DR. GERALD D. STIBBS
This course is dedicated to the memory of Dr. Gerald D. Stibbs, who in the course of his career influenced the development of so many dentists, and carried on the tradition of excellence that began with Dr. W. I. Ferrier. Some insight into Dr. Stibbs character can be gained from the preface to one of his manuals:

“To achieve competence with gold foil, one must read and more importantly, practice repeatedly the steps involved. While it is possible to become adept on one’s own initiative it is more practical to become an operating member of a study club that meets regularly, under the close supervision and coaching of a competent instructor.

Courses of various time lengths have been given in these procedures. In general it is best for the beginner to plan on a ten-day program, given in either a single course, or in two five–day courses. With less than a five-day exposure, there is a tendency for the inevitable problems to surface in two or three days, and there is not enough time to overcome the difficulties. For refresher courses, three to five days of exposure are advisable. It is recommended that beginners’ efforts should be restricted to improving their efficiency in securing a good operating field expeditiously, and to learning the basics and refinements of cavity preparation and of the manipulation of gold foil, by working on Class V restoration for a few months. During a second segment the acquisition of competence with Class IIIIs and Class IIIs and other classes comes more readily.

There is such a mass of trivia involved in becoming a master of the art and science of working with gold foil, that it takes a great deal of time and attention to detail, and a humble approach, if real success is to be attained.

It is hoped that the material herein, and the relatively brief exposure to clinical application will kindle enthusiasm to continue in this learning process, and will bring the great pleasure of producing life-long restorations that will preserve patients’ dentitions in good health and function, and the satisfaction of being able to accomplish something that relatively few in our profession achieve.”

G.D. STIBBS 1991
HISTORY OF GOLD FOIL IN THE PACIFIC NORTHWEST

Gold foil study club activity in the Pacific Northwest has been a strong factor in promoting and developing a high level of refinement in the quality of the restorative dental service provided for the public in this region.

In 1898 the first Gold Foil Study Club was organized in St. Paul, Minnesota and was called the G. V. Black Dental Club. It was initially instructed by Dr. G. V. Black and was later taken over by Dr. E. K. Wedelstaedt.

In the Northwest organized postgraduate activity in gold foil procedures began with the Seattle Dental Club in 1907. The club was modeled after the G. V. Black Study Club of St. Paul in that it had twelve members, and initially they studied all aspects of dentistry. In 1912 the club invited Dr. E. K. Wedelstaedt and Dr. A. C. Searle to present a two-week foil course to the club. The course was presented again in 1913. One of the participants was Dr. Walden I. Ferrier of Burlington, Washington.

After a few years it became necessary to reorganize the club and it was decided they would focus on gold foil. In 1923 the members asked their own member Dr. W. I. Ferrier to serve as the instructor of the group. From this point on the group progressed with great enthusiasm. It was in this period that Ferrier designed his separators, the 212 gingival retractor, and refined Dr. Black’s instruments and preparations. That original group was an incredible pool of talent, and they amassed an amazing list of accomplishments: designing instruments, developing improvements and variations on the technique, lecturing and mentoring.

Seattle Dental Study Club
(Formed November 1922)

Dr. R. E. Plummer        Dr. E. M. Jones
Dr. G. A. Ellsperman     Dr. C. E. Lindley
Dr. C. T. Fleetwood      Dr. O. T. Olsen
Dr. D. I. Burkhart       Dr. H. F. Schoonover
Dr. R. E. Hampson        Dr. D. A. Spratley
Dr. A. W. Jeffery        Dr. O. A. Anderson

Soon, others wished to join the club or to organize other study clubs. From 1930 through 1973 some fourteen new clubs formed. The members always complied with Dr. Ferrier’s insistence that each man should take an intensive introductory two-week course, followed by active participation in a study club.
In 1930 the individual clubs formed the Associated Study Clubs, which is known today as the Associated Ferrier Study Clubs. The membership of this combined group grew from 60 members in 1937 to approximately 100 members in 1980, 70 members in 2000 and declined to 50 in 2017.

Dr. W. I. Ferrier passed away in 1965, but he and the members of the Seattle Dental Study Club have left a living memorial in the study club movement of the Pacific Northwest and Western Canada.

<table>
<thead>
<tr>
<th>Study Club</th>
<th>Year</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seattle Dental Study Club</td>
<td>1922</td>
<td>Inactive</td>
</tr>
<tr>
<td>G. V. Black Dental Study Club (Seattle)</td>
<td>1930</td>
<td>Inactive</td>
</tr>
<tr>
<td>W. I. Ferrier Study Club</td>
<td>1930</td>
<td>Active</td>
</tr>
<tr>
<td>(later Hampson-Ferrier Gold Foil Study Club)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northwest Study Club</td>
<td>1932</td>
<td>Inactive</td>
</tr>
<tr>
<td>Vancouver Ferrier Study Club</td>
<td>1936</td>
<td>Active</td>
</tr>
<tr>
<td>Washington Dental Study Club</td>
<td>1940</td>
<td>Inactive</td>
</tr>
<tr>
<td>W. K. Sproule Gold Foil Study Club</td>
<td>1947</td>
<td>Active</td>
</tr>
<tr>
<td>University Ferrier Study Club</td>
<td>1949</td>
<td>Inactive</td>
</tr>
<tr>
<td>George Ellsperman Gold Foil Seminar</td>
<td>1956</td>
<td>Active</td>
</tr>
<tr>
<td>D. A. Spratley Gold Foil Study Club</td>
<td>1957</td>
<td>Active</td>
</tr>
<tr>
<td>Ralph E. Plummer Gold Foil Study Club</td>
<td>1968</td>
<td>Active</td>
</tr>
<tr>
<td>Edmonton Gold Foil Society</td>
<td>1970</td>
<td>Inactive</td>
</tr>
<tr>
<td>Winnipeg Ferrier Society</td>
<td>1972</td>
<td>Inactive</td>
</tr>
<tr>
<td>W. P. Whittaker Study Club</td>
<td>1973</td>
<td>Inactive</td>
</tr>
<tr>
<td>Alex Jeffery Gold Foil Study Club</td>
<td>1956</td>
<td>Active</td>
</tr>
</tbody>
</table>
GOLD FOIL

Gold was one of the earliest materials used to restore teeth. The first mention of gold foil as a restorative material was in a medical text by Giovanni d’Arcoli of Bologna in about 1425. By 1835 gold foil had replaced tin and lead foil as the primary restorative material, although it was about to face the challenge of silver amalgam. Gold foil fillings resembling the modern restorations began appearing in the mid nineteenth century. Over the years since then it has been gold foil operators who have been responsible for many of the innovations that are commonplace in dentistry today. By the middle of the twentieth century the technique had been refined close to the level it is practiced at today.

Gold foil restorations are also called “direct gold restorations”, meaning the gold is placed directly into the prepared cavity and finished in one appointment. This differs from cast gold restorations, which require two appointments: one to prepare the cavity and a second to insert the newly fabricated casting. Gold foil can be used instead of silver amalgam or tooth-coloured plastic (composite resin) to restore small lesions.

Dentists recognized a long time ago that gold has some exceptional qualities, which make it almost the perfect restorative material. One essential quality is biocompatibility. Gold is the most biocompatible dental material we have. Pure gold is inert. It produces neither local reaction nor any side effects elsewhere in the body.

Durability is another characteristic demanded of a restorative material. A material must not just fill the cavity but restore the surface to its original form as well. This is not a simple task given extreme conditions experienced in the oral cavity. Gold foil fillings can last longer than other types. This is because of three qualities:

1) Gold’s coefficient of thermal expansion closely matches that of tooth structure.

2) Pure gold can be hammered out into thin sheets of foil and hammered back together to form a near solid mass. This cohesion is rare in metals.

3) Gold’s malleability enables the thin foil pellets to be pressed and adapted so precisely to the walls of a preparation to produce a very intimate fit.

This intimate press fit, paired with near matching thermal expansions minimizes the tendency of water and bacteria to be drawn into the tooth/restoration interface with thermal changes. This micro leakage is the root cause of most restorative failures.

Finally, a material must be esthetic or used in an esthetic way. A great deal of thought has been spent designing cavity preparations that either minimize the show of gold, or position the outline of the filling in a way that it harmonizes with its surroundings and becomes less noticeable. Many foils have lasted longer than fifty years. Used conservatively in well selected cases, gold foil is a premier restorative material.

DWT
MATERIALS – EVOLUTION OF DIRECT FILLING GOLDS

GOLD FOIL

Originally all gold foil was non-cohesive

GOLD FOIL COHESIVE* (material still available)

Researchers experimented with many thicknesses but finally settled on #4 gold foil, which is 1/20,000 inch thick (.6 microns). This is 6 times thicker than gold leaf used in guilding. #4 gold foil derives its name from the fact that one 4-inch sheet weighs 4 grains.

“Cohesive” foil is packaged just as it comes from the beating operation. “Non-cohesive” foil has been surface treated with ammonia to protect the surface. This ammonia protectant should be renewed occasionally by placing a cotton pellet moistened with an aqueous solution of 28% ammonia in your foil box.

A compacting force of about 3 pounds is required for a .5mm diameter condenser.

The temperature of gold foil must reach at least 250 degrees F in the annealing process in order for the non-cohesive foil to be rendered cohesive. This is the minimum temperature required to anneal the foil. In the clinical setting much higher temperatures are used. Typically an ethyl alcohol flame (1250 degrees F)

The annealing instrument in your gold foil kit has a tip made of Nichrome wire. If an old instrument such as an explorer is used for annealing the foil in the alcohol flame, the metals used in the carbon steel instrument will cause contamination of the gold foil.

Research at the University of Washington showed that the welding depth (depth of sound compaction) only extends .2mm - .3mm beyond the face of the condenser if hand malleting is used as the compaction force. The depth of compaction is less if an electromallet is used as the condensing force. Therefore, one cannot expect to increase the condensation of an under condensed area once you have covered it with another pellet of gold. It is interesting to note that an inlay of 24 carat gold will not be as hard as a gold foil, which is 24 carat gold. This is because of the cold welding and strain hardening that occurs in the making of the gold foil restoration.

CARBONIZED FOIL

Sheets of gold foil are placed between sheets of paper and placed in a furnace with a low oxygen atmosphere. The sheets of paper are not burned, but turned to carbon. As this happens, the sheets of paper and gold are “wrinkled”. This wrinkled effect produces a gold product with a greater amount of gold per unit volume. This carbonized foil is wrapped around a mandrel to form a long cylinder. These cylinders are then cut into lengths of 68mm for ropes, or 2mm – 3mm for the short cylinders used in filling the preparation. #2 gold foil was found to be the best thickness for manufacturing machine rolled cylinders. So, ropes and machine rolled cylinders are made of #2 carbonized gold foil. (Remember, #2 foil would have been made from 2 grains of gold so it would be ½ the thickness of the #4 foil)
POWDERED GOLDS

MAT GOLD

Formed by electrodeposition of gold from solution first discovered in the 1890’s. Became popular again in the 1930’s. Again popular in the 1950’s. Work by Professor Jean Hodson at the University of Washington found that it is possible to compact mat gold as dense as gold foil, but it requires much more care. So, most mat gold restorations show a lack of density and exhibit more pitting as they age. The minimum temperature required for annealing mat gold is 350 degrees F, or about 100 degrees higher than for gold foil, due to the greater surface area of the particles in the mat structure.

MAT FOIL

Mat gold was wrapped in foil to keep it from crumbling.

LAMINATED FOIL

This was made of thicker foil, which was folded over upon itself several times. Used to surface the mat restorations.

BIOFIL (Filaro, Karat)
Vial of powdered gold and a small bottle of special liquid. The powdered gold was very difficult to handle. You would dip the condenser in the special liquid (alcohol) and then in the powdered gold to carry some of the gold powder to the preparation.

GOLD DENT

In 1962 Loyde Baum at Loma Linda wrapped 15 micron particle powdered gold in an envelope of gold foil. This was much easier to handle, and allowed the operator to insert a larger mass of gold in the preparation.

IMPROVED GOLD DENT

The larger mass of gold required a longer annealing time, so Dr. Baum added an annealing indicator (wax) to the Gold Dent. When the flame was gone, it was properly annealed. Dr. Baum further improved Gold Dent by adding atomized gold spheres to the powdered gold to improve the compacting properties and make the final gold restorations denser.

“The temperature required for complete removal of the wax is about 850 degrees F, but a higher temperature is required to get the partial sintering effect: about 1400 degrees F.”

