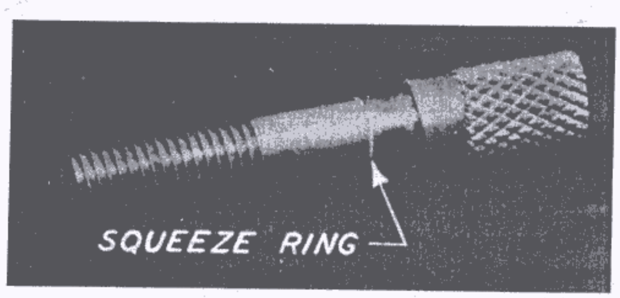
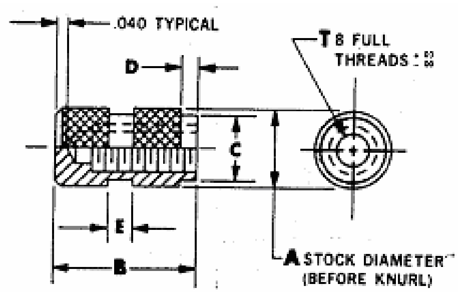


FIG. 7.53 Squeeze ring near center of insert is crushed to form a tight seal when the insert is driven into the mold pin. This prevents flash from flowing past the ring and into the thread. Ring also holds insert in mold member when loaded in upper half of mold.

3,1,6 Standard general purpose female thread inserts for plastics



TAP DRILL	KNURL PITCH (TPI)	A	B	C	D	E
50 (.070) 49 (.073)	50	.156	.250	.142	.031	.031
47 (.078) 45 (.082)	50	.188	.281	.171	.031	.031
43 (.089) 42 (.093)	40	.188	.344	.171	.031	.031
38 (.101) 37 (.104)	40	.219	.344	.202	.031	.031
35 (.110) 33 (.113)	30	.219	.406	.202	.062	.031
29 (.136) 28 (.140)	30	.250	.406	.226	.062	.046
25 (.149) 21 (.159)	30	.281	.531	.259	.062	.046
16 (.177) 14 (.182)	30	.312	.531	.288	.062	.046
7 (.201) 3 (.213)	20	.344	.625	.321	.094	.062
F (.257) I (.272)	20	.438	.719	.404	.094	.078
$\frac{5}{16}$ (.312) Q (.332)	20	.500	.812	.466	.094	.094

FIG. 7.55 Standard general-purpose female insert design for plastics materials. Because it is designed for flush molding no sealing ring is provided. (*Courtesy Standard Insert Co., Pacoima, Calif.*)

3,1,7 Insert Dimensions and Tolerances.

The vast majorities of mold-in inserts are produced on automatic screw machines and are made of various materials such as copper, brass, bronze, aluminum, and stainless steel. Cold forged inserts produced with rolled threads have been used where tolerances levels are more open. Materials suitable for cold forged inserts are brass, copper and copper alloys, stainless steel, and coin silver. This type insert can be produced to tight length and diameter tolerances but at the cost of added machining operations. Many of the above insert styles or types can be plated for special applications, generally to meet electrical, conductivity and/or corrosion resistance requirements. The decision to use or not to use molded-in inserts will often depend on

1, Ultimate number of parts to be molded
2, Quantity and variety of inserts in each part
3, Number of cavities in the mold

The total number of inserts to be loaded into a mold during the "open mold" segment of the molding cycle will obviously have a direct bearing on the total cycle time and, consequently, on the molding cost. There are effective ways to reduce the "open time" at the press, but they will bring with them some added costs in special equipment and/or increased mold and tool costs.

3,2 Thermosets

Material reinforcing members can be incorporated into parts molded from thermosetting plastics. However, molded-in inserts can cause problems. External metal inserts may become loose owing to shrinkage of the plastics material. Internal inserts may present problems with material cracking around them because of post mold shrinkage. Table given below indicates the minimum wall thickness to be used with plain round inserts to avoid this problem.

Molded-in inserts slow production rates because of the time required to position them into the mold during each cycle. In the injection-molding process, a vertical press or a specially designed shuttle press may be required for ease of insert loading. , Investigate the possibility of pressing an insert into the part immediately after molding, and let material shrink around the outside diameter of the insert. Epoxy cement may ensure better anchorage.

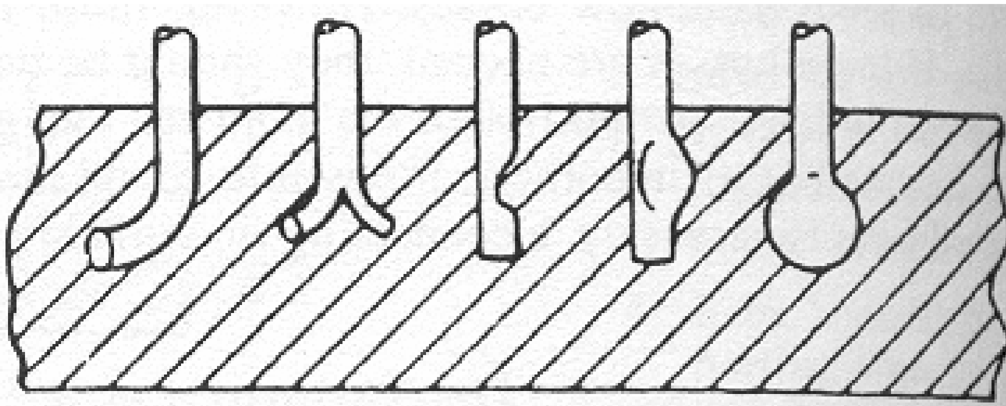
TABLE 6.1.3 Suggested Minimum Wall Thickness around Metal Inserts Molded in Thermosetting Plastics

