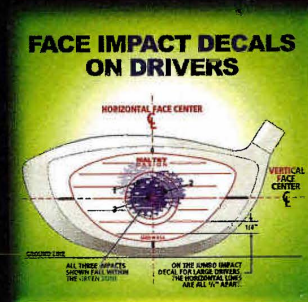
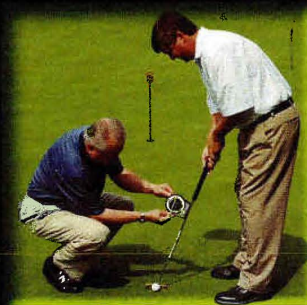


The Complete Book Of

Golf Club Fitting & Performance

THE PRINCIPLES, PROCEDURES AND PLAYABILITY FACTORS

By Ralph Maltby



TMG 1031
U.S. Patent No. 9,878,220

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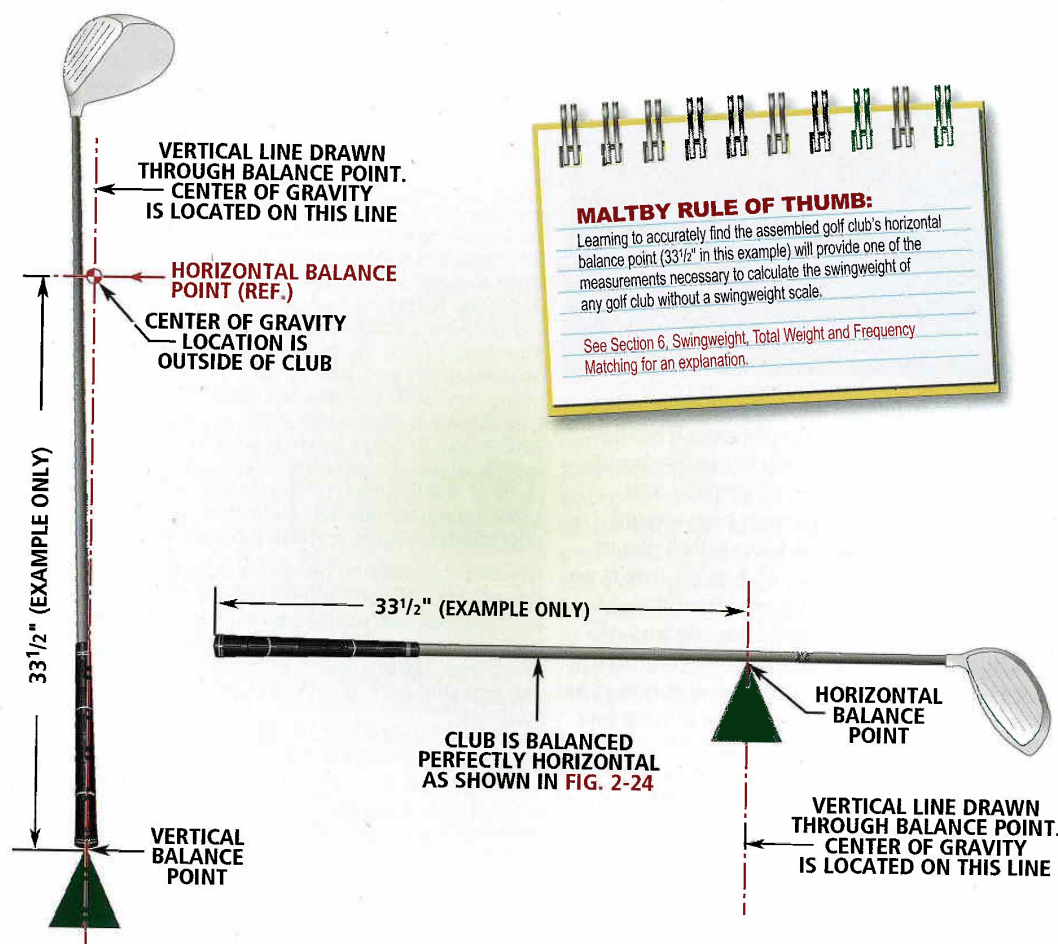
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Newark, Ohio 43058-3008

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DEFINING CENTER OF GRAVITY In An Assembled Golf Club

Fig. 2-25

⊙ = CENTER OF GRAVITY



Center Of Gravity Location Comparisons

As part of our ongoing research, each year we measure and record the center of gravity location for many different golf clubheads including both current models and more and more models from the past. Regarding irons, you can find hundreds of models that we measured at golfworks.com and ralphmaltby.com in the Maltby Playability Factor (MPF) listings. In the future we plan to add other categories of clubs.

Because the actual center of gravity information is readily available for so many different irons and because the actual vertical center of gravity is so important in the MPF calculations, I have included a general reference chart below as a guide.

continued on p. 54

Defining Actual Vertical Center Of Gravity (AVCOG) In Irons

AVCOG	Description
.450" to .624"	Highest Technology to Date, Highest Playability
.625" to .699"	Excellent, Solid Hits, Forgiving, Consistent
.700" to .799"	Very Good Playability for Many Golfers
.840" is Ball CG, Must Use	
.800" to .874"	Down and Through Swing, Expert Golfer's Only
.875" and Up	Avoid

NOTE: It is important when evaluating AVCOG to know if the golfer hits sharply down on the ball, slightly down on the ball or has a sweeping type swing such as most women do. You must drive the center of gravity of the clubhead equal to or preferably lower than the ball's center of gravity. Better players can usually get away with higher CG's than average to lesser skilled players. I would not consider playing an iron with a CG of .840" and above.