It is this partial sintering that makes the particles of gold hold together as the envelope of foil is broken open during the condensation process. If the pellet of Gold Dent is held in the flame so that it acquires a brighter than dull red colour, the particles of gold inside the envelope will be over sintered, resulting in a pellet that is stiff and difficult to condense properly.
E-Z GOLD* (material still available)

In the 1980’s the formula was re-worked again, changing the particle size and characteristics of the atomized gold to produce a gold dent that was even easier to condense. The initial idea was that the gold would only require hand condensation. However, it soon became apparent that it still required mallet condensation. This easier working gold was called “Easy Gold”.

MATERIALS FOR INCREASED HARDNESS

PLATINIZED GOLD* (material still available)

Dr. G.B. Baird of Los Angeles California developed the idea of sandwiching a layer of platinum foil between two sheets of gold to produce a restoration of great hardness. The strip of solid platinum is sandwiched between 2 strips of gold. This sandwich is bonded together by subjecting it to great pressure in a process called ‘cladding’, and then rolled to a thickness of 1/1000 inch. The sandwiched metal is then beaten in the same manner as gold foil to the thickness of #4 gold foil to be sold in books of four-inch sheets, or to the thickness of #2 gold if it will be manufactured into machine rolled cylinders.

Platinized gold foil was advocated by Dr. Robert Rule at the University of California, and he published several papers on his research.

Annealing: over annealing will burn off the gold covering, exposing the platinum and thus producing poor cohesion.

The minimum temperature required for annealing is 250 degrees F.

A restoration of pure gold foil has a Brinell hardness of 54.
10% - 15% platinum will increase the hardness by 24 points, to 78 points.
30% - 40% platinum will increase the hardness by 42 points, to 96 points.

ELECTRALLOY R.V.

This was mat gold sandwiched between foil. The gold used in the mat was alloyed with 0.1% calcium to increase the hardness. However, the calcium could not be found upon assay of the final restoration. The minimum temperature for annealing Electralloy R.V. is 350 degrees F.

NEW PRODUCTS

STOPFGOLD

This is a new product from Degussa, having come on the market in 1992. It looks similar to mat gold, but the research of its properties is as yet unknown.
GENERAL SUPPLIES – DIRECT GOLD RESTORATIONS

Operating gowns  
Rubber gloves  
Face masks  
Protective eye wear for patients, operator and assistant  
Hand mirror  
Mouthwash  
High-speed handpiece (Midwest 4 hole pattern)  
    bur changer  
Slow speed handpiece (Midwest 4 hole pattern)  
    straight handpiece and contra-angle  
    handpiece lubrication supplies

EXAM KIT

    #5 Suter explorer  
    #4 front surface mirror

LOCAL ANESTHETIC KIT

    syringe  
    needles  
    local anesthetic  
    topical anesthetic  
    cotton tip applicators

RUBBER DAM KIT

    rubber dam 6x 6 dark extra heavy  
    rubber dam pads (mask type)  
    rubber dam punch  
    rubber dam holder (Wizard or Woodbury ideal, Youngs O.K.)  
    rubber dam weights for Wizard holder  
    lubricating soap (lather type shaving cream)  
    rubber dam clamp forceps (Ash type)  
    rubber dam clamps  
        Ivory #00, #4, #5, #22, #26N, #16  
        four #212 gingival retractors  
    red stick compound (Kerr)  
    wax spatula #7  
    burnisher T-type #34  
    suitable scalers when needed  
    scissors  
    Instrument sharpener (rotating wheel type – Suter)
CUTTING INSTRUMENTS

Suter made (see instrument list)
Through use and sharpening, cutting instruments are soon worn beyond effective usefulness. Several of each of the finer instruments should be on hand.

BURS

- long shank (slow speed) #33 ½, #34, #35, #36 six of each
- friction grip (high speed) #2, #4, #169, (#33 ½ for Class III)
- friction grip finishing burs #7901 and #7404
- latch diamond disc #944-065 by Brasseler (if available)

COMPACTING INSTRUMENTS AND SUPPLIES

- Ferrier design foil mallet (similar to Clevedent)
- gold foil box
- gold foil #4 non-cohesive 1/10oz. book
- alcohol lamp
- alcohol – ethyl (pure, not denatured)
- shield for lamp
- mechanical condenser (bring if you have one)
- condensers – long handled (see instrument list)
- Ferrier separators for second week students #1, #2, #3 and #4

FINISHING INSTRUMENTS

- see instrument list

OTHER FINISHING SUPPLIES

- metal lightning strips
- 18” finishing strips, linen back is best (Moyco)
  - garnet fine – narrow
  - cuttle medium – narrow
  - cuttle fine – narrow
- brass centered Moore’s discs ½ inch (Regular)
  - garnet medium
  - sand fine
  - cuttle fine
- Moore’s mandrels (long shank and latch)
- Tucker mini disc kit (Moore’s)
  - garnet medium
  - sand fine
  - cuttle fine
Mandrels for Tucker mini discs (latch and long shank)
Vaseline
rubber polishing cups (soft, non-webbed Young’s)
mandrels for rubber polishing cups (long shank and latch)
glass dappen dishes (three)
flour of pumice - #4
15 micron WCA aluminum oxide
1 micron WCA aluminum oxide

CEMENTS AND BASES

Dycal applicator
glass ionomer cement, mixing pad
zinc phosphate cement powder and liquid
cement spatula
glass cement mixing slab
cavity varnish
plastic instrument
smooth faced amalgam plugger

MISCELLANEOUS

matches
steel matrix strips
Burlew wheel + Mandrel
two small needle nose pliers
small butane torch – Piezo “Blazer”

DWT/RDT
REQUIRED INSTRUMENTS FOR CLASS I, V, 
BUCCAL PITS AND CINGULUM PITS

CUTTING INSTRUMENTS

Hoe UW A 20/20c  
Hoe UW A 21/21c  three each  
Hoe UW A 23/23c  three each  

Angle Former UW A 34/35  
Angle Former UW A 36/37  
Angle Former UW A 38/39  three each  

Wedelstaedt Chisel UW A 1/2  
Wedelstaedt Chisel UW A 3/4  
Wedelstaedt Chisel UW A 5/6  
Wedelstaedt Chisel Jeffery #11  

Spoon Excavator UW A 47  

CONDENSORS

Gold foil Passer UW B 12  
Holding Instrument UW B 13  
Gold Foil Condensers:  
    parallelogram hoe UW B 14  
    parallelogram hoe UW B 15  
    .5mm straight condenser UW B 1  
    .75mm straight condenser Ferrier 3  
    .5mm offset condenser UW B 6  
    .8mm offset condenser Tucker 1  
    Ferrier 15 offset condenser  
    Jeffery 16 F  
    foot condenser UW B 8  

FINISHING

Beavertail Burnisher #2  
Spratley Burnisher #1  
Gold Knife Ferrier #29  
Gold File push cut UW B 44/45  
Gold File pull cut UW B 41/42  
Discoid Cleoid UW D 5  

DWT/RDT
CLASS V DIRECT GOLD PREPARATION
NOTES BY DR. D. A. SPRATLEY

P = Principal
R = Rational

PREPARATION

OUTLINE / CONVENIENCE FORM

P - Trapezoidal – in gingival 1/3 of facial
R – it conforms to the tooth shape and typical caries location

P – Circumscribes:
1) Decay, decalcification and defects
2) erosion and abrasion
3) Existing restorations
R – It eliminates weak or defective tooth structure so that margins of the restoration will terminate on sound tooth structure

P – Extensions – The mesial and distal outline is:
1) Straight and parallel to the mesial and distal tooth outline in the gingival 1/3
R – it conforms to the shape of the tooth
2) Extended to the line angles of the tooth.
R – extension for prevention, more aesthetic and harmonious

P – The occlusal / incisal outline is:
1) Straight and parallel to the occlusal plane.
R – more aesthetic and harmonious
2) Extended to the height of contour or to the occlusal extent of the lesion and mesially and distally to the line angles.
R – provides sufficient access for instrumentation and condensation.

P - The gingival outline is:
1) Straight and parallel to the occlusal wall.
R – it will allow maximum retention to be placed in cavity walls if occlusal and gingival outlines are parallel to start with.
2) Extended gingivally to a level normally covered by soft tissue and mesially and distally to the line angles.
R – extension for prevention
3) Extended gingivally .75 – 1mm incisal or occlusal to the properly positioned rubber dam retainer
R – more convenient for finishing procedures
RESISTANCE / RETENTION FORM

P – Depth – should be uniform and approximately 1mm (width of #21 Hoe)
R – a minimum depth is required to provide retention. Further tooth reduction is unnecessary and may result in pulpal encroachment.
P – Depth – may vary slightly depending on the size of the tooth, thickness of enamel etc. (axial line angles must be in dentin) Range = .75mm – 1.25mm
R – small teeth are more delicate and require more conservative cavity preparations.

P – Axial wall – should be smooth
R – provides resistance to forces of condensation
P - Axial wall – should be slightly curved mesiodistally to follow the contour of the tooth.
R – (easier to adapt gold to smooth walls)
- provides maximum pulpal protection while maintaining uniform minimum depth

P – Mesial and distal walls – are smooth and straight.
R – facilitates condensation, adaptation
P – Mesial and distal walls – flare mesially and distally respectively to form slightly obtuse angles with the axial wall.
R – prevents fracture of tooth structure

P - Occlusal or Incisal wall – smooth and straight mesiodistally
R – facilitates condensation, adaptation
P – Occlusal or Incisal wall – forms 90 degree cavosurface angle
R – prevents undermining of enamel rods, assists in providing retention by opposing the gingival wall, which forms an acute gingivocavosurface angle.

P – Gingival wall – smooth and straight mesiodistally.
R – facilitates condensation and adaptation.
P – Gingival wall – forms an acute cavosurface angle.
R – provides retention by opposing the occlusal wall and diverging axially with it.
P – Gingival wall – if terminated in enamel requires a small cavosurface bevel.
R – a small enamel bevel protects the very short gingival enamel rods from fracture during condensation

CAVITY FINISH

P - Line angles are sharp and well defined (8)
1) Mesioaxial, distoaxial, incisoaxial and gingivoaxial
2) Mesioincisal, distoincisal, mesiogingival, distogingival.
R – facilitates proper condensation, increase retention.
P - Point angles are sharp and well defined.
R – facilitates condensation, increases retention

P - Cavosurface line angles are clean and well supported
R – sound and clear cavosurfaces are required to resist condensation forces and produce a well adapted tooth-restoration margin.
P - The rubber dam and underlying soft tissue and remaining enamel, dentin and cementum are preserved undamaged.
R – cavity preparation must be carried out without damage to hard and soft tissues to prevent post – operative pain and sensitivity.

GOLD FOIL CONDENSATION (COMPACTATION)

I. OBJECTIVES OF COMPACTATION OF GOLD FOIL

P – Adapt the gold intimately against cavity walls and margins.
R – Produces a tight marginal seal.

P – Harden the gold.
R – Development of slip planes during condensation – strain hardens the metal.

P – Weld each pellet in the cold state to produce a dense mass free of air and voids.
R – A dense restoration will have a smoother surface and improved physical properties such as greater hardness and resistance to abrasion and wear.

P – Wedge the gold against opposing walls and into retentive features in dentin.
R – A wedging action against opposing walls and into retentive features in dentin activates the elastic property of dentin increasing retention

P – Build proper contour.
R – ensures ideal tissue health post operatively (DWT)
II. GENERAL GUIDELINES FOR PROPER CONDENSATION OF GOLD FOIL

P – Maintain a clean, dry field uncontaminated by oils, moisture, saliva, blood, lubricants etc.  
*R – contamination of the gold during condensation will inhibit the welding (cohesion) of the gold.*

P – Use sufficient condensation force (15psi) = 3-4 lbs. for a .5mm diameter condenser.  
(see footnote DWT)  
*R – a certain minimum of force is required to produce a weld and eliminate air from the rolled gold – dense mass.*

P – Use smaller condenser points.  
*R – The amount of force required to adequately condense the gold is dependant on the diameter of the face of the condenser.  Smaller condensers require less force to – adequate condensation and therefore – less stress on the periodontum and greater patient comfort during condensation.*

P – Use the straightest condensers where possible.  
*R – The line of force is determined by the direction of the handle of the instrument.  The straight condensers when used will provide the most direct condensation and visualization of correct line of force.*

P – Direct the line of force (dictated by the handle of the condenser) bisecting or trisecting the internal line angles and point angles throughout most of the condensation.  
*R – A line of force directed into the line angles and point angles will ensure adequate adaptation into the details of the cavity and assist in wedging of the foil between the retentive walls.*

P – Step the condenser uniformly in rows to overlap each previous area of condensation.  
*R – Stepping the condenser is necessary to ensure thorough condensation of the mass and to help eliminate voids before a second pellet is added to the surface – uniform texture and organized building of the gold.*

P – Use small increments of gold.  
*R – Cohesive foil can not adequately condensed in thickness greater than .2mm, therefore larger increments are to be avoided.*

P – Build gold in an orderly fashion.  Organize the gold with hand pressure prior to condensation with the mallet (a burlap fabric texture should appear on the surface if properly organized and condensed.)  
*R – Random placement of pellets will produce a rough surface which is lumpy and poorly condensed.*
CLASS V

P – Build the gold against the walls first, and the central mass secondarily to contour (maintain a saucer shape until final contour is reached)

R – If the central mass is built too rapidly to contour prior to building against the And margins, poor condensation or bridging of voids may result at the margins.