	Wall thickness, mm (in)					
Insert diameter	3.0 (1/8)	6.3 (1/4)	9.5 (3/8)	12.7 (1/2)	19 (3/4)	25 (1)
General-purpose phenolic	2.4 (0.093)	4.0 (0.156)	4.8 (0.187)	5.5 (0.218)	7.9 (0.312)	8.7 (0.343)
Medium-impact phenolic	2.0 (0.078)	3.6 (0.140)	4.0 (0.156)	5.2 (0.203)	7.1 (0.281)	7.9 (0.312)
High-impact phenolic	1.6 (0.062)	3.2 (0.125)	3.6 (0.140)	4.8 (0.187)	6.3 (0.250)	7.1 (0.281)
Urea	2.4 (0.093)	4.0 (0.156)	4.8 (0.187)	7.1 (0.281)	7.9 (0.312)	8.7 (0.343)
Melamine	3.2 (0.125)	4.8 (0.187)	5.5 (0.218)	7.9 (0.312)	8.7 (0.343)	9.5 (0.375)
Alkyd	3.2 (0.125)	4.8 (0.187)	4.8 (0.187)	7.9 (0.312)	8.7 (0.343)	9.5 (0.375)
Epoxy	0.5 (0.020)	0.8 (0.030)	1.0 (0.040)	1.3 (0.050)	1.5 (0.060)	1.8 (0.070)
Diallyl phthalate	3.2 (0.125)	4.8 (0.187)	6.3 (0.250)	7.9 (0.312)	8.7 (0.343)	9.5 (0.375)

3,3 Thermoplastics

Inserts are useful and practical to provide reinforcement where stresses exceed strength of the plastic material. Although they are economical, they are not without cost and should be used only when necessary for reinforcement, anchoring, or support

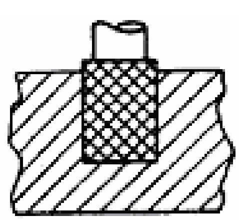
Sharp corners should be avoided on the portion of the insert that is immersed in, thermoplastic. Figure given below shows acceptable designs for the inserted ends of hook and anchoring rods.



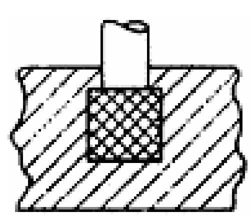
Acceptable

FIGURE 6.2.20 Recommended designs for the ends of hooks or rods to be inserted in plastic parts.

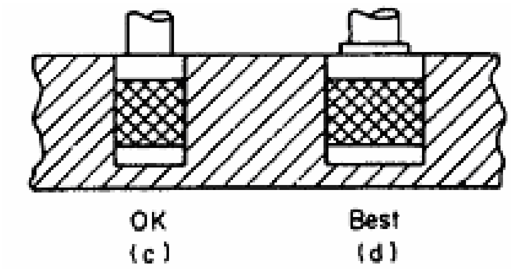
Figure below shows unacceptable and acceptable designs & locations for inserted ends of screw-machine parts. Knurls on machined inserts should be relatively coarse to permit the material to flow into the recesses. There should be a smooth surface where the insert exits from the plastic.



Not this
(a)



Better
(b)

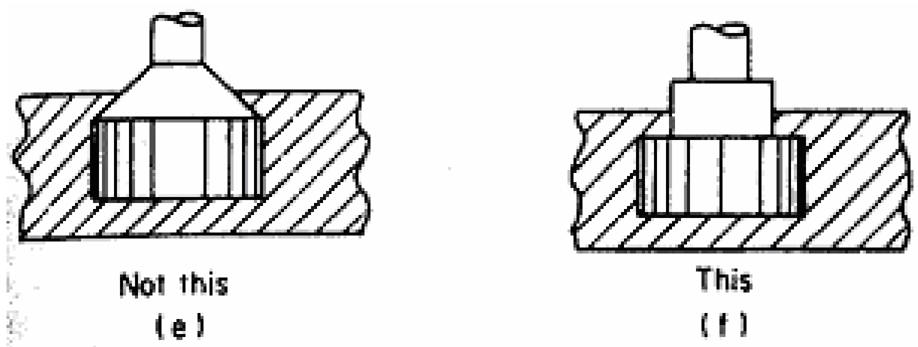


Design ***a***, is not a good design because there should be a smooth surface where the insert exits from the plastic

Design ***b*** is better but it does not allow the flow of plastic material to be sealed off from unwanted areas.

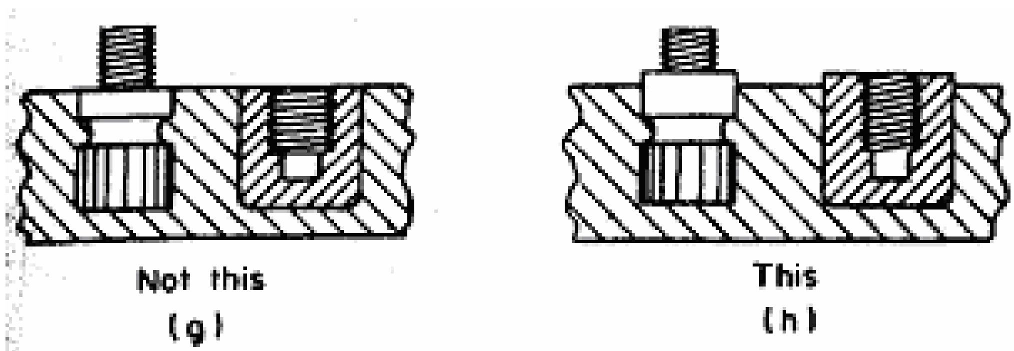
Design ***c*** is better from this standpoint.

Design ***d*** is still better because it provides a double-sealing surface.