CENTER OF GRAVITY

Comparing Center Of Gravity Locations As Iron Designs Evolved





The Evolution Of Ironhead Playability

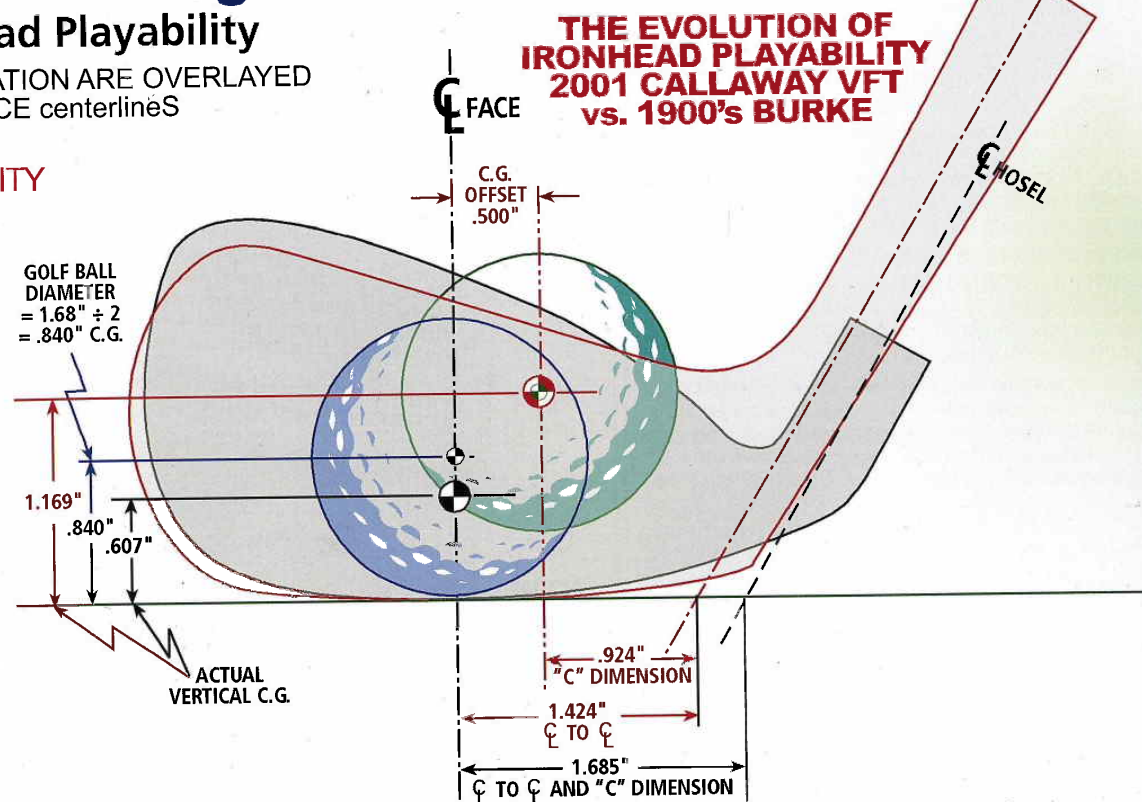
Fig. 2-33 IRONS IN THIS ILLUSTRATION ARE OVERLAYED BY MATCHING THEIR FACE centerlines

● ● ● ● = CENTER OF GRAVITY

MALTBY PLAYABILITY FACTOR (MPF)				
2001 CALLAWAY VFT #5 IRON				
1136 POINTS	= ULTRA GAME IMPROVEMENT			
EARLY 1900s BURKE #5 IRON				
-813 POINTS	= (BELOW) PLAYER CLASSIC			
PLAYABILITY FACTOR CATEGORIES				
851+ POINTS	= ULTRA GAME IMPROVEMENT			
701-850 POINTS	= SUPER GAME IMPROVEMENT			
551-700 POINTS	= GAME IMPROVEMENT			
401-550 POINTS	= CONVENTIONAL			
251-400 POINTS	= CLASSIC			
0-250 POINTS	= PLAYER CLASSIC			

#5 IRON SPECIFICATIONS				
MODEL	Loft	Lie	Weight	Length
2001 CALLAWAY HAWKEYE VFT	26°	61°	255 gm.	38 1/4"
EARLY 1900s BURKE	35°	63°	265 gm.	36 1/2"
COMPARISON/DIFFERENCES 1900 TO 2001				
Loft Difference	Callaway 9° Stronger			
Lie Difference	Callaway 2° Flatter			
Weight Difference	Callaway 10 Grams Lighter			
Length Difference	Callaway 1 3/4" Longer			

COLOR KEY TO ILLUSTRATION	
	= C.G. EARLY 1900s BURKE #5 IRON
	= C.G. 2001 CALLAWAY VFT #5 IRON
	= C.G. GOLF BALL POSITION - BURKE
	= C.G. GOLF BALL POSITION - CALLAWAY

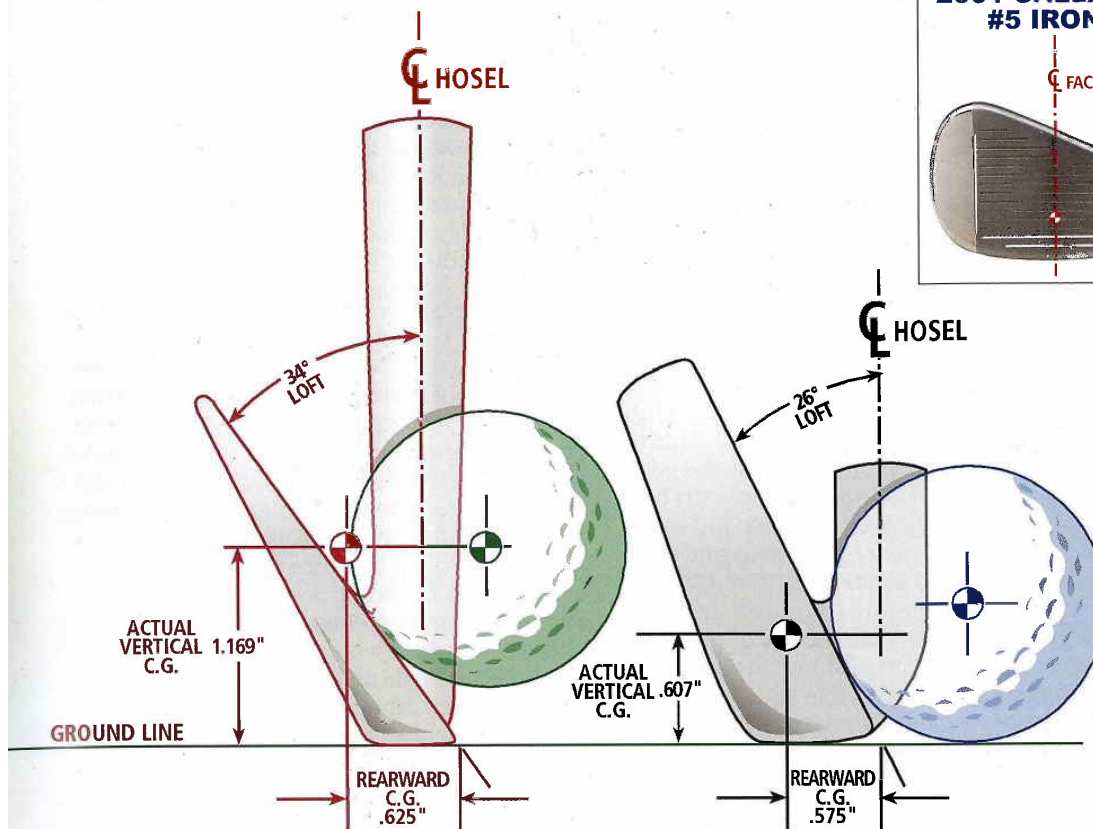


NOTES: 1. This is a full scale drawing of an early 1900s Burke wood shafted #5 Mashie Iron overlaid on a 2001 Callaway Hawk Eye VFT Tungsten Injected Titanium #5 iron.