P – Stabilize the gold mass during condensation.

R – To prevent dislodgment or movement of the foil mass as a result of condensing pressures. Hold the mass against the retentive areas. (DWT)

DAS

CONDENSATION FORCE FOOTNOTE

There is great confusion in the literature on this point, not only this set of notes by Dr. D.A. Spratley, see also Dr. G.D. Stibbs page 51 upper right side of page 1985 Operative Dentistry 10, 49 –57. (Included in this manual).

DWT
REQUIRED INSTRUMENTS FOR CLASS II GOLD FOIL

CUTTING INSTRUMENTS
- Explorer D E #5
- 169 bur Air Turbine Handpiece (high speed)
- 7901 bur Air Turbine Handpiece (high speed)
- 44 S Offangle Chisel
- 45 S Offangle Chisel
- 232 Gingival Margin Trimmer
- 233 Gingival Margin Trimmer
- Hoe 23/23c
- Angle Former UW A 36/37
- Spoon Excavator UW A 47

CONDENSERS
- Gold Foil Passer UW B 12
- Holding Instrument UW B 13
- Gold Foil Condensers:
  - .4 mm monangle UW B 2 (Ferrier #7)
  - .5mm monangle UW B 3 (Ferrier #4)
  - oblique monangle UW B 3S (Smith)
  - large parallelogram offset condenser UW B 16
  - long offset condenser Jeffery 16 F
  - very long offset condenser Ferrier #15
  - oblique face monangle condenser UW B 11S
  - foot condenser UW B 9 (Ferrier F)
  - foot condenser UW B 17
  - foot condenser UW B 18
  - back action foot condenser UW B 20

FINISHING
- 7404 bur Air Turbine Handpiece (high speed)
- Gold Knife Ferrier 29 or UW B 51
- Diecoid Cleold D-5
- Finishing Strips 18 inch fine garnet extra narrow width
- Finishing Strips 18 inch medium cuttle narrow width
- Finishing Strips 18 inch fine cuttle extra narrow width
- Finishing Strips 18 inch extra fine cuttle extra narrow width
- Tucker mini discs, garnet medium
- Tucker mini discs, sand fine
- Tucker mini discs, cuttle fine
- Flour Pumice #4
- 15 micron WCA aluminum oxide
- 1 micronWCA aluminum oxide
- Shofu Brown Polishing Points (high speed + low speed)
- Shofu Green Polishing Points (high speed + low speed)
REQUIRED INSTRUMENTS FOR CLASS III GOLD FOIL

CUTTING INSTRUMENTS
  Explorer D E #5
  33 ½ inverted cone bur for the straight handpiece (low speed)
  4/0 or 33-S bur
  Hoe UW A 21/21c
  Hoe UW A 23/23c
  Angle Former UW A 36/37
  Angle Former UW A 38/39
  Incisal Hatchet Ferrier 19
  Axial Wall Plane UW A 46
  Wedelstaedt Chisel UW A 1/2
  Wedelstaedt Chisel UW A 3/4
  Wedelstaedt Chisel UW A 5/6
  Spoon Excavator UW A 47

CONDENSERS
  Gold Foil Passer UW B 12
  Holding Instrument UW B 13
  Gold Foil Condensers:
    .4mm monangle UW B 2 (Ferrier #7)
    .5mm monangle UW B 3 (Ferrier #4)
    oblique monangle UW B 3S (Smith)
    small offset condenser UW B 4
    medium offset condenser UW B 5 (Ferrier #8)
    long offset condenser UW B 6 (Ferrier 9)
    foot condenser UW B 9 (Ferrier F)
    right angle hand condenser UW B 0 (Ferrier #11)

FINISHING
  Beavertail Burnisher F-2
  Gold Knife Ferrier 29 or UW B 51
  Finishing Strips 18 inch fine garnet extra narrow width
  Finishing Strips 18 inch medium cuttle narrow width
  Finishing Strips 18 inch fine cuttle extra narrow width
  Finishing Strips 18 inch extra fine cuttle extra narrow width
  Tucker mini discs, garnet fine
  Tucker mini discs, sand dine
  Tucker mini discs, cuttle fine
  Flour Pumice #4
  15 micron WCA aluminum oxide
  1 micron WCA aluminum oxide

RDT/DWT
REQUIRED INSTRUMENTS FOR INVISIBLE CLASS III GOLD FOIL

CAVITY PREPARATION
Explorer D E #5
33 ½ inverted cone bur for the air turbine handpiece (high speed)
4/0 or 33-S bur for the air turbine handpiece (high speed)
Jeffery #5
Jeffery #6
Jeffery #7
Jeffery #8
Jeffery #9
Jeffery #10
Jeffery #113
Spoon Excavator UW A 47

GOLD COMPACTION
Gold Foil Passer UW B 12
Holding Instrument UW B 13
Gold Foil Condenser:
   Hollenback Pneumatic or McShirley Electromallet
   with right angle condenser and assorted points

FINISHING AND POLISHING (invisible Class III Foil)
Beavertail Burnisher F-2
Gold Knife Ferrier 29 or UW B 51
Finishing Strips 18 inch fine garnet extra narrow width
Finishing Strips 18 inch medium cuttle narrow width
Finishing Strips 18 inch fine cuttle extra narrow width
Finishing Strips 18 inch extra fine cuttle extra narrow width
Tucker mini discs, garnet fine
Tucker mini discs, sand fine
Tucker mini discs, cuttle fine
Flour Pumice #4
15 micron WCA aluminum oxide
1 micron WCA aluminum oxide

All instruments listed are manufactured by the Suter Instrument Company, Chico, California
GOLD FOIL CONDENSERS

The Suter Gold Foil Condenser list shows the Ferrier number with its corresponding number for the University of Washington number system.

<table>
<thead>
<tr>
<th>FERRIER NUMBER</th>
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<tbody>
<tr>
<td>.5 mm straight condenser</td>
<td>F1</td>
</tr>
<tr>
<td>.55mm straight condenser</td>
<td>F2*</td>
</tr>
<tr>
<td>.75mm straight condenser</td>
<td>F3*</td>
</tr>
<tr>
<td>.5mm monangle condenser</td>
<td>F4</td>
</tr>
<tr>
<td>.5mm oblique face monangle condenser</td>
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</tr>
<tr>
<td>.55mm monangle condenser</td>
<td>F5</td>
</tr>
<tr>
<td>monangle condenser</td>
<td>F6</td>
</tr>
<tr>
<td>.44mm monangle condenser</td>
<td>F7*</td>
</tr>
<tr>
<td>.5mm off set condenser – 1mm long nib</td>
<td>F8</td>
</tr>
<tr>
<td>.5mm off set condenser – 1.5mm long nib</td>
<td>-</td>
</tr>
<tr>
<td>.5mm off set condenser – 2mm long nib</td>
<td>F9</td>
</tr>
<tr>
<td>very small parallelogram hoe condenser</td>
<td>-</td>
</tr>
<tr>
<td>holder/condenser</td>
<td>F10</td>
</tr>
<tr>
<td>holder/condenser with oblique face</td>
<td>-</td>
</tr>
<tr>
<td>.5mm right angle condenser</td>
<td>F11</td>
</tr>
<tr>
<td>medium foot condenser</td>
<td>F12*</td>
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<tr>
<td>small foot condenser</td>
<td>-</td>
</tr>
<tr>
<td>nichrome passers</td>
<td>*</td>
</tr>
<tr>
<td>curved holder (Woodbury 23)</td>
<td>*</td>
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<tr>
<td>hatchet parallelogram condenser</td>
<td>F13*</td>
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<tr>
<td>hoe parallelogram condenser</td>
<td>F14*</td>
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<tr>
<td>long off set condenser (22mm off set)</td>
<td>F15*</td>
</tr>
<tr>
<td>soft foil interprox. foot condenser right</td>
<td>F16</td>
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<tr>
<td>soft foil interprox. foot condenser left</td>
<td>F17</td>
</tr>
<tr>
<td>large round off set condenser non-cohesive</td>
<td>F18</td>
</tr>
<tr>
<td>large square off set condenser non-cohesive</td>
<td>-</td>
</tr>
<tr>
<td>back action soft foil interprox. foot condenser</td>
<td>F21</td>
</tr>
<tr>
<td>.6mm off set condenser – nib offset 9mm</td>
<td>Jeffery 16F</td>
</tr>
<tr>
<td>.8mm off set condenser – nib offset 3mm</td>
<td>Tucker 1*</td>
</tr>
</tbody>
</table>

*Instruments for first week of course
All other instruments suggested for the second week of course

Compiled by Richard D. Tucker
THE PREPARATION OF GOLD FOIL

PURPOSE

To prepare gold foil in a usable form, quickly with the least amount of handling. This reduces the risk of contamination or work hardening.

MATERIALS

- Book of non-cohesive gold foil #4
- Pellet and cylinder guide
- Foil pliers
- Fine sharp scissors
- Pencil and ruler (small plastic or metal)
- Paper clips
- Gold box
- Storage vials (pill bottles)
- Ammonia (28%)
- Clean towels (linen)
- Foil cylinder knife
- Cylinder fork (wool darter, 4/0)

PREPARATION

- Wash and dry hands.
- Spread out clean linen towel, on clean counter or table surface
- Using the pellet or cylinder guide draw the pattern needed on the book.
- Place paper clips on either side of book to hold foil in place while cutting.
- Hold the book firmly so pages do not buckle. Cut only a few squares off the book at a time to minimize their exposure to dust of contamination.
- If using a towel let the gold squares fall on the towel. If you are called away cover the gold and your foil box. An accident may befall the gold or, dust or moisture might contaminate the foil.
- Keep an adequate supply of each pellet size and cylinders on hand.
- Keep a reserve supply in separate bottles.
- When finished, place a small cotton pellet dipped in 28% ammonia and squeezed dry in each chamber of the box and in the storage vials.
- Change these pellets every month of two, when changing pellets plan not to use the foil for a few days afterwards.

PELLETS

- With pliers pick up a piece of gold at its centre and place it on the end of the thumb and first two fingers.
- Holding the foil loosely with the fingers turn the ends of the foil towards the centre to conceal the edges.
- gently roll the gold into a loose round pellet of the desired size.
- place the pellet in its correct place in the box or reserve vials.
- wash hands frequently to prevent contamination of the foil.

CYLINDERS

- fold a towel three or four times to make a pad.
- place a strip of foil on the pad.
- with a knife, lightly crease the foil and fold the gold lengthwise a shade less than half. Avoid too much pressure which will work harden the foil.
- depending on the size of cylinder needed fold gold to the appropriate width.
- lay the strip on the heel of the pad of the left thumb and hold the end lightly with the left index finger.
- engage the loose end of the strip with the foil fork and roll the strip into a cylinder. Do not roll in the palm of the hand, there is too much perspiration there, which contaminates the foil.
- slide the fork out of the cylinder and pinch the sides of the cylinder (rolled ends) with pliers to keep it from unrolling.
- place in appropriate storage

DWT
PELLET AND CYLINDER GUIDE

BOOK OF FOIL
Measure into ½” x ½” square

P = Pellet 1/128 1/64 1/43 1/32 1/16
C = Cylinder 1/64 1/32 1/16 1/8 1/4

PATTERN BY DR. NORMAN FERGUSON
GOLD FOIL PELLET SIZE GUIDE

G.D. Stibbs
<table>
<thead>
<tr>
<th>Size</th>
<th>Description</th>
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<tbody>
<tr>
<td>4.0 mm</td>
<td>1.5 mm</td>
</tr>
<tr>
<td>3 mm</td>
<td>1 mm</td>
</tr>
<tr>
<td>3 - 3.5 mm</td>
<td></td>
</tr>
<tr>
<td>3.5 mm</td>
<td></td>
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</table>

G.D. Stibbs
All retainers are modified in the same way. Using a high speed drill or a diamond disc, excess material is removed from the anterior portion of the beaks and from the lateral aspects of the jaws. The advantage of this modification is to enable the rubber dam to slide over the retainer easier, and to give better access to the tooth immediately anterior to the anchor tooth as well as not interfere with the bows of the 212 retractor.