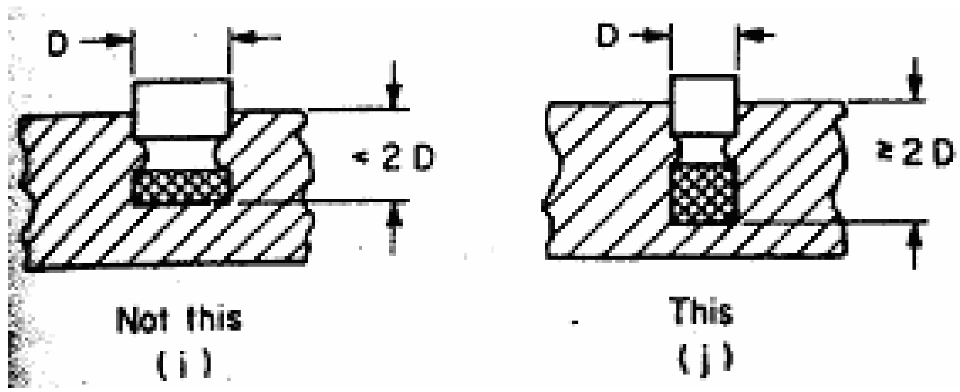
Design ***e*** is not satisfactory because it would result in a feather edge of plastic material around the insert.

Design ***f*** avoids this



In Design ***g***. the two parts lie apart to suffer contamination of the screw threads with plastic material.

Design ***h*** avoids this problem by raising the threaded portion of the insert above the surface of the part.



In view ***i*** the part is not sufficiently embedded in the plastic material of the part.

As shown in ***j*** the depth of insertion should be at least 2 times the insert diameter.

.

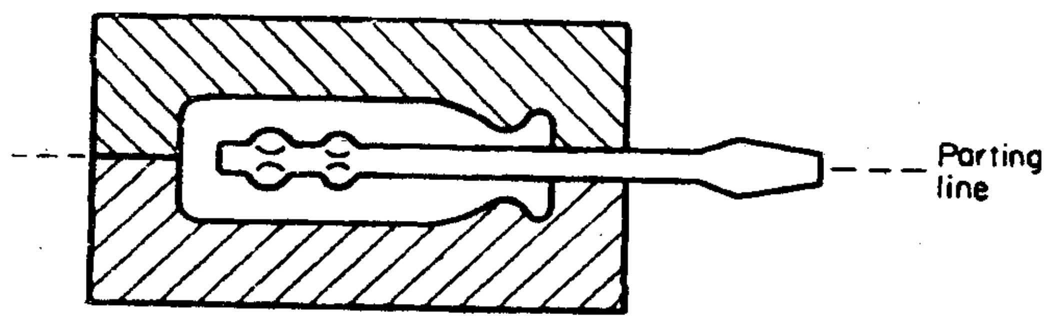


FIGURE 6.2.22 Irregularly shaped inserts are placed on the parting line of the mold.

Screw-machine inserts should be placed perpendicular to the parting line of the mold to facilitate placement and avoid complications in mold construction. Irregular inserted parts such as screwdriver blades with non inserted widths or diameters larger than the inserted diameter are placed with their axes on the parting line of the mold. Otherwise, side cores must be provided to permit removal of the insert from the mold.

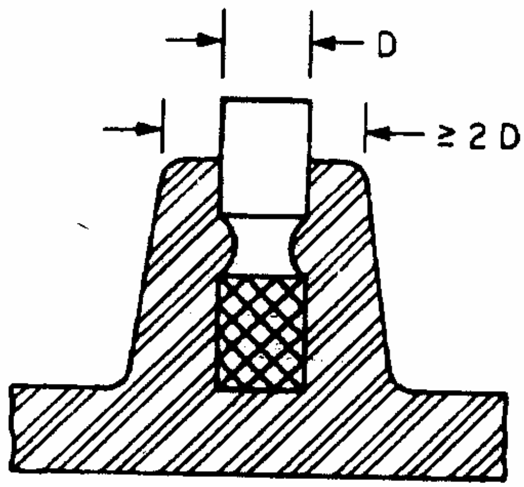


FIGURE 6.2.23 Ample supporting material must be provided around an insert. If the diameter of the insert is ¼ in or less, the boss diameter should be at least twice that of the insert.

Inserts very often are incorporated in a boss that provides supporting material for the insert. If the outside diameter of the insert is less than 6 mm, the outside diameter of the boss should be twice that of the insert.

If the outside diameter of the insert is larger than 6 mm, wall thickness should be 50 to 100 percent of the insert diameter. Whenever the configuration permits, it is desirable to design the insert so that the flow of plastic is sealed off from threaded areas and other areas where plastic materia1 is not intended to be. A good rule of thump is to make the embedded length of an insert twice its diameter

It is often advisable to press in the insert after molding. This avoids problems of contamination of the exposed surface of the insert with plastic material. It also avoids the possibility of damaging an injection mold with a misplaced insert. Ultrasonic techniques are particularly reliable for inserting metal inserts into plastics parts after molding.

Threaded portions of inserts should be raised from the surface of the molded part to avoid contamination of the threads with material. Also, featheredges of plastic material around inserts should be avoided.