2. The Callaway #5 iron has a Playability Factor of 1136 points and is in the "Ultra Game Improvement" category. The 1900s Burke #5 Iron has a Playability Factor of -813 points which is significantly lower than the lowest Playability category which is called "Player Classic", which starts at 0 points.

3. The blue ball outline and blue C.G. symbol represent an actual golf ball at rest on the same ground line as both iron clubs. Note that a golfer hitting the Callaway iron could hit down and through the ball, sweep the clubhead into the ball or hit up on the ball and the golfer would still drive the C.G. of the clubhead at impact below the C.G. of the ball, resulting in a solid hit.

4. The green ball outline is drawn with its C.G. directly level with the Burke ironhead C.G. This would be the minimum height the ball must be at during impact to get a somewhat solid hit. Since the older style golf swing had a more "sweeping hit" than a present day "down and through hit" it was very difficult to drive the C.G. of the clubhead under that of the golf ball. In essence, the golf ball needed to be a minimum of 3/8" off the ground when struck or the ironhead needed to be below the ground a minimum of 3/8". It is quite obvious that the ability of the golfer that could hit this iron solidly would need to be of Tour pro caliber or a very skilled golfer. The truth is that a solid feeling ball strike was very rare for most golfers. Keep in mind also that golf balls of this era were generally softer than balls are today. Imagine striking a 100-compression solid ball of today with this iron.



5. A big difference in Playability also exists here because of the loft differences. It is indeed fortunate that the 1900s Burke #5 iron is 9° weaker (more loft) than the 2001 Callaway #5 iron. This does not nearly make up for the Playability Factor differences but it certainly helps. Note that a 1900s Burke #2 iron had 24° loft.

6. The sole width of the 1900s Burke #5 iron is 1/2" at face center with 0° bounce, it's perfectly flat and has a sharp leading edge. The Callaway #5 iron by comparison has a sole width of .900" at its center with 1° bounce, has a 1 3/4" sole radius front to back and has a very radiused leading edge. Once again, there are vast differences in the Playability of these two sole designs. Basically, when a golfer hits down and through with the Callaway, the clubhead's sole

brings it up and out of the ground without bouncing or digging. Conversely, the 1900s Burke sole is a digger and requires precision clubhead control to keep from sticking it in the ground.

7. Note that the Actual Vertical Center Of Gravity is forward and outside of the head on the Burke #5 iron. Even on modern clubs, the C.G. may be outside the actual head in some designs. This usually only occurs in the short irons.

We just mentioned this, but it deserves additional attention and definition here for clubfitters to take note. Maltby Rule of Thumb; a more rearward center of gravity increases the flexing in the shaft tip (actually everywhere in the shaft to a degree) and will create a different feel (softer) to the shaft than the lesser rearward center of gravity club assuming they are otherwise equal heads. This can be counteracted by slightly tipping the shaft or changing to another shaft with a stiffer tip design.

A more rearward center of gravity in the clubhead is one of the big reasons why hybrids are easier to hit than the irons they replace. Here are the four main reasons for the hybrids success in easier to hit clubs;

- 1** A more rearward center of gravity
- 2** Usually an extra $\frac{1}{2}$ " in club length over the iron it replaces and also a heavier head weight than a comparable loft fairway metal.
- 3** Using more flexible shafts like those in fairway metals and not using stiffer iron type shafts. Special hybrid shafts are also in this category.
- 4** Hybrids are lighter in total weight than the iron they replace. If you take all this into the playability equation, here is what you get; a club which can be swung faster (lighter total weight and longer club length), increased shaft flexing which increases the loft and closes the face more at impact (more rearward center of gravity and softer shaft flex) and finally resulting in a higher playability golf club with much better feel and more consistent performance than a long iron.

NOTE:

It needs to be mentioned that for some players, especially better players, an iron may be more accurate than a hybrid which replaces it. Again, the hybrid is easier to hit solid and will go a longer distance, but its longer club length and softer shaft flex can, in some players hands, be less accurate than an iron. Only the golfer can determine the trade-off, if any, they want or need to make.

Hollow Iron Technology

At the end of 1984 a new type of iron was introduced. It was referred to as a "hollow iron" and looked totally different than any previously manufactured iron head. The hollow iron was then and is now a true technological advance as it still exists today in many modern sets of irons. It is important to understand the principle behind its design and to be able to compare it to conventional irons and the modern true hybrid clubs. While many refer to any hollow iron as a hybrid, for our purposes we will refer to them as hollow irons because they are not true hybrids. Instead of an iron replacement club which is what a hybrid actually is, hollow irons are simply an iron set design variation. Besides, hollow irons in most all cases use the same shafts used in conventional irons.

Perhaps the simplest way to initially describe hollow iron playability is to think of it as an extension of the principles that made the cavity backed perimeter weighted club so successful. In addition to creating a hollow cavity inside the iron head, club designers produced a much broader or wider iron head.

As a result of this wider configuration and the resulting hollow cavity, an iron was created with a much greater perimeter weighted condition, almost the same as hybrids and fairway metals. However, it is important to be aware that the larger the hollow cavity and the wider the head, the more effective the perimeter weighting concept.

A few of the hollow irons are conventional in appearance, with only small hollow cavities. These thinner, more traditional-looking hollow irons are not going to possess the same degree of forgiveness on off-center hits as the wider or thicker bladed hollow iron designs. Designing a larger cavity and a thicker head shape means that the sole of the iron will be much wider than normal. In turn, this means that the wider hollow irons will have a lower and farther back center of gravity (away from the face). See Figure 2-37. Mostly, modern combination sets of variable width hollow clubheads will have the widest heads in the longer irons and the narrower or even solid heads in the short irons. This provides the highest playability in the harder to hit long irons and the more conventional appearance which many players prefer in the shorter irons. Actually, this can make a very playable and practicable set of irons. Also, many of the newer hollow designs utilize heavy metal weighting such as tungsten to further lower the center of gravity and make the clubs even easier to hit. These start to approach hybrid ease of playability but with the factor of increased directional control from the iron design format which basically relates to using the stiffer iron shaft vs. the more flexible hybrid shaft.