Retainers that can be modified in this manner are:

GINGIVAL RUBBER DAM RETRACTORS

TYPES

Ferrier #212 - Ideal minimum is four but really need a set of six.
Ivory #16 - Useful for gingival retraction on molars. Works best after the buccal jaw is reduced markedly, see illustration. Ivory #16 is very hard to obtain now, may have been discontinued.

Advantages:
1) Provides access and visibility for gingival caries.
2) Retracts and protects tissue.
3) Most importantly, when properly stabilized:
   a) distributes operating force over several teeth.
   b) prevents retractor from rocking therefore prevents risk of scarring root surface.

FERRIER #212 RETRACTOR

This retractor designed by Dr. W.I. Ferrier is the best one for most restorations in the gingival 1/3. To achieve maximum results the principles of its use must be understood and followed. The clamp is an unbalanced instrument, and must be supported of stabilized with red stick compound to prevent the lingual jaw from sliding gingivally and damaging the tooth and soft tissue.

MODIFICATIONS

The basic form of this retractor will fit most teeth but they usually need some refinement of the manufactured form.
1) The labial and lingual notches for the beaks of the clamp forcep should be accentuated. This reduces the risk of the #212 slipping off the forcep at an inopportune time.
2) The edges of the jaws should be smooth, polished and slightly rounded so not to scar the root surface.
3) The preferred finish for the carbon steel retractor is nickel rather than chrome, and satin rather than high polish. The compound adheres to the satin nickel surface the best. The reflection from the highly polished metal surfaces is annoying to an operator’s eye, and can be dulled by sandblasting.
4) For smaller teeth such as lower incisors, one #212 should be modified by thinning the labial and lingual jaws and increasing the concavity of their edge.
5) For teeth with marked labial recession the lingual jaw needs to be bent more incisally and the labial jaw slightly more gingivally. Note that the more the labial jaw is bent, the less access there is for the operator.
The process of bending the jaws is different depending on whether the retractor is carbon steel or stainless steel.

Carbon steel
- heat the jaws until cherry red, bend the jaws quickly and allow to Bench Cool.

Stainless steel
- heat the jaws until cherry red, bend quickly, Bench Cool. Then place clamp in cool burnout furnace and raise the temperature to 500 degrees F. Remove the retractor and Quench in water.

Repolish surfaces with a rubber abrasive disc.

6) Two other retractors should be modified for teeth in which the lesion is off-centered mesio-distally due to rotation of the tooth. The alteration consists of grinding a bit off the left side of one jaw and the right side of its opposing jaw, see the illustration.
   The second retractor is prepared in the opposite manner.

7) A final modification is to anneal a retractor so it can be bent to fit any case that presents. This is done by heating a retractor in a furnace to 1300 degrees F and then turning off the furnace to cool slowly. The instrument may then be bent at will.

DWT
GINGIVAL RETRACTOR MODIFICATIONS

ROUTINE CORRECTION

FOR SMALL TEETH

FOR OFF-CENTERED LESIONS

FOR LABIAL GINGIVAL RECESSION

IVORY #16 MODIFIED
1) Punch Pattern

2) Floss lopped through extra hole and abutment to be isolated hole. Spin the floss together so easy to slip under pontic. Lubricate the underside of the dam, thread the floss under the pontic from the buccal to the lingual. Let floss lie in middle of mouth.
3) Apply rubber dam and place retainer on distal abutment. Rinse off lubricant and invert dam where possible.
Note: The rubber dam is draped over top of the pontic.
The floss is laying in the centre of the mouth under the dam having been threaded under the pontic. Insert a pair of cotton pliers into the centre hole and pull the floss up through the hole.

4) Apply 212 clamp, stabilize with red stick compound. Pull on the floss and pull the rubber dam underneath the pontic. Separate the two ends of the floss and ligate around the tooth directly across the arch from the abutment tooth that needs to be restored. Place the rubber dam frame and begin the case.

Dr. C.T. Fleetwood of the Seattle Dental Study Club devised this isolation technique to operate on bridge abutments.
**REFERENCES – DIRECT GOLDS**

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Journal/Journal Section</th>
<th>Date</th>
</tr>
</thead>
<tbody>
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<td>Jones, E.M.</td>
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<td>Prime, J.M.</td>
<td>Gold Foil</td>
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<td>Smith, B.B.</td>
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<td>JADA</td>
<td>Mar. 1950</td>
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<td>Compaction of Gold Into Retention in Class III Preparations</td>
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<td>Apr. 1972</td>
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<td>Author</td>
<td>Title</td>
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<td>Stibbs, G.D.</td>
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</tr>
</tbody>
</table>

These papers are representative of informative, traditional, technical, and research writings in Gold Foil Literature. They are not all-inclusive, but will provide a broad, sound overall picture. It is hoped they will guide readers into a more complete understanding of gold foil. Contained in them are additional references. These papers should be available, on loan, from the Library of the A.D.A. and the C.D.A. Some titles have been abbreviated.

From Dr. Stibb’s manual 1991
DENTAL PRACTICE

Direct Golds in Dental Restorative Therapy

GERALD D STIBBS

INTRODUCTION

In addressing the important subject of "Direct Golds in Dental Therapy," there is so much to tell that the greatest problem is deciding on the best approach. Some of you are highly competent, enthusiastic, direct gold users. What can I tell you! Others have an aversion to these materials, or have had limited or no exposure to the procedures involved. I cannot make expert direct gold operators of you in the few minutes at our disposal. What I hope to do is whet your appetite so you will progress from your present point, and become more competent, and more enthusiastic about the service you can render.

REDUCED EMPHASIS ON DIRECT GOLD

Admittedly, there is now less emphasis on the direct golds than there was some time ago. Why?

In Schools

In many of the dental schools this material receives less attention because:

- There is constant encroachment by aggressive curriculum innovators on the time given to restorative training.
- There is a tendency to follow the example of elementary and high school methods, and teach as little as possible with the least effort possible.
- Many teachers do not know how to use direct golds or teach their use.
- Many licensing boards do not require evidence of refined competence in conservative, permanent, restorative procedures, or else make the direct gold restoration an alternative to more casual operations.

433 Medical-Dental Building, Seattle, WA 98101, USA

GERALD D STIBBS, BS, DMD, conducts a private practice part time and is professor emeritus of restorative dentistry at the University of Washington. He is mentor of three gold foil study clubs—the George Ellsperman Gold Foil Seminar, the Vancouver Ferrier Study Club, and the Walter K Sproule Study Club. He is a member of the American Academy of Gold Foil Operators, the Academy of Operative Dentistry, the American Academy of Restorative Dentistry, an honorary member of the Canadian Academy of Restorative Dentistry and a fellow of the American College of Dentists.

Presented at the essay session of the annual meeting of the Academy of Operative Dentistry, Chicago, 14 February 1980.
In Practice

- Many of us yield to economic pressures and the pursuit of the dollar, mistakenly thinking that direct golds do not fit into that picture.
- Many of the dental insurance programs do not support conservative, permanent, dental restorative therapy and, of course, they are assuming an ever-expanding place in dental practice today.

VALUE OF DIRECT GOLDS

In spite of these adverse influences and circumstances, the direct golds still constitute one of the best of the available restorative materials, if—if—
1. They are used where indicated.
2. They are manipulated properly.
3. The operator has, or is willing to acquire, the necessary expertise.

G V Black once wrote, “No other material can be so worked against the walls of a cavity as to make full use of the sustaining power of the elasticity of the dentin” (1908). That still holds true.

As you know, pure gold is one of the oldest restorative materials, yet it is still the standard-bearer, or the yardstick, or, in today’s parlance, the meter stick. Other materials are compared with foil, the other forms of gold are compared with foil, so we should know how and where to use it. While I am a long-time disciple of foil in dentistry, I also recognize that, if foil is not used correctly, it is one of our least successful procedures. I extol its virtues, but I also caution against anyone thinking that going through the technic once or twice, or reading a few papers on the subject will make him adept or even semicompetent in its use. As W I Ferrier used to say, “It does not come by a ‘laying on of hands.’”

HOW TO LEARN THE PROCEDURE

For the benefit of you who have received limited coaching in the procedure, or who have not given it any thought or attention recently, let me give you a few pros and cons and outline the state of the art. I want you who are interested to know that you are not alone. I encourage you to follow your inclination to use this excellent restorative medium.

Literature

There is a wealth of material in the literature, if you will take the time to look it up. It is fascinating reading. To assist you, a short list of representative articles to initiate or further your search is given at the end of this article. I could not be all-inclusive and have undoubtedly omitted some excellent presentations. In those listed you will find reference to other fine reports.

Instruments and Supplies

The second step in learning this technic is to assemble a basic kit of instruments and supplies (a list is available from the author) and a small amount of each type of gold. Such an introductory package is available from the manufacturer, Williams Gold Refining Co (2978 Main St, Buffalo, NY 14214, USA; 800/828-1538). By trial and error, determine which one, or ones, best suit your needs, and go from there.

Study Clubs

The third, and preferred, approach is to join an operating study club and, with the aid and guidance of the mentor or preceptor, develop your skills under his supervision. It will be the greatest thing you can do for your dental advancement, for improvement of your restorative service, and to stimulate your sense of accomplishment.

Each of us who talks about, and uses, direct golds acknowledges prime stimulus from one or other of the great operators who preceded us. Some of these leaders have been rather regional in their influence; others have had a nationwide or worldwide impact. Each, in his own way, has given unstintingly of himself, and we are all indebted to them.

OBSTACLES

The principal obstacles to the use of direct golds are:
1. The operator’s lack of training and consequent lack of enthusiasm and comfort with the technic.
2. The patient’s aversion to an unsightly display of metal.
3. Many carriers of dental insurance plans do not accept the direct golds, and the non-dental adjudicator thus arbitrarily excludes our superior preventive restorative medium.

4. Concern of some dentists that the present cost of gold will price foil and gold alloys out of the market. These objections can be met by the operator becoming familiar with a good, sound technic, by having the proper armamentarium, and by knowing the possibilities of restoration outlines that minimize or eliminate the display of metal.

As to the third-party encroachment, we can keep working to enlighten the bureaucracy and in the meantime resume the good, old-fashioned, direct relationship of patient to dentist, and do what is best for the dental health, regardless of outside political and financial pressures.

As to the cost, it is still a minor consideration. For example, when gold sold for $35 an ounce, we bought foil for approximately $18 per 1/10th ounce. Since the average class 5 foil weighs about 0.05 pennyweight, and the average class 3 foil weighs about 0.06 pennyweight, they contained about 45¢ and 54¢ worth of gold, respectively. Today, even though the market fluctuates wildly, if we consider gold at $700 an ounce, our foil is priced around $140 per 1/10th ounce. The mat and powdered golds are priced at 4% to 10% over that. The gold in the same class 5 and 3 foils then would cost about $3.50 and $4.20, respectively. Hardly enough to talk ourselves out of using this excellent medium!

**INDICATIONS**

The indications for direct gold may be debated and may be different in different parts of the country. In general:

- The smaller the lesion the greater the indication.
- The greater the need for conservative, permanent restorations, the greater the indication for foil.

**REQUISITES**

Now, getting to specifics, there are a few fundamental requisites to be considered if we are to produce successful, lifetime restorations:

1. There must be a proper cavity preparation.
2. There must be a dry field.
3. The restorative material must be properly manipulated. Each of the forms presently available requires some slight differences in handling.
4. There must be the usual respect for protecting the health of the supporting and surrounding tissues.

Complying with these requisites is facilitated by:

1. Having in mind a picture of the proper cavity preparation, and the ultimate goal
2. An adequate armamentarium readily available to include:
   a. The best available cutting instruments, handpieces, and burs.
   b. A basic array of compacting instruments or condensers or pluggers, so that the gold may be inserted with proper and controlled line and degree of force.
   c. An efficient setup to contour, finish, and polish the restoration without injury to the tooth, the pulp, and the supporting tissues. This includes adequate coolant, proper operating illumination, and controlled speed of rotary instruments.

**Cavity Preparation**

In the cavity preparation, briefly the requisites are:

1. Mechanical retention
2. Harmonious or controlled outline form to meet the patient’s needs in terms of esthetics
3. Adequate access for proper instrumentation
4. Concern for pulp protection

**Operating Field**

As for any restoration, the operating field is important. There are two essential factors to consider:

1. Cleanliness, including lack of moisture
2. Access for operating—preparation, insertion and finishing

The dry field is best attained with rubber dam. Different operators have different preferences about the details of obtaining such a field. Some find the frame type of holder to be
adequate; others prefer the control of cheeks, tongue and lips afforded by the headband type of holder.

Ireland (1962) has said that the most time-consuming thing about the rubber dam is convincing dentists that they should use it.