Table 8-4 Suggested minimum wall thicknesses for inserts of various diameters

Plastic Material	Diameter of Inserts, in. (mm) 0.125 (3.17)	0.250 (6.35)	0.375 (9.52)	0.500 (12.7)	0.750 (19.0)	1.00 (25.4)
ABS	0.125 (3.17)	0.250 (6.35)	0.375 (9.52)	0.500 (12.7)	0.750 (19.0)	1.00 (25.4)
Acetal /	0.062 (1.57)	0.125 (3.17)	0.187 (4.75)	0.250 (6.35)	0.375 (9.52)	0.500 (12.7)
Acrylics	0.093 (2.36)	0.125 (3.17)	0.187 (4.75)	0.250 (6.35)	0.375 (9.52)	0.500 (12.7)
Cellulosics	0.125 (3.17)	0.250 (6.35)	0.375 (9.52)	0.500 (12.7)	0.750 (19.0)	1.00 (25.4)
Ethylene vinyl acetate	0.040 (1.02)	0.085 (2.16)	N.R.	N.R.	N.R.	N.R.
FEP (fluorocarbon)	0.025 (0.64)	0.060 (1.52)	N.R.	N.R.	N.R.	N.R.
Nylon	0.125 (3.17)	0.250 (6.35)	0.375 (9.52)	0.500 (12.7)	0.750 (19.0)	1.00 (25.4)
Noryl (modified PPO)	0.062 (1.57)	0.125 (3.17)	0.187 (4.75)	0.250 (6.35)	0.375 (9.52)	0.500 (12.7)
Polyallomers	0.125 (3.17)	0.250 (6.35)	0.375 (9.52)	0.500 (12.7)	0.750 (19.0)	1.00 (25.4)
Polycarbonate	0.062 (1.57)	0.125 (3.17)	0.187 (4.75)	0.250 (6.35)	0.375 (9.52)	0.500 (12.7)
Polyethylene (HD)	0.125 (3.17)	0.250 (6.35)	0.375 (9.52)	0.500 (12.7)	0.750 (19.0)	1.00 (25.4)
Polypropylene	0.125 (3.17)	0.250 (6.35)	0.375 (9.52)	0.500 (12.7)	0.750 (19.0)	1.00 (25.4)
Polystyrene	Not recommended					
Polysulfone	Not recommended					
Surlyn (ionomer)	0.062 (1.57)	0.093 (2.36)	0.125 (3.17)	0.187 (4.75)		
Phenolic GP	0.093 (2.36)	0.156 (3.96)	0.187 (4.75)	0.218 (5.53)	0.250 (6.35)	0.312 (7.92)
Phenolic (medium-impact)	0.078 (1.98)	0.140 (3.56)	0.156 (3.96)	0.203 (5.16)	0.312 (7.92)	0.343 (8.71)
Phenolic (high-impact)	0.062 (1.57)	0.125 (3.17)	0.140 (3.56)	0.187 (4.75)	0.281 (7.14)	0.312 (7.92)
Urea	0.093 (2.36)	0.156 (3.96)	0.187 (4.75)	0.218 (5.53)	0.250 (6.35)	0.281 (7.13)
Melamine	0.125 (3.17)	0.187 (4.75)	0.218 (5.53)	0.312 (7.92)	0.312 (7.92)	0.343 (8.71)
Epoxy	0.020 (0.51)	0.030 (0.76)	0.040 (1.02)	0.050 (1.27)	0.343 (8.71)	0.375 (9.52)
Alkyd	0.125 (3.17)	0.187 (4.75)	0.187 (4.75)	0.312 (7.92)	0.060 (1.52)	0.070 (1.78)
Diallyl phthalate	0.125 (3.17)	0.187 (4.75)	0.250 (6.35)	0.312 (7.92)	0.343 (8.71)	0.375 (9.52)
Polyester (premix)	0.093 (2.36)	0.125 (3.17)	0.140 (3.56)	0.187 (4.75)	0.343 (8.71)	0.375 (9.52)
Polyester TP	0.062 (1.57)	0.125 (3.17)	0.187 (4.75)	0.250 (6.35)	0.250 (6.35)	0.281 (7.14)
					0.375 (9.52)	0.375 (9.52)

3,4 Rotomolding

Inserts maybe used to fix or locate outlets, filters, valves, and the in the walls of rotational molded parts. They may be plain or threaded, but metal units should have knurling or projections to secure them into the plastic material after it forms (one-step operation, eliminating post finishing). Prior to molding, metal inserts may be positioned in the mold by screws, bolts, or a magnet. Plastic or plastic-metal inserts are also used, and a thin plastic flange is designed so that it melts allowing the molding powder to adhere. (Being heavier, the body of the plastic insert does not melt during molding.)

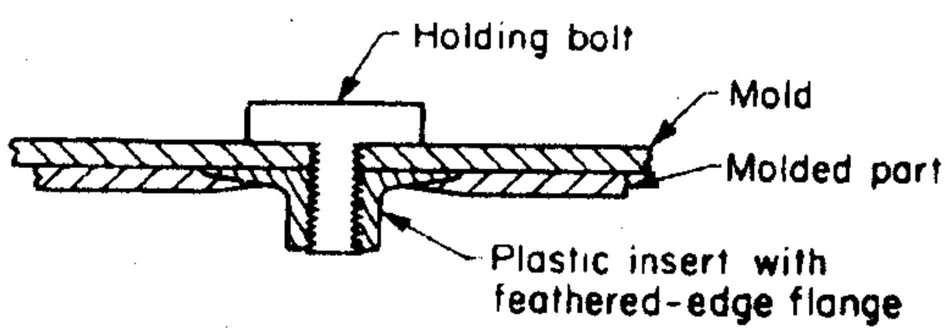


FIGURE 6.4.11 Incorporating plastic inserts into roto-molded parts.

3,5 Reinforced –Plastic/composite (RP/C) Parts

3,5,1 Press Molding:-

Inserts can be either molded in or set mechanically after molding except with perform and cold-press molding, for which only after molding assembly is recommended. A variety of interface surfaces, including diamond knurl, I-beam type etc., may be employed for the molded in inserts. Threads on inserts are preferable to threading molded RP/C parts.

3,5,2 Open-Lay-Up Molding:-

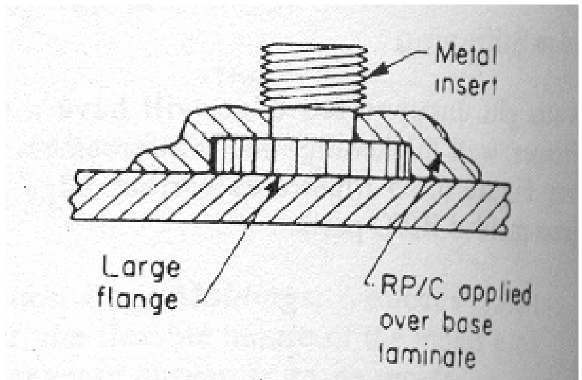


FIGURE 6.6.11 Wide-flanged metal inserts in RP/C parts can be fastened by applying material over the flange.