Perimeter weighting, a low center of gravity and a more rearward center of gravity are not new design concepts when it comes to golf clubs. However, original 1984 hollow irons represented the first time that all these ideas were put together in the construction of an advanced playability iron head. These new thick-bladed hollow irons allowed the design of irons to go a step further than the earlier acclaimed low profile iron designs by adding greater perimeter weighting influences (MOI) to the lower center of gravity concept. At the same time, the hollow cavity can support a conventional height iron design profile if desired, thus eliminating the negative affect some golfers had of the very low profile iron, especially in the short irons.

continued on p. 63

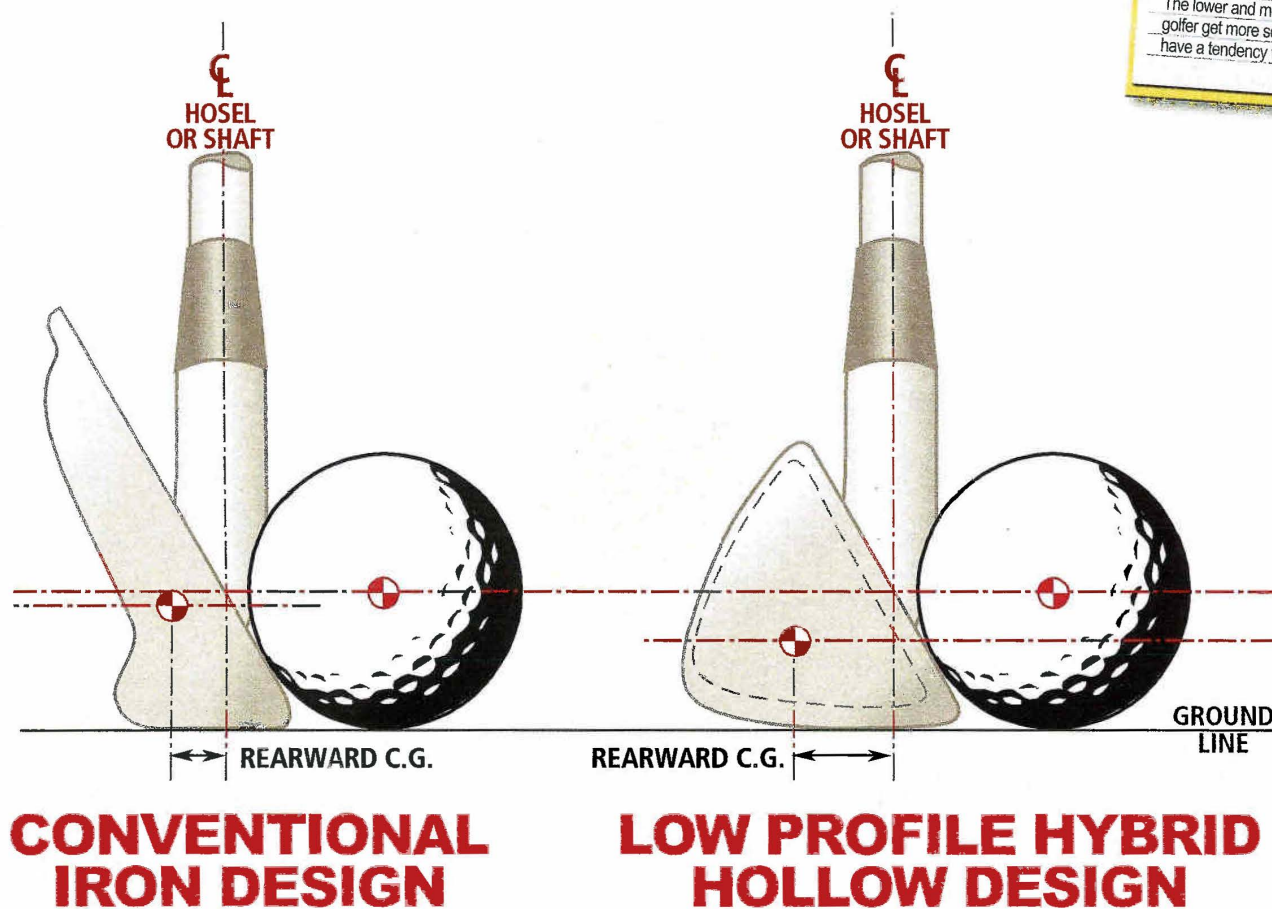
CENTER OF GRAVITY

Comparing The Rearward Center Of Gravity

Conventional Irons vs. Hybrid Hollow Irons

Fig. 2-36

☉ = CENTER OF GRAVITY



MALTBY RULE OF THUMB:

The lower and more rearward the center of gravity, the easier the iron is to hit.

The reason is that the lower center of gravity in the iron makes it easier at impact to drive the clubhead's center of gravity below that of the golf ball's center of gravity. Also, the more rearward center of gravity can create more shaft bending which slightly increases the loft and closes the face. Thus, higher shots that do not want to slice or go right as easily.

The lower and more rearward center of gravity also helps any golfer get more solid hits and more consistent trajectories if they have a tendency to sweep the ball vs. hitting down and through.

NOTE:

- This figure is for illustrative purposes only. Actual differences may vary more or less depending on each iron design.
- The distance from the centerline of the hosel or shaft to the rearward center of gravity location denotes the main performance characteristic of the rearward center of gravity.
- For hollow iron designs to be most effective, the club designer must specify the shell thickness during casting to be sure of maximizing the benefits of hollow iron technology to get lower centers of gravity and a more rearward center of gravity.

continued from p. 61

Like everything else however, designs of golf clubs usually are trade-offs of one design feature for another. Hollow irons are no exception. Like most low profile irons, the back portion of the club can be seen in the address position. This usually only affects the very low handicap traditionalist, if at all. However, many tour players on all tours are currently playing with hollow long irons and the increased playability seems to far outweigh the fact that they can see the bulging back of the iron.

Regarding any iron or wood club design, an important point needs to be made. If a player contacts the ball in the center of the face with the golf club's center of gravity equal to or lower than the golf ball's center of gravity, the shot will most likely have the proper shape in trajectory and a solid feel. Picking an iron design type is one of the things fitting is all about.

The right clubs for a particular golfer may not only be those that perform and feel best, but clubs also that possess acceptable trade-offs.



Adding Weight To The Clubhead & Center Of Gravity

One of the more abused areas in manufacturing golf clubs is adding weight down the shaft instead of directly to the head. I think it was abused more in the past than it is today, but it still exists and is something of which we need to be aware. Properly added weight should be placed as low as possible, in line with the center of the face or equidistant on either side of the face center.

Adding weight down the shaft has the effect of shifting the clubhead's center of gravity toward the added weight. See Figure 2-38. Next, take a look at Figure 2-39 which shows the center of gravity shift if weight is added properly.

Weight added down the shaft lowers the Maltby Playability Factor (MPF) of the head and thus reduces the playability of the club. Generally, depending on the amount of weight added, a reduction in solidness of feel results. Along with reducing solidness of feel, distance is usually less and the ball flight may be lowered. Unfortunately, this common method of adjusting swingweight is difficult to check. The best way to check for weight added down the shaft, but also the most impracticable way, is to remove the heads (both woods and irons) from the shafts and run a drill bit up inside the shaft tip allowing the contents to fall out on a gram scale. Every 2 grams or approximately .07 ounce is equal to one swingweight. Another method for checking is to use a thin rigid wire (.093" or .125" diameter mild steel) and push it down through the small hole in the top of the grip until it bottoms. Of course, only epoxy could be in there, but it shouldn't be very far up inside the shaft. This tool is manufactured by The GolfWorks and is called a Weight Checker Rod. You can also easily make your own.