To achieve a clear operating field for a gingival third lesion, a few operators make a surgical flap of the gingiva; however, most use a mechanical retractor, which, if well designed as is the Ferrier No. 212, and if carefully applied, is less traumatic to the tissues. The matter of design, modification, and application of the retractor, while not complicated, does require training and guidance. There are several good sources of information in the literature if the assistance of an operator familiar with the technic is not available. If not used properly, the clamps or retractors can do much harm.

To achieve access to a proximal lesion, and to have a restricted preparation for it, a mechanical separator is an essential aid. It, too, must be well designed and correctly applied for maximum safety and optimal access. The Ferrier pattern has been the best design available for many years. For a time the separators did not measure up to specifications and required considerable modifying and refining. Now a new manufacturer, Almore International (Portland, OR 97225, USA), is producing three of the six patterns. In the literature there is information about the application of these instruments (Stibbs, 1967).

Types of Gold and Their Manipulation

TYPES OF GOLD

There are enough types or forms of gold to satisfy every taste and whim. Each will do a fine job if handled properly. Some are better than others. Basically there are three forms—foil, crystalline, and granular.

Gold foil, or fibrous gold, is one of the oldest, if not the oldest form we have. It is rolled and beaten by fascinating procedures. Gold leaf, as used in gliding or ornamentation, is about 1/250,000 in (0.1 μm) thick. Our dental foil (the usual No 4) is six times that thick, or 1/40,000 in (0.6 μm). It is available in several types:

- Sheets, usually for preparation in the dental office
- Manufactured pellets or cylinders
- Ropes
- Laminated—varying thicknesses of foil stacked and slightly precondensed

Crystalline, sponge, or mat gold. In use for many years, mat is a microcrystalline form, produced by electrodeposition, the crystals being dendritic or fern-like in shape about 0.1 mm long. It can be used plain or sandwiched in gold foil to make it easier to handle, in which form it is designated as mat foil.

Granular, or powdered, gold. The first ones appeared in this country about 1960, having gone through a number of evolutionary forms. These irregularly shaped, precondensed pellets or clumps of particles (Biofil, Filoro, Karat) were prepared by one of three basic methods: comminution, chemical precipitation, or atomization from the molten state. With some of them a volatile liquid was provided to act as a carrying medium to convey the pellet to the cavity. In general they are difficult to control.

Goldent: The next type of granular gold, developed in this country about 1962, was called Goldent (originally by Morgan, Hastings Co, now by Williams Gold Refining Co Inc, Buffalo, NY 14214, USA). The individual particles or granules, averaging 15 micrometers (μm), are gathered into conglomerate masses of irregular shape ranging in diameter from 1 to 3 mm, lightly precondensed to facilitate handling. The masses are encased in an envelope of foil to make it easier to convey them to the cavity. The present form has some spherical atomized particles mixed with the granules to improve compacting properties.

Electraloy R V: The newest form of gold is known as Electraloy R V. All compacted golds develop increased hardness with the introduction of stresses. However, greater hardness occurs with the introduction of minute quantities of other elements, such as palladium, platinum, indium, silver, and calcium, without lessening desirable manipulative characteristics. In this product, the granular gold, alloyed with a trace of calcium, is manufactured electrolytically. Sintering (a method of heating under controlled temperature and time) changes the alloy into a mat. The strips of mat, of varying widths, are sandwiched between foil to improve handling properties.
MANIPULATION

As to the manipulation of the direct golds, there are a few principles to keep in mind:

1. The increments of gold need to be of proper size for insertion, and in proper condition for condensing, or 'compacting', a term introduced by Hodson (Hodson & Stibbs, 1962) that conveys a more accurate picture of the procedure since 'condensation' usually implies the conversion of a gas to liquid or solid state.

2. Gold has the property of cold welding, one piece to another, if the surface is free of contaminants and moisture.

3. Gold flows under pressure, so it will seal the cavity and be securely locked in place if the compacting force is correct in direction and amount. Improper line of force will loosen or dislodge the foil, and if we try to hurry too much or do not control the stopping of the condenser the end product will be a poorly condensed mass that will be pitted and will fail.

So, you must have a means of cleansing the surface of the gold, and you need to apply controlled force.

Annealing. The cleansing or annealing to remove the volatile protective coating may be done pellet by pellet over an open flame of pure alcohol or en masse on an annealing plate having an electric, gas, or alcohol source of heat. The annealing temperature ranges from 650–700 °C (not Fahrenheit) depending on the method and length of time of heating (Smith, 1973).

The easiest way is to have the chairside assistant anneal the gold as it is needed, over an open flame, heating just until the gold becomes a dull red. Care to not overheat it is important. If the protective coating is not driven off, the gold will not cohere, one piece to another. It is then considered noncohesive. The noncohesive type is useful to line and protect peripheral cavity walls in class 1 and class 5 preparations, and to rapidly build the proximal portion of a class 2 restoration.

Compacting force. The source of force can be by hand pressure alone (which becomes very tiring), or by hand mallet (which is strongly favored by many operators), or by a mechanical device that is activated by spring (Snow), pneumatic pressure (Hollenbach), or electronically (Electromallet).

The direction, amount, and pattern of application of the compacting force are all highly important.

Direction: It is essential to direct the compacting force into the cavity, utilizing the property of flow of gold under pressure, in the direction of the force. The handle of the condenser should be at about 45° to the wall of the cavity. The direction should never be cut of the preparation.

Amount: We recall from our early reading of G. V. Black and others that with a condenser having a face of 1 mm², the optimal force is 15 lb. But our condensers are not that large. A round-faced condenser of 1 mm diameter (which is still too large) has an area of 0.8 mm², so it would require a compacting force of 12 lb. The usual 0.5 mm diameter condenser has a face area of 0.2 mm², so the required force is but 3 lb. For Goldent, some recommend hand pressure only, using a larger-faced condenser (0.016 x 0.045 mm = area 0.465 mm²) and a force of 6-8 lb.

The condensers vary widely in shape and size. They can be straight, curved, or angled; they can be round, square or rectangular; they can be smooth or serrated; they can be flat-faced or convex-faced. It is well to begin with a basic minimal set and add to that as needs arise.

Hodson has pointed out that the plastic flow of gold occurs for only short distances under the face of the condenser (Hodson, 1961). Areas not covered by the face of the condenser remain porous (Hodson & Stibbs, 1962). Condenser penetration is less than the thickness of the increment (Hodson, 1964). The welding depth is not over 0.2–0.3 mm. Final density is influenced greatly by the direction and the magnitude of the compaction force, and by the size and shape of the face of the condenser (Hodson & Stibbs, 1962). The quality of compaction depends strictly on the operator's manipulative technic (Hodson, 1964).

Pattern: It is important to step the condenser in a controlled pattern. Methodical backstepping or overlapping, one half the diameter of the condenser face, produces the finest specimens (Hodson, 1964). Not only will this ensure uniform compaction and a dense mass, but also it will achieve optimal flow of metal, and sealing of cavity walls.
Porosity is inherent in any compacted gold restoration. In foil, the porosities are of the ‘closed’ or cell variety. In the granular or powdered golds, porosities are of the ‘open’ type and therefore are more dangerous if not controlled (Hodson, 1964).

Each type of gold requires some slight variation in technic. If mat or powdered gold is compacted in the same manner as foil, it is very easy to have incomplete sealing of cavity walls, and incomplete compaction of the gold. Better results are achieved with condensers with a slightly larger face and finer serrations when working with mat. The powdered or granular pellets need to be opened up in the cavity before compaction begins, to minimize voids in the mass.

Some find that these golds crumble too readily in transporting them to the cavity, and that they are difficult to manage. Some operators obtain a dense hard restoration using only mat or powdered gold; others find that if these forms are used it is easier to obtain a better surface and polish if they apply a surface lamination of cohesive foil to the compacted mass of mat or powdered gold.

Finishing. In the finishing of any of the direct golds, the principles that have been used for many years for foil apply to the other forms as well.

- A controlled amount of excess is built up to allow for restoration of normal contour and a smooth surface.
- The excess is removed with very sharp knives and files of suitable design, and with abrasive discs, stones, and strips. Whenever the strips are used, adequate coolant must be supplied to avoid overheating the metal and consequently traumatizing the pulp.
- Separation is increased slightly to enable passage of the strips through the contact but is removed as soon as possible to minimize harmful stress on the periodontal ligament and injury to the interdental papilla.
- Care must be exercised when discing to not cut into the surface of the tooth. Careless finishing can also injure the adjoining soft tissues.
- For final polish, a satin finish is preferable to a high gloss. This minimizes reflection of the light rays and creates a more aesthetic and harmonious end result.

CONCLUSIONS

- The direct golds offer one of the most conservative, permanent, and serviceable means of restoring teeth to proper contour, function, and appearance.
- If you haven’t been using direct gold to any extent, start with simpler, smaller lesions, and work your way into the more complex situations. Ask for assistance and guidance.
- Keep in mind that the technic for providing this restoration for your patients, while exacting, is not unduly difficult to acquire. On the other hand, you cannot become proficient by reading about it once.
- Familiarize yourself with the various forms of gold now available and determine which ones best meet the needs of the patient.
- Operating dexterity can be improved and refined by practice and particularly by participating in study club activity.
- In this endeavor we should keep in mind that improving our competence with the direct golds will also improve our service with other materials and will provide our patients with superior restorative therapy and us with an unparalleled inner glow of satisfaction in a job well and beautifully done.

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For Further Reading

GENERAL


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**OPERATING FIELD**


Manipulation of Cohesive Gold Foil in Dental Restorations

GERALD D STIBBS

Summary

The requirements for the manipulation of cohesive gold foil are the selection and preparation of the desired form of gold, a suitable array of instruments, a good means of annealing and purifying the surface of the foil before carrying it to the cavity, correct and controlled force of compaction, an awareness of the importance of line of force, rhythmic teamwork by operator and assistant in placing and compacting the foil, a control of excess so that minimal surplus gold is added, and finally, standardized technics of contouring, finishing, and polishing. Last but not least is the instruction to the patient, so he is aware of the quality of the service received, and of his responsibilities in maintaining the restoration.

The procedure should not be unduly arduous for either the patient or the operator. It should conserve the tooth structure, maintain pulpal health, and avoid damage to the tooth and supporting and surrounding tissues. The objective is to provide a lifetime, superlative service for the tooth concerned.
Introduction

The principles and technics of fabricating gold foil restorations have been published and taught for many, many years. However, the articles tend to become dusty treasures in libraries, and the incoming generation of restorative dentists do not have ready access to the masterful teachings of the past, though many are eager to increase their knowledge of this valuable phase of restorative therapy. Further, regional technics are apt to be exhibited and taught only to geographically limited groups, yet it is of interest to others to learn the details of these procedures. A third reason for recounting the steps in the exhilarating but demanding technic of working with pure gold is the hope that the repetition will encourage other clinicians to tell of their contributions to the art and science, with resultant benefit to all. Therefore the objective of this treatise is to record some of the details that are seldom described in papers and which can be lost to the profession as those who are familiar with the technic fade out of the dental picture. Perhaps some benefit will occur before this, too, joins the forgotten publications in dental library stacks. The procedures to be described have come from the inspired teachings of the author’s instructors, and from refinements or alterations that have evolved from over half a century of clinical application.

All three phases of the gold foil operation are vitally important. Without a properly prepared cavity, without proper manipulation of the gold, and without proper finishing to attain a contoured, functional, polished restoration the service will be a failure. The greatest amount of time and attention tends to be given to the preparation of the cavity. However, the technic of inserting, compacting, finishing, and polishing the foil restoration is also precise and demanding. Attention must be given to a multitude of seeming trivia if restorations of optimal quality are to be produced.

Materials and Instruments

The selection of the type of direct gold is important. It may be foil in either hand-rolled or manufactured form, or mat gold, mat foil, laminated foil, or powdered gold. Described here is the use of cohesive gold foil that has been prepared by office personnel from sheets of No 4 gold (4 grains per 4-inch square).

The instruments required include an assortment of compacting, or condensing, instruments of varied shapes, sizes, and forms to enable effective compaction of the gold, and a suitable passing instrument to convey the foil from the annealing medium to the cavity. Finishing instruments and polishing materials should also be of the highest quality and must be kept in peak condition.

Finally, an annealing medium is required. It can be either an electric annealer, or a mica or enameled metal plate that will hold the foil over an alcohol or gas flame, or it can be the flame of an alcohol lamp. Clinical experience by many foil operators, supplemented by research by Hollenback and Collard (1961), has shown that the most satisfactory annealing is accomplished by heating the gold to a dull red (1200 °F or 649 °C), pellet by pellet, over an open shielded alcohol flame.