Inserts may be incorporated for a variety of applications such as bolting, joining, etc. Threading of open lay-up molded parts is not recommended. Insert flanges or bases should be as large as is feasible. Often inserts can be incorporated by applying additional material over the flange base of the insert.

		Compression molding			Injection molding (thermoplastics)	Cold-press molding	Spray-up and hand lay-up
		Sheet-molding compound	Bulk-molding compound	Preform molding			
Metal inserts		Yes	Yes	Not recommended	Yes	No	Yes
Bosses		Yes	Yes	Yes	Yes	Not recommended	Yes
Ribs		As required	Yes	Not recommended	Yes	Not recommended	Yes
Molded-in labels		Yes	Yes	Yes	No	Yes	Yes

3,6 Rubber Parts

3,6,1 Stagger the location of non flush threaded inserts to keep more uniform rubber thickness and therefore lower stress concentration, as shown in Fig. 6.10.14. Use inserts with flush heads to reduce stress concentrations further.

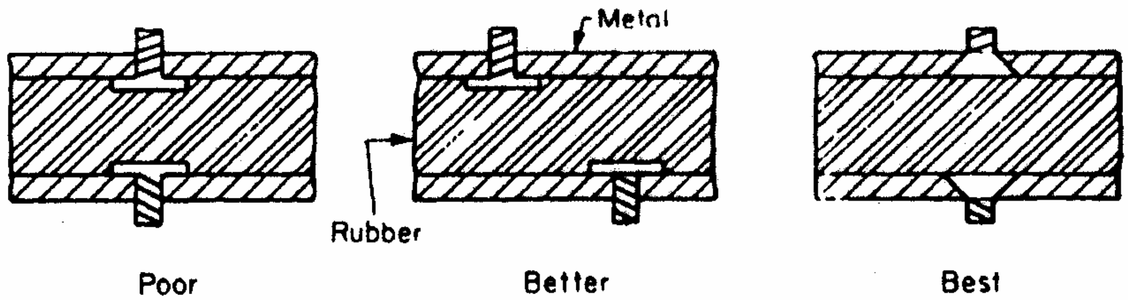


FIGURE 6.10.14 If it is not feasible to separate fasteners from the molded rubber, they should be placed so as to keep the rubber thickness as uniform as possible to avoid stress concentrations. (*From A. R. Payne and J. R. Scott,* Engineering Design with Rubber, *Interscience, New York, 1960.*)

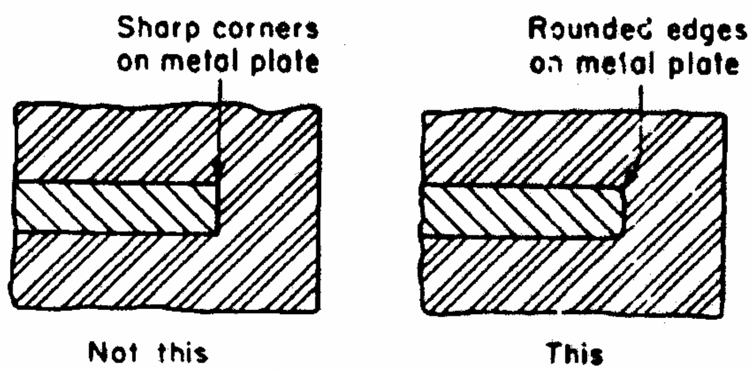


FIGURE 6.10.15 Radius metal edges that contact rubber.

3,6,2 The design should permit gate locations that avoid flowing rubber tangential to adhesive-coated metal during injection molding. This prevents scouring adhesive from the metal, causing loss of adhesion.

3,6,3 Avoid inserts with sharp edges, as shown in Fig. 6.1 10 15, to avoid cutting the rubber.

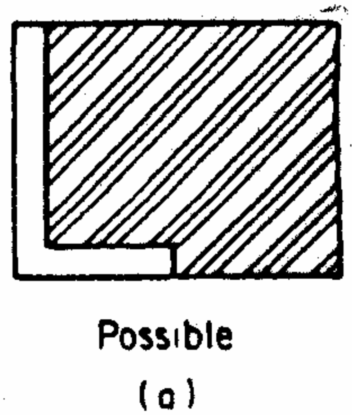


FIGURE 6.10.16 Angle inserts molded in rubber. (*From Roger W. Bolz*, Production Processes: The Productivity Handbook, *Conquest Publications, Winston-Salem, N.C., 1977.*)