I receive many assembled #5 and #6 irons in my studio for measuring MPF. I need to disassemble them to measure MPF since it applies to the head only. I often find weight added to the tip of the shaft for swingweighting.

Some companies use it for minor adjustments which has little affect on playability. However, a few companies use 6, 8, and 10 gram weights (10 grams is equivalent to 5 swingweights) in some of their clubs and this is really not acceptable. I prefer a 2 gram limit but can accept a 4 gram tip weight if necessary (2 grams equals 1 swingweight point).

Weights heavier than this added to the tip of the shaft represent sloppy manufacturing or a custom club where the proper head weight was not available. Iron heads with adjustment screws in them are very practical for custom clubmaking and particularly those with adjustable heel and toe weights.

Weighting golf clubs down their shafts is a very common practice and I will make a statement here that I would not play with anybody's clubs unless I personally checked for possible abusive tip slugging. *Example: By switching from standard weight steel shafts to lightweight steel shafts allows you to put approximately three additional swingweights of weight into the head to still maintain the same swingweight with which you started.*

Why stick almost 1/4 ounce (6 grams) of weight down the hosel? Put it where it will do the most good and increase the playability at the same time. Note on increasing the playability; in the above example, we have lowered the total weight of the club and we have added weight to the head. This allows the club to be swung faster with a heavier head so the Kinetic energy applied to the ball is greater. This usually results in more distance assuming the optimum or close to optimum trajectory can be maintained.

Back Weighting & Forward Weighting

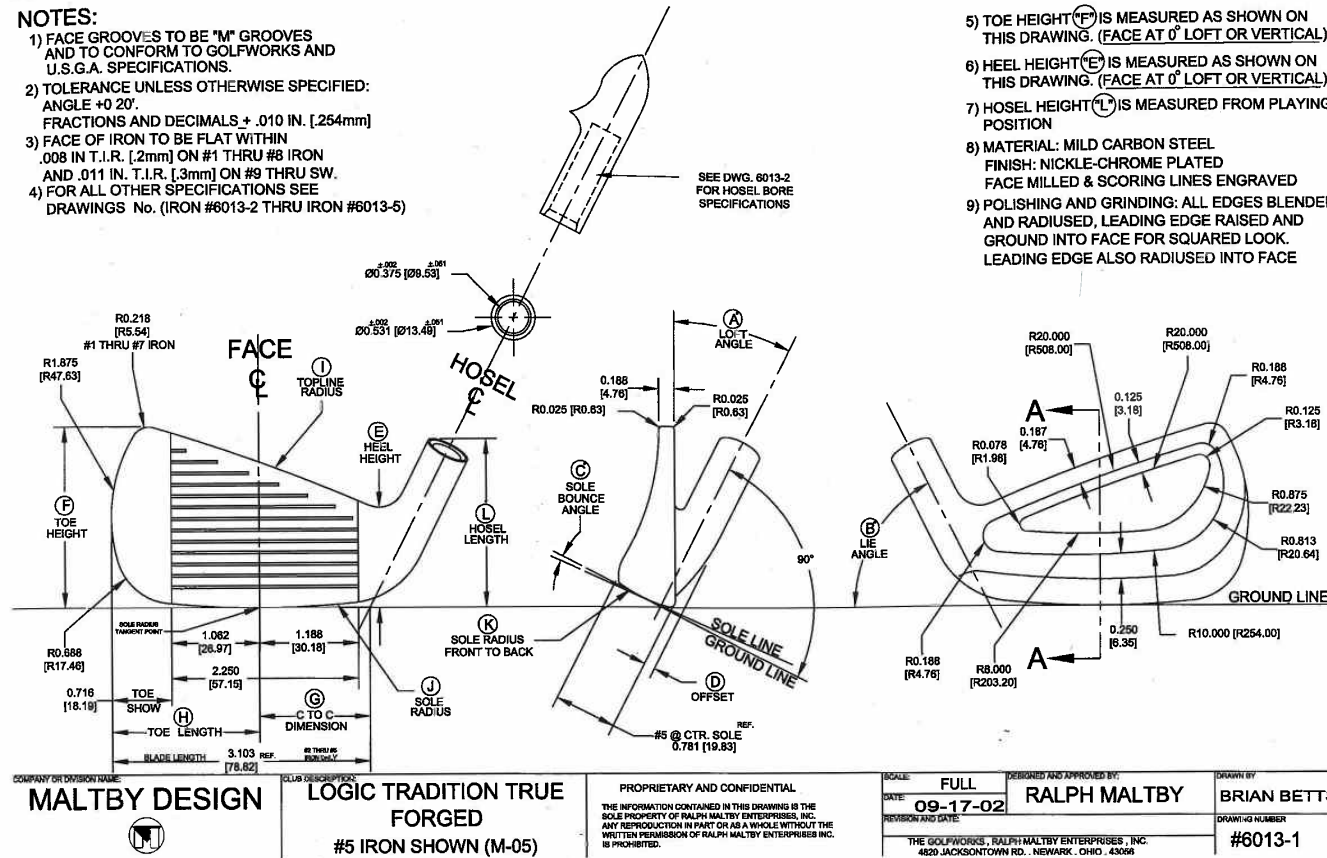
Another interesting area to look at is the center of gravity's effect on the face angle of a wood or iron when the club is laid across a table. The face angle being referred to here is not the hook or slice type but the angle of the face plane to vertical. Figure 2-40 shows a comparison of two clubs. One has a center of gravity close to the shaft or hosel centerline (forward weighted) and the other has a more rearward center of gravity (back weighted).

continued on p. 67

Fig. 2-106

- 1) FACE GROOVES TO BE "M" GROOVES
AND TO CONFORM TO GOLFWORKS AND
U.S.G.A. SPECIFICATIONS.
- 2) TOLERANCE UNLESS OTHERWISE SPECIFIED:
ANGLE +0.20".
FRACTIONS AND DECIMALS +.010 IN. [.254mm]
- 3) FACE OF IRON TO BE FLAT WITHIN
.008 IN T.I.R. [.2mm] ON #1 THRU #8 IRON
AND .011 IN. T.I.R. [.3mm] ON #9 THRU SW.
- 4) FOR ALL OTHER SPECIFICATIONS SEE
DRAWINGS No. (IRON #6013-2 THRU IRON #6013-5)

- 5) TOE HEIGHT (T) IS MEASURED AS SHOWN ON THIS DRAWING. (FACE AT 0° LOFT OR VERTICAL)
- 6) HEEL HEIGHT (E) IS MEASURED AS SHOWN ON THIS DRAWING. (FACE AT 0° LOFT OR VERTICAL)
- 7) HOSEL HEIGHT (L) IS MEASURED FROM PLAYING POSITION
- 8) MATERIAL: MILD CARBON STEEL
FINISH: NICKLE-CHROME PLATED
FACE MILLED & SCORING LINES ENGRAVED
- 9) POLISHING AND GRINDING: ALL EDGES BLENDED AND RADIUS, LEADING EDGE RAISED AND GROUNDED INTO FACE FOR SQUARED LOOK. LEADING EDGE ALSO RADIUS INTO FACE



2. After 8 hours of milling on a Toolmaker's Milling Machine, the face program is completed first, followed by the hosel program and finally the back design program.