Insertion and Compaction of the Gold

G V Black (1908) stated that “much hammering of gold will make a hard mass, but no amount of hammering of gold, that is available in the mouth, will make close adaptation to cavity walls, unless the laying of the gold, stepping of the plugger point on the gold, and the direction of force are correlated to this end.”

E K Wedelstaedt, in his voluminous writings and lectures, emphasized the importance of precise, careful technic in the compaction of gold foil. In a paper written 12 April 1917, he stated that the principal objective when using gold foil for dental restorations is to make watertight margins. He advocated “acquiring such habits as will enable operating with the greatest facility.” He observed, however, that “a high percentage of operators use their pluggers in anything but a scientific way. They may here and there make tight margins, but everything about their results is uncertain.” The same holds true today.

There are several methods of applying compacting force to gold. It can be done with hand pressure by the operator alone, hand pressure supplemented by malleting by the chairside
The assistant, or with one of the mechanical instruments, such as the Snow spring mallet, or the Hollenback Pneumatic Condenser, or the McShirley Electro-Mallet. With any of the technics excellent restorations can be produced if the technical procedure is adjusted to the requirements of the particular instrument.

The long-handled condenser in the hand of the operator, with proper initial finger pressure, and supplemented by mallet force with a leather-faced or plastic-faced mallet in the hand of the assistant, gives as fine a result as does any method and has the further advantage of sharing the work. With the malleting being done by the assistant, the operator is able to concentrate on the control of the compacting instrument, the line of force, and the protection of the tooth and the supporting structures.

Another advantage of hand malleting is that it is much easier for the operator to change compacting instruments than to change points in one of the automatic devices, and it is important, when considering the line of force, and the shape and size of condenser, that we do change back and forth. For example, while it is desirable to use the simplest design of condenser — and in a large portion of a class 5 a straight condenser can be used — certain areas will dictate the use of other designs. For sharp occlusop proximal angles, the 0.4 mm monangle is a desirable condenser; and in many class 5s an offset or bayonet design of instrument is more suitable than a straight or monangle condenser to achieve the proper line of force of 12½ centigrades (45°) against the occlusal wall. If an operator has to take the time to remove a straight condenser point from the chuck of a handpiece and change to another design, he is more apt to try to get by without a change, and hope the line of force will be adequate, and he may or may not — likely will not — seal the gold well against the cavity wall.

The mallet we use is the one designed by WJ Ferrier, which is presently available from J V Gourley, 12238 Olympic View Road NW, Silverdale, WA 98382, USA, or American Dental Mfg Co, Missoula, MT 59806, USA. It is somewhat different from the Prime mallet, which has a longer handle and is heavier. It varies, too, from the Woodbury design. The head of the Ferrier mallet weighs 2½ ounces (71 g). The handle is delicate, well turned, finely finished. The head and handle are well balanced.

The assistant using the mallet holds it between thumb and index finger of her malleting hand (the left hand, if the operator is right handed); she determines the point of balance and develops the ability to strike the end of the compacting instrument properly, with the mallet head traveling approximately 0.75 - 1 inch (2.0 - 2.5 cm). The amount of force is best when it is the equivalent of 15 pounds (66.7 N) with a condenser whose nib has a diameter of 1.0 mm at the face. Further, the most practical diameter of nib is 0.5 mm, and should rarely exceed 0.75 mm. This means that the mallet force on a 0.5 mm condenser would be approximately 4 pounds (17.8 N), actually 3.9604 pounds (17.6 N).

The technic of malleting must be developed. It should be practiced regularly by the assistant. The type of blow should be supervised consistently by the operator. This step is one of the weakest and least uniform among foil operators. Some assistants hold the mallet too close to the end of the handle or, occasionally, too close to the head of the mallet. Some hold the mallet between the thumb and third finger and use the index finger as a 'stop', holding it against the back edge of the handle, a method which produces a dead, heavy blow traumatic to the periodontal ligament.

Compaction depends not only on the amount of the force but also upon its velocity, so a suitable rhythm and technic must be worked out by the operating team. In essence, the operator institutes finger pressure with his condenser against the gold, taking up the slack or the compressibility of the periodontal ligament. Immediately thereafter the assistant strikes two blows with the mallet, two "taps" with the mallet traveling parallel with the central axis of the handle of the condenser. It is a short, lively blow, with but split-second contact of the mallet on the condenser. It is executed so the mallet pivots between the thumb and finger; it is not a firm hammer grip; the mallet almost does its own work. The end of the mallet handle bounces against the base of the thumb, and this produces a rebounding action. After the two blows the operator lifts the condenser and moves it half to two-thirds the diameter of the condenser face, exerts finger pressure, and receives two more taps. Again he lifts, moves, exerts finger pressure, and receives two more taps.
The sequence of malleting should be rhythmic and methodical. Figures 1 and 2 show the sequence of the steps used when beginning to condense from the central part of the cavity. Go along in rows from one edge of the pellet — a, b, c, d — over to the other edge; move one half the diameter of the condenser nib closer to the margin of the cavity into row 2; repeat — a, b, c, d — and move another row closer to the margin. So the progression from the central part of the cavity to the edge of the pellet is row 1, 2, 3, and 4, and the sequence of malleting is from left to right, or right to left, whichever is most convenient.

As the operator reaches the final row, say row 4 or 5, he comes to the margin. Rather than keep on to the very edge of the pellet, it is best to either double the pellet back on itself, and complete the compaction near the margin or, if he is close to the margin, scuff off the last edges of the pellet so he does not lose sight of the margin. Thus the amount of excess can be controlled.

In the case of a class 5, the gold is built up from the internal portion to the margins, banking or saucering it against the surrounding walls, and filling the central part of the cavity as the last step (Fig 3). The amount of gold, or the size of the pellet, should be determined by the convenience form, by the bulk of gold that can be accommodated effectively, and by the size of the condenser. The most useful size of hand-rolled pellet seems to be the ‘43rd’, that is, 1/43 of a 4-inch square of No 4 gold. Perhaps the most frequently used size is the 1/4, but in the cavity of average size it is too small and therefore too time-consuming. The smallest size, the 1/128, can be used for an initial starting point and for completing the coverage of margins. Of course, in very tiny cavities a considerable portion of the gold used may be the 1/128 size.

The Operating Team — Dentist and Assistant

The teamwork between the operator and the assistant is an extremely important consideration. When the operator receives the properly annealed gold, he tacks it on to the existing compacted mass and packs the pellet lightly by hand while the assistant is picking up another pellet, annealing it, and coming back to malleting position. At a given signal — a nod of the head or a move of the condenser or, if need be, a voice signal — the assistant mallets, with her left hand, until the pellet is compacted. Then (assuming that the operator is right handed), the assistant, with her right hand, conveys the next pellet into the cavity and places it at the spot designated by a motion with the condenser by the operator. She makes sure that he receives the pellet and that it remains in the
cavity; then while he is packing it lightly with hand pressure, she picks up the next pellet, anneals it, comes to the 'ready' position, and awaits the signal to mallet. If this is done well the procedure is smooth, with minimal expenditure of time, minimal signaling, minimal talking, and maximum speed and efficiency.

The operator's responsibilities — aside from his hand-packing, controlling the proper sequence of movement of the condenser point, and his surveillance of the malleting by the assistant — include also a constant awareness of the direction of the compacting force. One of the primary considerations in the compacting of foil is the control of the line of force. Gold flows under properly directed compacting force, and our intent is to utilize this property of gold to make it move into the retentive areas of the cavity. Of course the gold must be in suitable condition, properly annealed and pure, and applied to a dry surface, so that the next pellet will cohere to the existing mass. The cold welding property is essential, but if the line of force is not controlled, foil can be tipped out of even a well-prepared cavity; a dense well-malteded foil can be lost through an incorrect line of force.

The line of force is determined principally by the axis of the shaft or handle of the condenser. For example, with a monangle condenser in a class 3 restoration, that monangle is used to wrap around the approximating tooth. If the angle is wrapped around the labial margin of the cavity, the axis of the condenser is not directed into the axiogingival angle but is mistakenly directed out of the cavity. The result then is to tip the foil and loosen it. It should be stressed that if movement is ever seen in a foil during its compaction no attempt should be made to relock it; it just will not reseal the wall. If there is movement, the foil should be removed and the insertion started again.

It is usually best for the operator to use a holding instrument to stabilize the first pellets of gold while he is condensing and until he locks the gold into the second convenience point or against the opposite wall of the cavity. There are some operators who are able to start with one pellet and so control the line of force that they do not need to worry about the slipping or buckling of the foil, and they do not use a stabilizing instrument, but they are few and far between. It is the better part of valor to use the holding instrument.

Operating Position

So far we have considered the material, the means of preparing it for compaction, the highly important contribution by the assistant, and factors to be controlled by the operator. A word might be said about the operator's stance at the chair. The past masters in gold foil procedures advocated the direct approach to the cavity with the gold. Rather than use a palm and thumb grasp on the condenser and work in a mirror, it is preferable to use the pen grasp, stabilized with a finger rest with the other hand, and look directly into the cavity, and thus control the line of force more readily. While the current trend is for the operator to sit constantly and never bend, and to use a mirror routinely, if one is having any problem with the placing of gold he might give consideration to resuming the proven, advantageous method of working directly into the cavity. As an example, when a right-handed operator is restoring a gingival third lesion on the left side, he should not try to work over the patient and upside down. He will be thrown off balance and is not properly oriented. He should turn the patient toward him and work from the right front position so he can see directly into the cavity. In the same way, even though it is a little more uncomfortable for the patient, when adding foil from the lingual in a class 3, it is better to have the patient's head back, and chin sufficiently raised from the chest, so the operator can look directly into the lingual and be sure of the line of force.

Quality Control

The uniformity of compaction of the foil is important. Each pellet must be condensed thoroughly before proceeding to the next pellet. Hodson (1961) showed that the usual compacting force is not conveyed through a thickness of gold greater than 0.2 mm. If we hurry over the compacting of one pellet and leave any void, and then add another pellet over the void, it is unlikely that the initial void will be eliminated with the succeeding pellet, unless the thickness of the second pellet is less than 0.2 mm. So it is important to develop a good rhythmic sequence of passing the condenser back and forth over the pellet, compacting as we go, producing a uniformly smooth, mat surface, then
adding the next pellet and keeping control of the contour. It is essential, too, that margins be completely covered, yet not damaged by striking with the condenser. A valuable instrument to check marginal coverage is a very sharp explorer, passed lightly from the gold to the tooth. If there is a catch, the margin is not covered completely and another pellet can be added.

With class 3s, care must be taken in several areas to avoid defective compaction. The first is the linguogingival angle where it is easy to cut off one's access by building the foil labial to that area too rapidly. Secondly, the central area, where, if compaction is not confirmed during the building of central bulk with an oblique-faced condenser or with a foot condenser, there is danger of having poorly compacted gold in the contact area, or just gingival to the contact. The third problem area is the linguoincisal cavosurface. Inadequate compaction in this location can be avoided if the cavity has a definite incisal wall as advocated by Ferrier (1936) and if the operator will be sure, as he "makes the turn," that the compacting force is directed from the gingival to the incisal so the gold is definitely condensed. It is usually unsatisfactory to attempt to add foil from the lingual in that location. The gold may appear to be dense for awhile, but soon it will exhibit a pitted surface, or the added foil will be displaced. It is most important to be careful with the compacting of the foil in these three areas. One of the most useful instruments for ensuring density in these locations is an oblique-faced monangled condenser. It will reach directly into the linguogingival angle and into the central area after the bulk has been compacted with the regular condenser, and it will also cover the linguoincisal cavosurface margin without damaging the enamel rods.

Finishing and Polishing

After the restoration has been built to contour with a slight excess to allow for finishing, the surplus is reduced, and the restoration is contoured, carved, and polished. The general procedure is to confirm the compaction of the gold by so-called after-condensation, which is a matter of going over the surface with a finely serrated condenser, usually foot-shaped. This flattens out the serrations resulting from the original condenser point. It also detects any dips in contour where a little additional foil might be needed.

When satisfied that there is sufficient foil and all margins are covered, the operator should lightly burnish the surface. This is not so much to work-harden the surface, but rather to confirm uniformity of density and to ensure that there is no dip in contour below the final one desired. If such a dip is evident, the surface can be reserrated and another pellet or so added.

After the light burnishing, the restoration is finished by alternating between the use of hand instruments and rotary abrasives. Both must be used properly, because either the hand instrument, the rotary instrument, or the polishing abrasive can damage not only the restoration but also the tooth. It is preferable generally to favor the use of hand instruments rather than rotary tools. Excessive bulk can be reduced with a disc or with a coarser strip; otherwise, finishing is begun with the push-cut and pull-cut files. These should be sharp. The sharpness can be assured by discarding the instruments promptly when they are dull, or by learning how to resharpen them with a suitable Swiss file. Gold is worked from the mass of metal to the margin. If it is dressed in the other direction the bite of the file may loosen or dislodge the foil.