CHAPTER-4

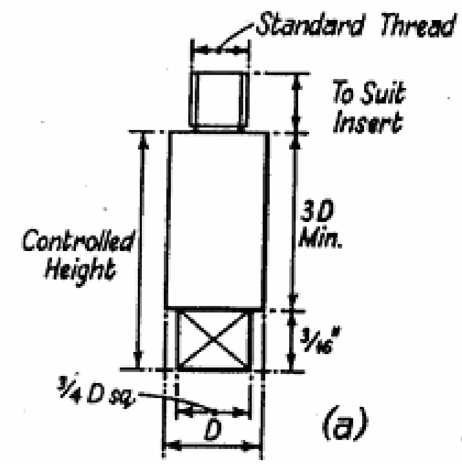
LOADING & LOCATION OF INSERTS

4, LOCATION OF INSERTS

4,1 Using Carriers

Two principal types of carrier are employed, they are

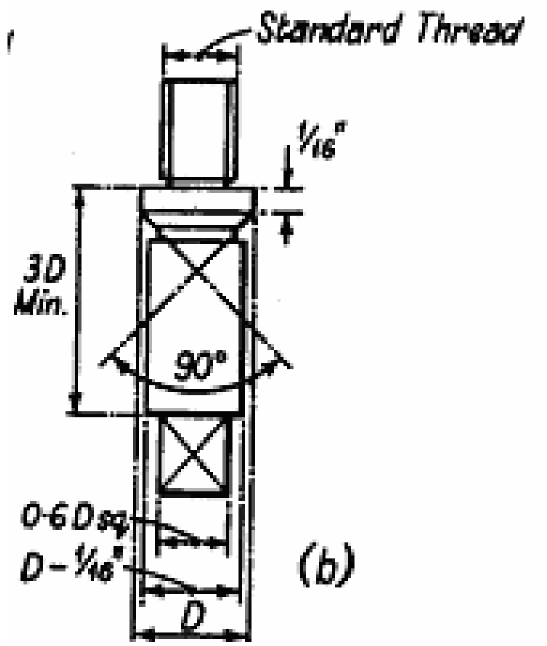
4,1,1 Parallel-shank type



It is the cheaper form of carrier, and the easiest to replace and maintain. With the parallel type, the only feature that prevents flash penetrating down the side of the carrier is the close fit of the shank in its mating hole. The thread on insert carriers (but not on pins for molded threads) may be run out into an undercut as indicated in the illustration, The shank slips into a closely fitting hole in the tool, the shoulder of the screw and thus the face of the insert, being made flush with the mould face. The position in the tool of the parallel type is controlled by the length of the carrier and the depth of its hole

In many cases, it is desirable and convenient to eject the molding at the inserts; this is particularly the case where the insert is molded into a boss which might otherwise tend to stick in the mould and break off, Here the carrier is positioned in the ejector pin itself. The ejector is bored to receive the carrier. This is essential, because, when the carriers are to be loaded into the mould in the press-open position, the ejectors will be forward. Parallel shank carriers are generally used with quill ejectors.

4,1,2 Valve-seat type



Valve seat type, if carefully made, is probably the most efficient, The flash entry is positively prevented by the seal. In the valve-seat type, the carrier hole can be bored completely through,, location being provided by the much shorter valve depth dimension,

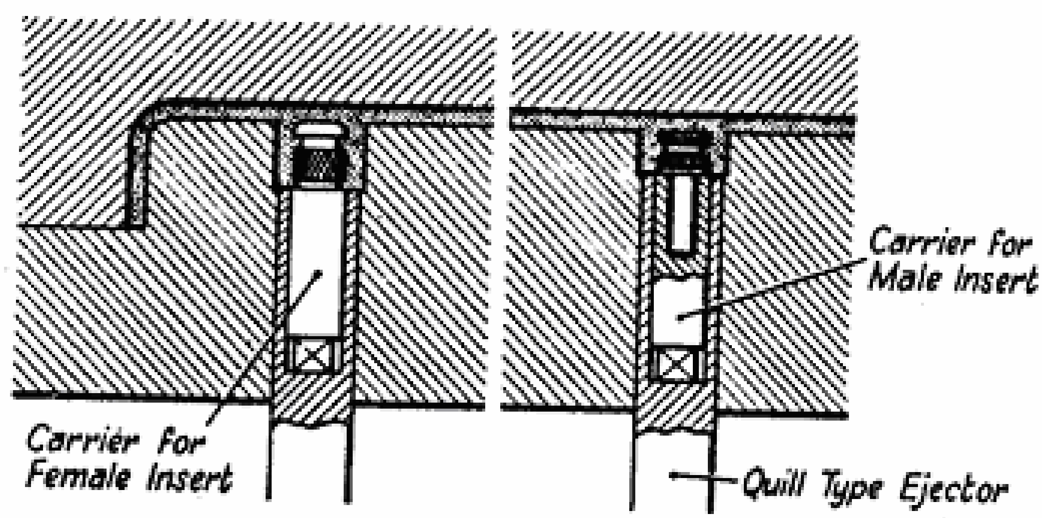
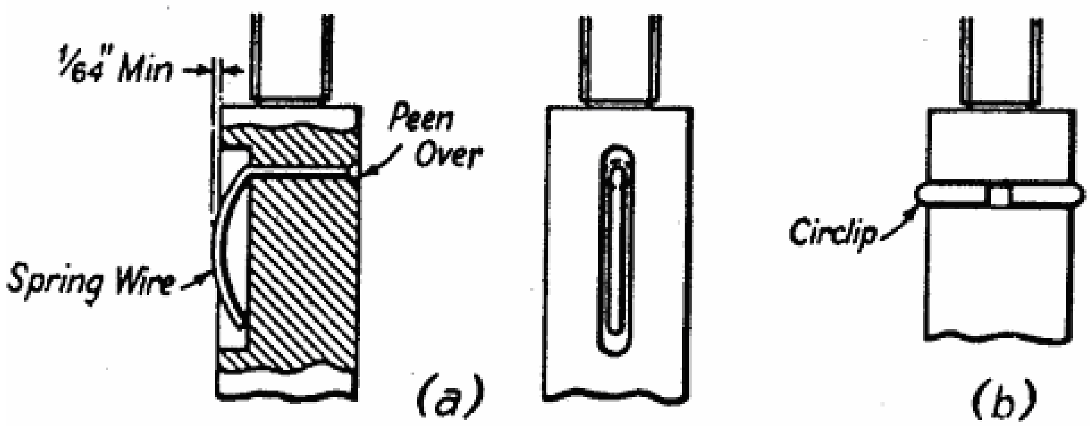


Fig. 7.3. Insert Carriers mounted in Ejectors.

4,1,3 Retaining of Carriers



(a) and (b) Carrier-retaining Methods.