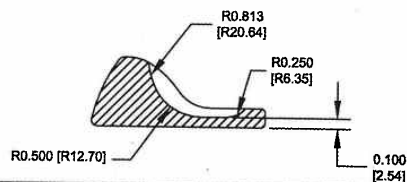
3. The final CNC (Computer Numerical Controlled) hand built precision milled prototype. Many of these prototypes are tested at various tour sites with the finest players in the world. By request, a new prototype can be machined to change anything a certain player desires to see and hit. If a change request is made, the player usually requests a slightly shorter or longer blade length, a reduced or increased hosel offset or a special leading edge grind. A new model will then be made and sent back out on tour for further evaluation and testing.



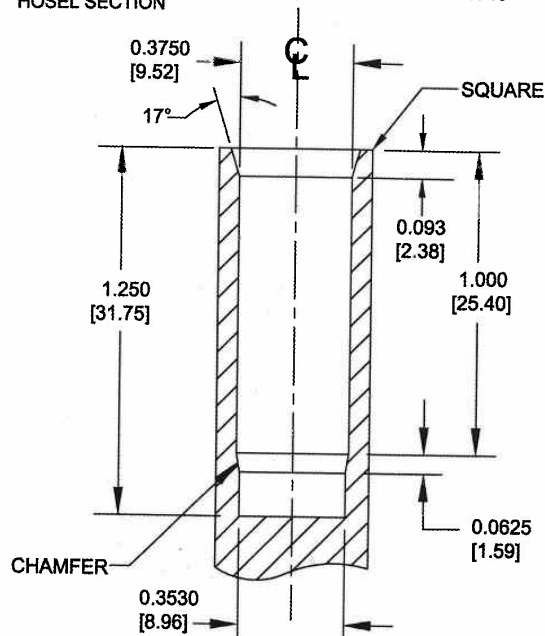
A FULL SET OF FINISHED IRON DRAWINGS

Fig. 2-106 continued

SECTION VIEW A-A



UNIVERSAL HOSEL
HOSEL SECTION (ACCEPTS .370 PARALLEL TIP & .355 TIP TAPER SHAFTS)



NOTE: ALL DIMENSIONS ARE FOR FINISHED PART

MALTBY DESIGN



LOGIC TRADITION TRUE
FORGED
#5 IRON SHOWN (M-05)

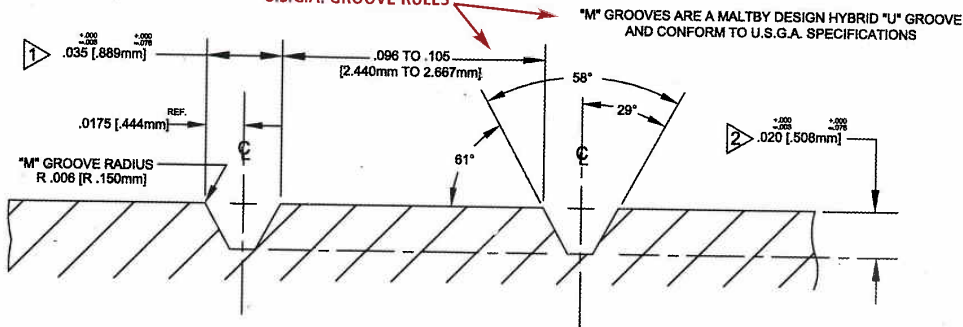
LOGIC TRADITION TRUE FORGED (M -05)

SPECIFICATION TABLE

IRON No.	A° LOFT TOL +1	B° LIE TOL +1	C° SOLE BOUNCE TOL +1	D° OFFSET (INCHES)	E° HEEL HEIGHT (INCHES)	F° TOE HEIGHT (INCHES)	G° "C" TO "C" DIMENSION (INCHES)	H° TOE LENGTH (INCHES)	I° TOPLINE RADIUS (INCHES)	J° SOLE RADIUS (INCHES)	K° SOLE RADIUS FRONT TO BACK (INCHES)	L° HOSEL LENGTH (INCHES)	FINISH HEAD WEIGHT TOL +3 GRAMS
2	18°	59°	3°	.100	1.093	2.062	1.325	1.778	25 R	12 R	1.625 R	2.156	235
3	21°	59.5°	3°	.100	1.125	2.093	1.325	1.778	24 R	12 R	1.625 R	2.187	242
4	24°	60°	3°	.100	1.156	2.125	1.325	1.778	23 R	12 R	1.625 R	2.218	249
5	27°	60.5°	3°	.100	1.187	2.156	1.325	1.778	22 R	11 R	1.625 R	2.250	256
6	31°	61°	3°	.100	1.218	2.187	1.335	1.778	21 R	11 R	1.625 R	2.281	263
7	35°	61.5°	3°	.100	1.250	2.218	1.345	1.778	20 R	11 R	1.625 R	2.312	270
8	39°	62°	3°	.100	1.281	2.250	1.355	1.778	8 R	11 R	1.625 R	2.343	278
9	43°	62.5°	3°	.100	1.312	2.281	1.365	1.778	8 R	11 R	1.625 R	2.375	287
PW	47°	63°	5°	.100	1.343	2.312	1.375	1.778	7 R	11 R	1.625 R	2.406	293
GW	51°	63°	5°	.100	1.343	2.312	1.375	1.778	7 R	11 R	1.625 R	2.406	293
SW	55°	63°	12°	.100	1.343	2.312	1.375	1.778	7 R	11 R	1.625 R	2.406	302

ALL "M" GROOVES TO CONFORM TO MALTBY DESIGN AND U.S.G.A. SPECIFICATIONS

NOTE THAT THIS GROOVE DESIGN DOES NOT CONFORM TO THE NEWER 2010 U.S.G.A. GROOVE RULES



"M" GROOVES ARE A MALTBY DESIGN HYBRID "U" GROOVE AND CONFORM TO U.S.G.A. SPECIFICATIONS

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DATE: 09-17-02
REVISION AND DATE:

DESIGNED AND APPROVED BY:

RALPH MALTBY

DRAWN BY:

BRIAN BETTS

DRAWING NUMBER

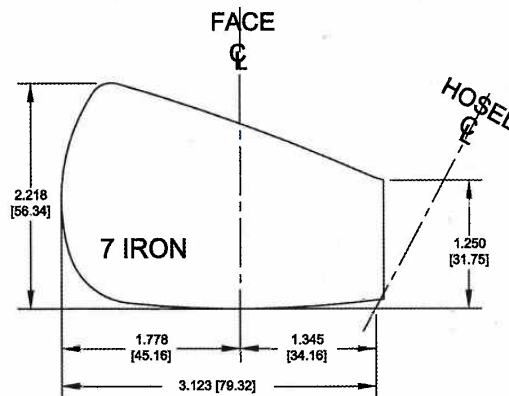
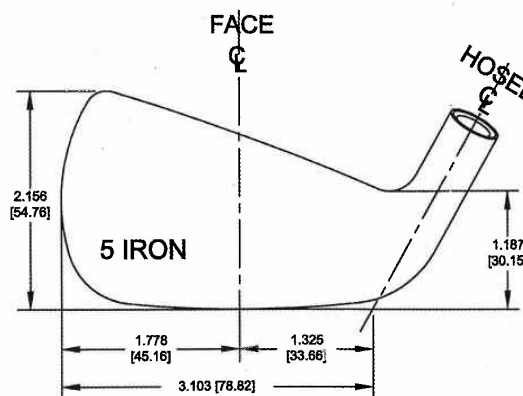
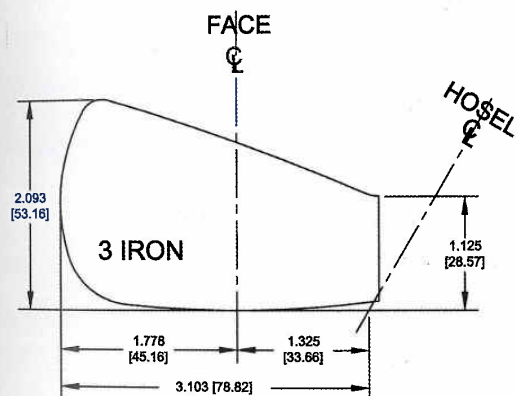
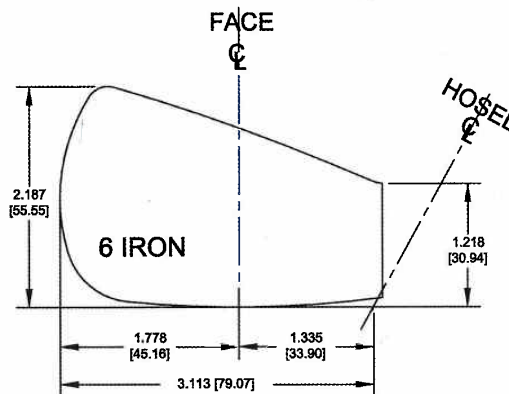
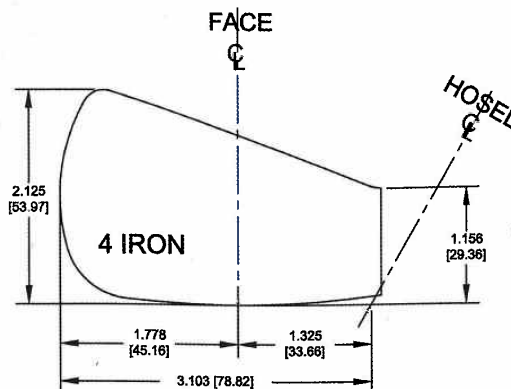
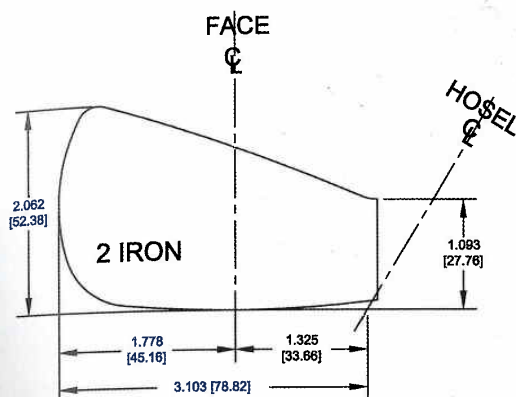
#6013-2

THE GOLFWORKS, RALPH MALTBY ENTERPRISES, INC.
4820 JACKSON TOWN RD., NEWARK, OHIO, 43056

A FULL SET OF FINISHED IRON DRAWINGS

Fig. 2-106 continued

ALL FACE PROFILES SHOWN WITH LOFT AT 0°



COMPANY OR DIVISION NAME:

MALTBY DESIGN



CLUB DESCRIPTION:

**LOGIC TRADITION TRUE
FORGED
FACE SHAPES (M-05)**

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FULL

DATE:

09-17-02

REVISION AND DATE:

DESIGNED AND APPROVED BY:

RALPH MALTBY

DRAWN BY:

BRIAN BETTS

DRAWING NUMBER

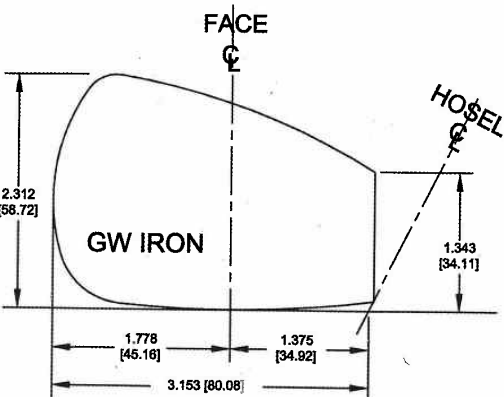
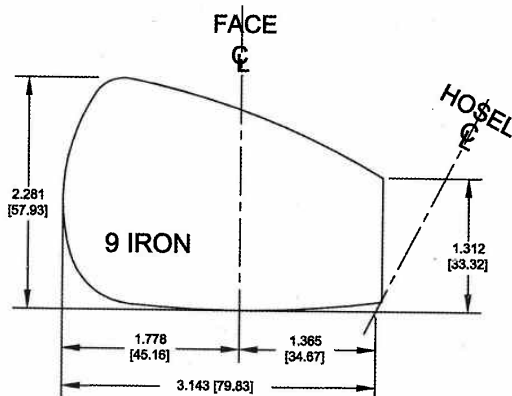
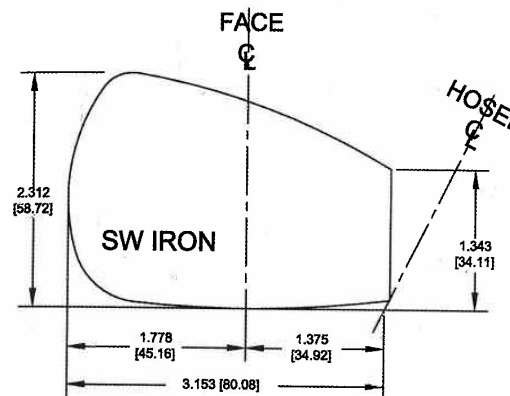
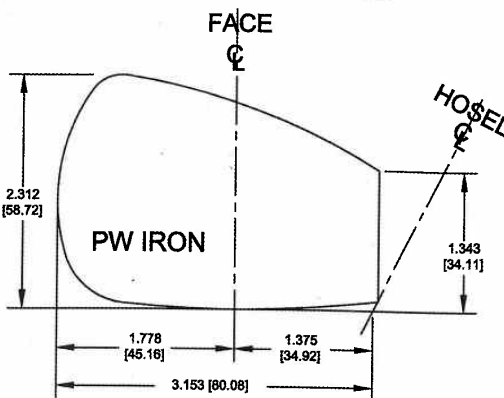
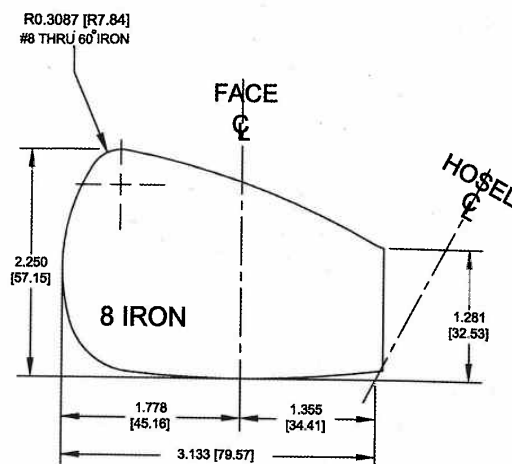
#6013-3