In a class 5 restoration the push-cut file is used on the gingival and approximal portions and the pull-cut file is used on the occlusal portion. The file should be kept flat on the surface of the gold rather than to cut with just the end, because, particularly when reducing excess from the gingival, if just the end of the file is on the gold it is easy to gouge the cementum. It is important, too, when filing, to keep control of the instrument by having a short grip on the file and maintaining a supporting finger rest. It is unfortunate, and a mark of careless operating, for the soft tissues to be bruised and mutilated when a foil is finished.

After the preliminary dressing with the files, contouring is continued with a disc of extra-fine garnet, % inch in diameter, mounted on a miniature snap-on mandrel, such as the Sproule type, if available, rather than on a screw-head mandrel, running at slow speed and with a constant stream of cool air on it, and with a very
slight film of vaseline on the surface of the gold. The reason for using the tiny 3/8-inch or even ¼-inch disc is that it will reach into the embrasures more readily, and the cutting is controlled more easily. The reason for the disc mandrel rather than the screw-head mandrel is that the operator can revolve it from gold to tooth, and reverse it readily, whereas with the screw-head type the head simply unscrews in reverse; it is a definite handicap if the disc revolves only one way. The reasons for the vaseline are that it lubricates, the cutting is less harsh, and the disc will convey some of the lubricant to the dam so the rubber is not torn.

By alternating back and forth from files to discs and back to files, then changing discs from fine garnet disc to a coarse cuticle disc, then filing again, then using a medium or cuticle disc, and finally a fine cuticle disc, the excess is systematically reduced to the desired contour, the scratches of the coarser instruments are eliminated, and the foil is brought to a satin finish. The filing and discing may drag gold over the margins; if so, these little tags are removed with the file or with the back of a sharp gold knife. The knife is kept keenly sharp, sharpening from the front edge of the blade all the way to the back so there will be three cutting edges on the blade, and a light push cut will flick off the excess.

In a class 3 restoration discs are used only rarely. The abrasive medium used is a linen strip, 18 inches long, carrying various abrasives, either cuticle or garnet. After the preliminary burnishing and filing, contouring is accomplished with the very sharp gold knife, then with controlled use of strips. Whenever strips or discs are used cool air must be kept on that tooth so the gold will not be overheated with resultant damage to the pulp. Draw the strip across the surface of the gold, not too quickly, and do not seesaw as though polishing shoes. Again, the sequence is to progress from the coarser to the finer strips.

In class 3s separation is needed. If the separator has not been placed during compaction, one is placed before finishing procedures are instituted; or, if a separator has been on during compaction, a little extra tension is provided to increase separation during the preliminary burnishing and carving with the knife. A strip of steel matrix metal is passed through the contact area to facilitate passage of strips and to work-harden the foil in the contact zone. When some contour has been developed with a knife and files, an extra-fine cuticle linen strip is passed over the gold a few times; it is then laid aside to be used again later in the operation. More contouring is done with the knife and occasionally with the files. If there is considerable excess a coarser strip, such as a medium cuticle of medium or wide width is used. The wide strip is preferred if there is a prominence to be reduced, for it will stay on the peak or hump rather than slip off to one side or the other. Very occasionally a garnet strip may be used, but one's objective should be to control the amount of excess of gold during compaction to avoid the need for such a coarse abrasive. As finishing progresses, the sequence is to reduce the abrasiveness of the strips. Go from medium to fine, then to extra-fine, and finally to the partly worn-out extra-fine strip that was used at first. If a class 3 foil extends further on to the lingual surface than usual, a small mounted stone may be required to develop the desired lingual contour. Occasionally a ¾-inch disc may be needed, but usually there is not much use for discs on class 3s, unless they are of the lingual approach design.

After the foil is brought to the best possible finish with the strip or disc and instruments, the final finish is developed. While some operators use a wet slurry of abrasive or polish when finishing a class 5 so as to minimize the danger of thermal irritation to the pulp, the slurry tends to obstruct the vision of the operator. This permits the rubber cup to go beyond the gingival margin on to the cementum, and the cementum is ditched. It is safer to use the polishing powder dry and keep cool air on the field rather than to use a paste or slurry. While rougher finishing can be done with a coarse abrasive such as flour pumice, a nicer preliminary surface is produced by lap emery, which is designed as No 303 lap emery by the manufacturer. Some use a fine silex powder, but it can cut tooth structure readily.

The next step in the finishing procedure is the final polishing. One highly satisfactory product for this is the White Polishing Compound No 309, which is used by optical glass laboratories; alternatives are tin oxide or one of the proprietary high-gloss polishing materials. Some time ago the department of dental materials of one of the dental schools conducted
tests and compared the results obtained with tin oxide, one of the proprietary agents, and the No 309. The finest polish, with the least effort, was that obtained with the No 309. A powder named Tru-Polish, manufactured by the Dentists Supply Company, also creates an excellent surface. However, it is slightly more abrasive, so it is apt to ditch tooth structure unless very carefully controlled. Class 5s in the maxillary arch or those that may be visible when the patient smiles or talks are usually not carried beyond the stage of the satin finish produced by lap emery. The mandibular teeth or those that are not conspicuous are given the high gloss.

For class 3s, the finish generally advocated is that produced by a worn-out extra-fine cuttle strip. This is the reason for saving the strip that was used first in passing the contact. The long strip is carried over and over the surface and the scratches from the coarser strips are eliminated. Be sure to hold the strip at the same end always, or nip off the final inch of the strip. Otherwise, if it is picked up end for end you can be polishing with the first 17 inches of the 18-inch strip and scratching with the unused final inch, negating the polishing effect. Unfortunately, it has become almost impossible to secure the former "extra-fine" grit on strips, in spite of the packages being so labeled. Manufacturers at present tend to turn a deaf ear to requests for some high quality products. Therefore it is necessary to dull one of the so-called extra-fine strips by running it across the roughened surface such as the handle of an instrument before performing the final stripping. The satin finish obtained with the worn-out strip minimizes the reflection of light from the gold. Some operators like to bring the lingual to a higher polish, although the shine will not last very long. For a clinic or display, however, the high shine is appropriate.

The finishing of class 2s is perhaps the most difficult step in that class of foil restoration. The "after-condensation" of the noncohesive foil in the approximal portion is highly important. For a class 2 involving the distal surface, a back-action, noncohesive foil condenser is required; for a mesial surface, the finely serrated goose-neck condensers with the long thin nibs are used. They will reach into the interproximal space and complete the compaction of the noncohesive foil. Then the burnisher is used.

The occlusal of class 2s is usually dressed down first. The separator is not placed yet. The excess is removed with a suitable 12-bladed carbide bur or a plain-cut straight fissure bur. Care must be taken to not cut into the occlusal tooth structure. If the bur is applied so part of its head lies on the occlusal surface, it is easier to restore the occlusal anatomy in the gold. The straight fissure bur does an excellent job of reforming cusp ridges, central grooves, developmental grooves, and spallways. The anatomical form can be further refined with a sharpened cleoid. After the occlusal anatomy is developed, the buccal, occlusal, and lingual embrasures are established with a disc, followed by the use of gold knife and files. When preliminary work on the approximal surface is completed, a separator is placed and stabilized with modeling compound. Next a strip of matrix steel is worked through the contact area, followed by a fine linen abrasive strip, and then a coarser strip to finish the contouring of the approximal surface. The surface finish is refined and completed with progressively finer strips. Finally, the separator is removed and the polishing is accomplished with the No 303 and No 309 powders.

After the finishing and polishing are completed, all remaining debris must be removed. Particularly in class 5s, the cuttings from the files tend to be pushed under the cupped rubber dam. They can work their way into the gingival sulcus and the soft tissues, become lodged there, and be almost impossible to remove. So a required step after the retractor or separator, and dam, are removed is to irrigate the tissues and massage them gently. A transilluminating light and some air are helpful to be sure that the gingival sulcus is clear of all polish and debris. It takes only a few seconds, but lessens postoperative pain, reduces the danger of leaving extraneous material in the sulcus, and of gold filings being embedded permanently in the soft tissues. Next it is advisable to apply a soothing antiseptic to the operated area, because it is probable that some degree of trauma has occurred.

Finally it is highly desirable to instruct the patient. Inform him that after the anesthesia wears off there will probably be some degree of reaction to thermal change for a brief period and that, in the case of class 5 restorations, the retracted gingival tissues may be tender for a few days. If the patient knows this beforehand
he is not alarmed if such reactions do occur. He should be advised to divert foods or liquids that are extremely hot or cold away from the new restoration for a little while. Sometimes class 5s are quite comfortable for a week or two and then may become sensitive for a period of time. Operators and patients alike should be aware of this possibility. Usually the temporary sensitivity to thermal change will fade away very soon. However, when you warn patients that such a reaction may occur, you should also advise them that if the tenderness should increase, they must let you know promptly so steps can be taken to protect the pulp with a periodontal pack, or varnish, or other suitable means.

If the cavity was of proper depth, neither too shallow nor too deep, and if the compacting force was not excessive, and if retraction or separation was performed with due care, and if finishing was atraumatic — that is, with a constant air coolant while discing, stripping, or polishing — rarely are the teeth uncomfortable. In a class 5 the application of cavity varnish to the axial wall before placement of the gold is an additional help; it does not seem to be necessary in class 3s.

The patient should also be instructed in the correct care of the tooth and the new restoration. The goal of the operator should be that when he removes the retractor or separator, and the dam, only an impression or indentation from the pressure of the retractor or separator should be evident. There should be no tearing or bruising of the gingivae. The patient should be guided to relieve any tenderness by irrigating the site with warm saline mouthwash or one of the proprietary mouthwashes comfortably warmed, two or three times a day. In class 5s he should be cautioned not to brush too vigorously for the first few days. With a class 2 restoration, occlusion should be checked. This will be necessary also in class 3 restorations that extend to functioning areas on the lingual surface.

Conclusion

In summary — aside from a correct cavity preparation in a moisture-free field — fabricating a lifetime restoration of gold foil demands the following:

- Balanced, skilled teamwork by the operator and the assistant
- An adequate assortment of sizes and forms of foil, correctly annealed
- Unwavering attention to compaction of the foil in respect to line of force, amount of force, and compaction pattern
- Building the gold to seal the cavity walls and cover the cavosurface margin; dressing the restoration to correct contour, restoring function, and completing the finishing and polishing procedures
- Consideration for the health of the dental and supporting tissues
- Instruction to the patient

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**Essentials**

**ANNEALING GOLD FOIL**

“In more recent years, I have gotten to use more gold foil than I did perhaps ten years ago, because of the failure of the silicates I put in myself and the failure of the silicates put in by the hands of others. . . . I am getting back to gold foil, and I think more men, as time goes on, will be glad to get back to gold foil, which has stood the grueling test of many years of time.”

*DR. WILLIAM DWIGHT TRACY*

MORGAN, HASTINGS & COMPANY
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Annealing

In making a restoration with cohesive Gold Foil, annealing is really the initial step. As an operation, it is simplicity itself; but its consequences are basic and far-reaching. If it has been done improperly, even a restoration that is apparently successful will ultimately fail — according to the failure of the annealing.

Why ANNEAL Gold Foil?

The annealing of Gold Foil is not a process to alter its molecular state. Gold Foil, when absolutely pure, is cohesive inherently - is inherently capable of uniting throughout the mass. Its laminae will stick together on mere contact. It is this unique property that makes it possible to weld it in the cold state.

But its purity is impaired easily, so that it either is no longer capable of cohering or can cohere only imperfectly, making it impossible to weld it successfully in the human mouth. Even mere exposure to the air may so contaminate its surface as to destroy its cohesiveness, and hence weldability, altogether. Gold Foil must therefore be expressly protected and, just before use, have its surface thoroughly cleansed. It is for the purpose of the latter — to drive off all volatile impurities — that Gold Foil is subjected to annealing. And its annealing is thus simply and wholly a cleansing operation.

What CONTAMINATES Gold Foil?

Gold Foil may so easily be contaminated on mere exposure to the air because the atmosphere almost always contains gases that are attracted to its surface. They attach themselves by molecular attraction, depositing a film of salts that coat its surface and
render it incapable of cohering. Some of these adhesive gases, being volatile, can be driven off by heat. They are the neutral and the alkaline gases, such as carbonic-acid gas and ammoniacal gas. Annealing drives them off completely, rendering the surface chemically clean again and restoring the inherent cohesiveness. Others, however — the acid gases, such as the sulphurous and the phosphorous group — cannot be volatilized by heat. Their salts are fixed, and consequently remain condensed upon the surface, rendering Gold Foil irretrievably incohesive.