The figure above illustrates two common methods of retaining the carrier in the tool, both employing spring clips. At (a), a length of spring wire is housed in a slot in the shank. This is compressed when the carrier is inserted into its hole and prevents the carrier from being shaken out of position by the movement of the tool. At (b), a similar result is achieved by employing a spring circlip around the shank.

While these can be employed on any mould, they are primarily of importance on carriers housed in ejectors. Here the return movement of the ejectors, as the mould closes, could easily displace the carrier unless it was retained.

The determination of the side of the tool where the carriers are to be placed may be decided by the design of the component, or may be decided by the requirement to eject off the inserts. For full through inserts, the choice may arise at to whether the carriers should be placed in the male or the female tool. Normally they are placed on the ejection side, but the main point in making a cho ice is ease of loading the carriers. Difficulty may be encountered if the carriers are to be loaded behind a large male punch on the side remote from the operator, but these conditions are occasionally inescapable.

4,2 Loading Of Inserts

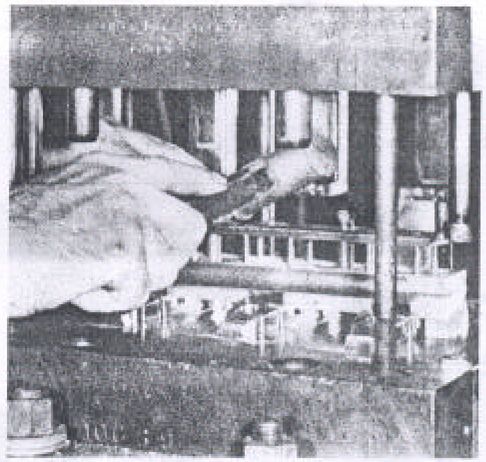


FIG. 5.13 This insert loader holds four inserts for each of the three cavities. They are released by withdrawal of the slide and are then tapped firmly into position on the mold insert holding pins.

It is frequently desirable to load metal or other inserts in a mold to become a part of the molded product. Many inserts are used to provide a strong threaded anchorage for screws. Such inserts have an external knurl that strengthens the attachment to the plastics material. The plastics materials shrink more than the metals, making a fairly tight fit. Inserts may be loaded individually by hand, or special fixtures may be designed to index the inserts in relation to their holding pins, facilitating loading the entire mold at one time, as shown in Figure below. The quick loading of inserts is an important design consideration for the lowest cost molded parts. Location of inserts and their holding pins must be given careful consideration in the product and mold design, since tremendous molding pressures are generated during material flow that may "wash" the inserts off their locating pins, or break them. Baffle pins are sometimes used to protect the inserts whew unusual flow conditions must be encountered. The internal pressure other flowing material may reach 4000 or 5000 psi, a force sufficient to break large pins or thin mold sections. Fillets in comers and streamlined sections are used whenever possible, to increase the mold resistance to these stresses. Most thin-walled inserts will crush under this pressure, and often need to be retapped after molding. Tight fits eliminate compound from threads. When possible, inserts should be designed for post-molding assembly.

CHAPTER-5

INSERTS MATERIAL & SPECIFICATION

5, Material and Specifications

5,1 Specification

Specifications governing the inserts are usually spelled ,out on part drawings that will list the following

5,1,1 Material
5,1,2 Dimensions with appropriate tolerance
5,1,3 Special requirements: plating, knurling, hardness
5,1,4 Type of lubricant for coating the exterior of the insert to `
facilitate flash removal after molding

5,2 Material

5,2, 1 Brass
5,2,2 Aluminum
5,2, 3 Steel
5,2, 4 Copper
5,2,5 Bronze

5,3 Properties

5,3,1 Corrosion Resistance
5,3,2 Thermal Conductivity
5,3,3 Dimensional Stability
5,3,4 Machinability
5,3,5 Ductility and Malleability

CHAPTER-6

ADVANTAGES & DISADVANTAGES

6,1 ADVANTAGES.

6,1,1 **P**rovide a durable thread for assembly purposes
6,1,2 Powder metal inserts may be cost effective when more complicated geometries are required
6,1,3 Molded-in inserts offer additional design flexibility
6,1,4 Molded in inserts are durable, high quality, method of assembly for parts subjected to frequent assembly and a variety of geometries can be used.
6,1,5 Very good holding power
6,1,6 Reassembly without holding power loss
6,1,7 To achieve greater dimensional stability, because the metal will shrink less and is not sensitive to moisture, is also, a better heat sink.
6,1,8 To provide greater load-carting capacity
6,1,9 To provide increased rigidity
6,1,10 To permit repeated assembly and disassembly
6,1,11 To provide a more precise bore to shaft fit

6,2 DISADVANTAGES

6,2,1 Cycle Time: The time required to place the inserts into the injection mold does add to the overall molding cycle time. Molding machine operating cost is significantly greater than that for post molding insertion equipment. Another problem is loading time variation (and cycle time variation), which can lead to non-reproducible product quality. In addition, if the inserts are loaded incorrectly (for example, if one insert is out of place or omitted), the entire part is either rejected or must be repaired after molding if possible. The use of robotics can improve the speed and repeatability of the insert loading process.

6,2,2 Rejected Parts: Parts that are of inferior quality for one reason or another (short shots, surface splay or improper dimensions, etc.) are more difficult to recover. Either the entire part must be scrapped, or the inserts must be removed before the part is granulated for recycling. These recovery operations can be expensive in terms of both materials and labor. When post molding insertion techniques are used, the molded parts can be inspected for quality prior to insertion of the metal fasteners.

6,2,3 Mold Damage: Inserts, even of softer brass or aluminum inserts, can cause a great deal of mold damage if their dimensions are not to specification or they are improperly loaded. Inserts that engage into the opposite side of the mold during mold closing should contain a radius or bevel as a lead-in to prevent skiving. The molding clamp systems should have sensitive low pressure safety controls to minimize damage to the mold should misalignment occur. Quality and dimensional inspection of the inserts is an important prerequisite to their use. Vertical clamp injection molding machines are preferred over horizontal clamps since gravity can be used to keep the inserts in place during the mold closing operation.