THE GOLFWORKS, RALPH MALTBY ENTERPRISES, INC.
4820 JACKSONTOWN RD., NEWARK, OHIO, 43056

A FULL SET OF FINISHED IRON DRAWINGS

Fig. 2-106 continued

ALL FACE PROFILES SHOWN WITH LOFT AT 0°



COMPANY OR DIVISION NAME:

MALTBY DESIGN



CLUB DESCRIPTION:

LOGIC TRADITION TRUE
FORGED
FACE SHAPES (M-05)

PROPRIETARY AND CONFIDENTIAL

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IS PROHIBITED.

SCALE:

FULL

DESIGNED AND APPROVED BY:

DATE:

09-17-02

RALPH MALTBY

DRAWN BY:

BRIAN BETTS

REVISION AND DATE:

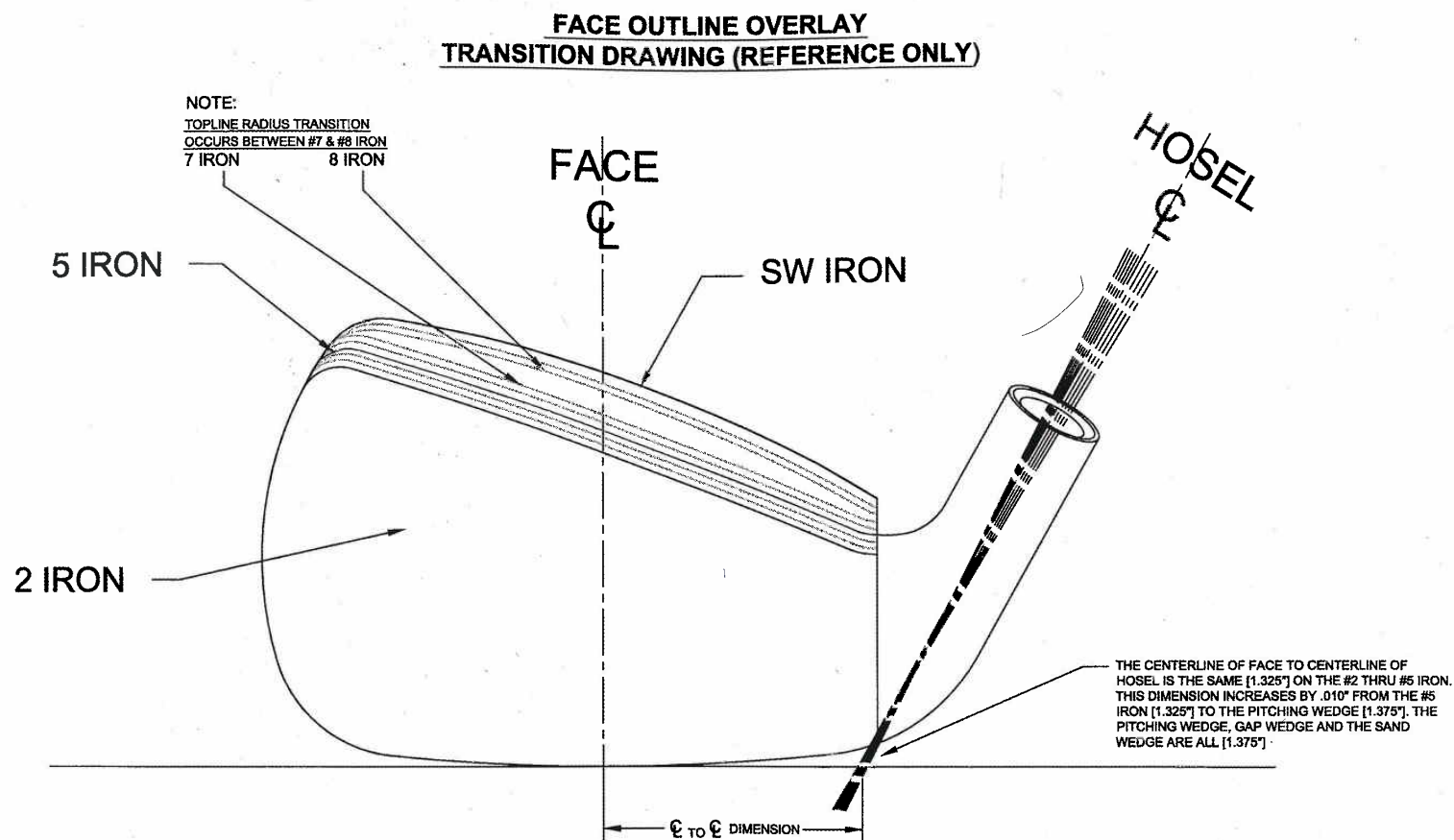
THE GOLFWORKS, RALPH MALTBY ENTERPRISES, INC.
4820 JACKSONTOWN RD., NEWARK, OHIO 43058

DRAWING NUMBER

#6013-4

A FULL SET OF FINISHED IRON DRAWINGS

Fig. 2-106 continued



COMPANY OR DIVISION NAME:

MALTBY DESIGN



CLUB DESCRIPTION:

**LOGIC TRADITION TRUE
FORGED
OVERLAY (M-05)**

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DATE:

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DRAWN BY:

BRIAN BETTS

DRAWING NUMBER

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