6,2,4 Weld Lines: Inserts and gates should be positioned in such a way that weld lines due to flow around the entire circumference of the insert is avoided. Wall thicknesses around inserts should be large enough so that flow is not restricted. Controlled preheating of the insert can improve the flow, wetting and weld line quality. Weld lines are a more significant problem when the inserts are used with filled or reinforced materials

6,2,5 Molded in Stress: Molded in stress is perhaps the most significant problem associated with tile use of molded in inserts. The plastic material surrounding the insert is stressed since shrinkage of material around the rigid metal insert is restrained. The residual strain, which is essentially the mold shrinkage value for the plastic material around the insert, can result in delayed crazing or cracking around the insert. Preheating the insert can reduce the problem of molded .in stress by allowing the insert to shrink along with the plastic material, however, the mismatch in coefficient of thermal expansion (most plastics having higher CTE than most metals) results in only a partial reduction in residual strain. The heating process for the metal insert should be well controlled and consistent to ensure repeatable part quality. When preheating is used, the tooling (that accepts the insert) should be sized for the hot insert. Processing conditions, such as holding pressure, which influence the plastic part shrinkage will also influence the shrinkage around the insert, and therefore the residual stress level.

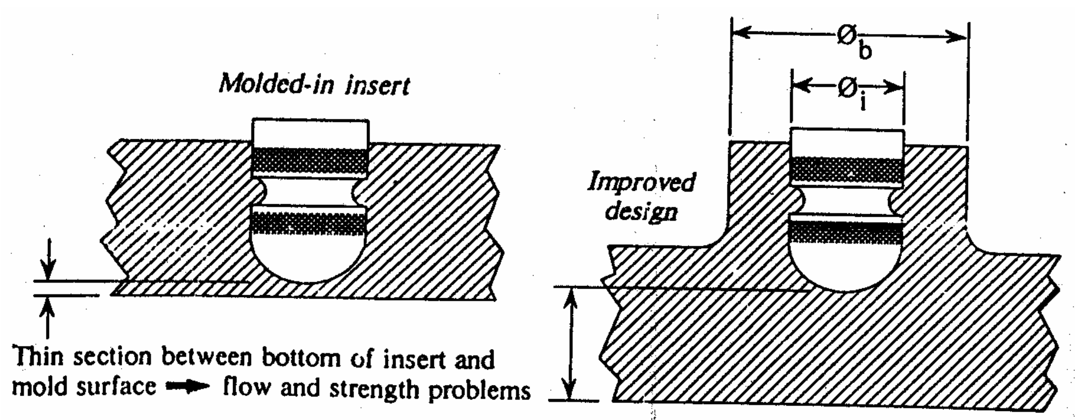


Figure 6.75. **In most cases, metal inserts are inserted into molded pilot bosses after molding, however, inserts can also be molded-in during the primary molding operation.**

6,2,6 Chill Effect of Large Cold Inserts

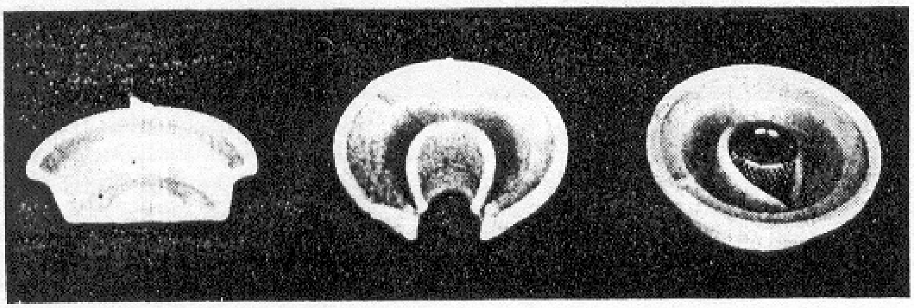


Fig. 3.19. Radio Knob in Polystyrene Copolymer—the Chilling Effect of the Large Cold Insert can be clearly seen.

6,3 INSERT TROUBLESHOOTING GUIDE

Table 10-1 Insert Troubleshooting Guide

Problem	Solution	Problem	Solution
Insufficient pull-out or torque strength	Decrease pressure Increase weld time Increase amplitude (change booster)	Damage to insert	Decrease weld time Decrease amplitude (change booster) Increase pressure
Plastic cracks	Make sure ultrasonics are on Decrease pressure Increase wall thickness	Partial Insertion	Increase pressure Decrease down speed Decrease amplitude (change booster)
Inserting time is excessive	Decrease weld time Decrease hold time Decrease amplitude (change booster)	System overloads	Decrease pressure Decrease down speed Decrease amplitude, (change booster)

CHAPTER-7

APPLICATIONS

7, APPLICATIONS

7,1 Automobile parts

7,2, Keyboard Keys

7,3, Toys

7,4, Circuits

7, 5, Electrical Components

7, 6, Computer Hardware’s

7, 7, Connectors

7, 8, Medical Equipments etc…

CHAPTER-8

CONCLUSION

8, CONCLUSION

In this seminar I have tried to give a brief introduction about the process, the various types of inserts available, location and loading of these inserts, the design considerations and their standards, its advantages and disadvantages .This gives the reader a brief idea about the do's and don'ts and things to be taken care of while planning for the insert molding process.

Post molding insertion is an alternative to reduce the number of defects and the problem of flash generation at the cost of increased labor cost and cycle time. Researches are going on to improve the insert design as well as the insert material to reduce or avoid defects

Hence, this report is only a modest attempt to introduce the reader to this technology and help him in appreciating the immense opportunities this technology has to offer.

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