Of the gases that are deleterious irretrievably, those of common occurrence in the dental office are sulphuric-acid gas, phosphoric-acid gas, and sulphureted-hydrogen gas. Sulphuric-acid gas is given off by the sulphur of ignited matches, and is constantly exhaled by all rubber goods. A prolific source of this gas is that of the trimming and finishing of rubber dentures, vulcanizing, and the various other dental operations using rubber. And in towns and cities where sulphurous coal is burned or paper is manufactured, it is extensively present in the general atmosphere.

Phosphoric-acid gas too is given off by ignited matches, either by the phosphorus in the tips or, in the case of "safety matches," by the phosphorus-treated surface on which they are struck. It is thrown off also by the spontaneous combustion of sulphureted-hydrogen gas, which is a product of the decomposition of animal or vegetable matter. Sulphureted-hydrogen gas is another product of such decomposition. It is very common in the general atmosphere.

Still other airborne contaminators, even of more common occurrence, are those of dust and moisture. Lastly, Gold Foil may be contaminated also by any solid or liquid that can impart to its surface an adhesive impurity on contact. Mercury, in particular, is to be guarded against. So is also moisture from the skin of the hands. So, while the restoration is being made, is also saliva.

How TO PROTECT Gold Foil

The protection of Gold Foil from contaminative solids and liquids is obviously an ordinary affair. Likewise the neutral and the alkaline gases present no special problem — inasmuch as annealing drives them off completely. But with the gases that are deleterious irretrievably, the case is quite different. Destroying as they do the cohesiveness of Gold Foil so that it cannot be restored even by annealing, they must be prevented from settling on its surface at all. And with their occurrence in the dental office so common, that isn't likely to be successful with anything like ordinary precautions.

An express and thoroughly efficacious way of protecting Gold Foil from contamination by such gases is that of coating it, as a preventive, with a film of alkaline salts. This protective film, usually of ammonia, prevents deleterious gases from condensing directly on the Foil. Instead, these gases combine with ammonia, as an alkaline base, to form other salts, and they are neutralized by it when it is present in excess. They are then driven off by annealing as easily as any neutral or alkaline gas.

Such protection is generally effected by the simple means of keeping with Gold Foil, as in a drawer,*

*It is best for the Gold Foil in the drawer not to be loose. It should be kept, either in the original container or in a satisfactory substitute, tightly corked. And it is inadvisable to keep with it, in the same drawer, such articles as vulcanite, rubber dams, etc.

a small bottle of ammonia loosely corked. Equally satisfactory is a small sponge, or
a cotton roll, saturated with spirits of ammonia and, to avoid staining, kept in an open small bottle.
When the operator prepares forms of his own — pellets, ropes, etc. — and the Foil is handled with the fingers, it is advisable always to wear chamois finger-tips. This will provide complete protection from moisture on the skin.

AIM and METHODS of ANNEALING

From the foregoing, it is plain that the annealing of Gold Foil presupposes its express protection, and that the general aim of annealing is to drive off its surface all atmospheric moisture and whatever film has been formed by the protective alkaline gas in combination with gases that may have settled afterward.

PROPER ANNEALING is then a matter of heating Gold Foil long enough, at a given temperature, to volatilize all moisture and gases, of cleansing all its surface, of avoiding injury to the Foil in the process, and of guarding it against all contamination, from the start of its annealing to its condensation in the cavity.
UNDERANNEALING is to be avoided. It leaves impurities on the Foil, which prevent its thorough condensation, and thus cause the restoration, eventually, to pit and flake. OVERANNEALING is to be avoided no less. It scorches the Foil, shriveling the fine edges, and rendering it generally harsh and unworkable — with the same harmful consequences as those of underannealing. It can be the cause of some of the difficulty encountered, especially by beginners, in seating the first third of a Gold Foil restoration. And scorched Foil will not burnish properly. As to CONTAMINATION of Gold Foil during or after annealing, it may be as harmful, obviously, as contamination before annealing.

Gold Foil can be annealed, in general, by either of two methods: (1) piece by piece, in an open flame; or (2) in bulk, on a tray or some other suitable receptacle. Each has its advantages and disadvantages, and either is capable of giving satisfactory results. To ascertain current annealing practices, Morgan, Hastings & Co. recently sent out a questionnaire to dentists in various parts of the country. The answers received were divided between the two methods about evenly: those from dentists who annealed piece by piece totaled 247, while those from dentists who annealed in bulk totaled 234. Many an operator quite naturally believed his favorite method to be superior; and there were in each group about an equal number of those who reported having had satisfactory results for as long as 20 years. On the other hand, there were in each group also those who had tried the alternative method and found it less satisfactory. Then again, there were some who, according to circumstances, now used one, then the other, with equally good results. And so it seems reasonable to conclude that either method is sufficiently satisfactory in itself and that success depends entirely on its being employed with understanding and care. The choice is thus a question simply of the operator's personal predilection. He would evidently do well to adopt the one that is more to his liking.

The two methods of annealing are described in what follows — which also further summarizes the findings of the aforementioned questionnaire.

ANNEALING PIECE by PIECE

The method of annealing piece by piece consists in picking up each piece of Gold Foil, of whatever form, individually, heating it directly in an open flame, and placing it in the cavity.

The instrument best adapted for carrying the Foil is one with a fine, smooth point. Pliers, even with the smallest beaks, are less practical. The part of the Foil that is covered by the beaks is annealed less thoroughly than the part that is exposed to the flame fully, necessitating a second annealing, for which the position of the grasp must be changed so as to expose fully the part insufficiently annealed the first time. Not only does this take longer; it increases the hazard that a portion of the Foil may be overannealed.

The instruments used for the purpose are ingeniously various. Particularly excellent is one devised by Dr. Charles E. Woodbury. Its nichrome point is easily kept sharp and smooth; in contrast to that of steel, which soon becomes carbonized and rough. It is better also than one of gold or platinum, which tends to dull easily, and to stick to the heated Foil. An instrument of Dr. Woodbury's specifications can be made by the operator simply by sharpening and smoothening one end of a piece of 16-gauge nichrome wire, bending it like an explorer, and setting the other end into a broach-holder.

A similar instrument in common use is made by flattening and sharpening an old stainless-steel explorer to a spear-like point. Or, with a Joe Dandy disk, the flattened explorer is made into a tiny fork. Some employ, set into a broach-holder, an old broach with its barbs clipped off, or a piece of iridio-platinum wire with one end sharpened. The
latter is usually bent like an explorer. Other operators, mostly those working without an assistant, pick up the Foil on the point of the condenser.*

* The term "condenser" is here adopted in place of "plugger" at the instance of Dr. James Mark Prime, as well as in recognition of its growing favor with members of Gold Foil study clubs generally. Its advocates argue that it describes the real purpose of the instrument more accurately than "plugger"; an opinion with which it is easy to go along.

Whatever the instrument, its point should be nonoxidizing, and it should pick up the Foil so as neither to crush it nor to cover any portion of it. And it should obviously be cleaned just before use. Simply scrub it with a stiff nail-brush dipped in alcohol, and then dry it thoroughly with a towel.

The fuel for the flame may be alcohol or gas (the latter may be natural or manufactured). Alcohol is widely preferred; gas is believed to be more intense, also more carbonizing. The alcohol, whether from wood or from grain, should be chemically pure. Denatured alcohol is seldom satisfactory; most denaturing agents yield an overplus of carbon and are contaminating. An increasingly popular brand of alcohol is that known as Methanol.

When the annealing is done with an alcohol lamp, the flame should be moderately strong, of a clear light-blue color, and free from soot. This requires not only that the alcohol be right, but that the lamp be thoroughly clean, and that the wick not be up too high. In lighting the lamp, the match is not to touch the wick, or else enough sulphur may stick to it to contaminate the Foil during annealing. Apply the flame of the match to the extreme edge of the wick. Or light a toothpick with the match, and then light the lamp with the toothpick. In any case, the charred part of the wick is to be trimmed off after each annealing. Some remove it by rubbing the wick with a towel. The Foil is passed through the flame at the tip of the inner cone — neither close to the wick nor through the upper portion of the outer cone. Either of the latter may contaminate it with carbon. It is passed through the flame - not held — at a rate that will bring every particle to a dull red. If kept in the flame till it shows a bright glow, it is liable to be overannealed before it can be withdrawn. Heating it to a dull red usually takes no longer than the count of two. The exact length of time depends on the size of the piece and on the intensity of the flame. Gauging it, is entirely a matter of feel, which comes with experience.

When annealing with a Bunsen gas burner, be sure to have a reducing flame, and turn it down to about an inch high. Pass the Foil through the middle of the flame, somewhat more quickly than through an alcohol flame.

Whatever the fuel, the hazard of open-flame heating is not so much that of underannealing as that of overannealing. One must always guard against it. If a piece comes out of the flame looking the least bit shriveled, it is doubtless scorched, and is best discarded.
Every annealed piece, in all open-flame annealing, is carried from the flame direct to the cavity. This has the important advantage of precluding all possible contamination of the Foil after annealing, whether by atmospheric moisture or gases or by substances that can contaminate it on contact. A common procedure is as follows. While malleting an annealed piece with one hand, the assistant picks up a fresh piece with the other. When the condensation of the former is finished, she then anneals the latter and carries it to the cavity. And so on till the restoration is completed. On reaching the cavity, the Foil should have cooled sufficiently not to cause any painful reaction. Its cooling can be hastened by waving it in the air for an instant.

Other operators have the assistant anneal a piece immediately after placing one in the cavity. While the latter is being malleted, the former, on the foil-carrier, is then cooling. According to the most recent reports, the method of annealing piece by piece is increasingly giving way to that with an electric annealer, described below.

ANNEALING in BULK

Annealing in bulk is done by spreading a number of pieces of Gold Foil, of whatever form, on a tray or some other suitable receptacle, heating them through the latter, and placing them in the cavity one by one.

Of the various receptacles in common use, mica, as a sheet or a disk, was formerly a standby. When used as a sheet, its size averages about four inches square, and it is held over the flame, of an alcohol lamp or a Bunsen burner, with ordinary cotton-pliers. About 10 pieces of Foil, spread out so that no two pieces touch each other, are laid out in the
central portion of the sheet; the flame, which is to be of a clear light-blue color, is turned on fairly strong; and the mica is then held over it, with-out quite touching it, until it (the mica) turns a dull red. The actual annealing time is about five or six seconds. The exact length of time varies, of course, with the intensity of the heat and with the size of the different pieces. The annealed Foil is removed to a clean, dry napkin or a clean piece of chamois skin, from which it is carried to the cavity piece by piece.
The mica should be sound and clean. Mica that has begun to check or flake is an unnecessary hazard. The condenser should be cleaned just before picking up the first piece. As previously suggested, simply scrub it with a stiff nail-brush dipped in alcohol, and then dry it thoroughly with a towel.
More operators, of those answering the aforementioned questionnaire, have reported difficulty with this mode of annealing than the total number of the operators who have found difficulty with each of the other procedures. The reasons are various. First of all, there is the hazard of simultaneous over-annealing and underannealing. Because the degree of heat reaching the different pieces is not uniform, those farthest from the hottest point of the flame may remain insufficiently heated even though those directly over it are already overheated. To minimize this troublesome variation, some operators, instead of holding the mica in one position, pass it, slowly, over the flame to and fro, distributing the heat more evenly throughout the surface.
There is another disadvantage, after annealing. It is rather difficult to remove the Foil to the napkin or the chamois skin without some of the pieces sticking together.
Still another disadvantage, also after annealing, concerns the possible contamination of the Foil while lying on the napkin or the chamois skin, waiting to be placed in the cavity. Even when it is hot, it may be contaminated by dust or acid gases; while as soon as it has cooled, it may be contaminated also by moisture or volatile gases.
When the weather is humid, atmospheric moisture should be guarded against especially. And while the Foil is thus exposed, it is best not to light a match. Also, if there is any odor of smoke coming in from the outside, it is well to close the windows, shutting out the contaminative sulphides that abound in the smoke of coal or oil.

MICA ANNEALING TRAY: Mica is used also to form what is known as a mica annealing tray. The latter consists of a metal stand designed to be mounted on an alcohol lamp or a Bunsen burner and of a disk of mica that fits as its top. The underside of the mica comes to within an inch or so of the flame.
As many as 20 pieces of Gold Foil, spread out so that no two pieces touch each other, may be placed on the tray at a time. The flame is turned on a bit stronger than under a plain sheet of mica, and the Foil is heated till the mica begins to show a tinge of red. The average annealing time is about five minutes. The flame is then turned down a little and left on till the Foil is used up. The annealed Foil is carried from the tray direct to the cavity, with the pieces in the center of the tray picked up first and the outer ones last. Additional batches are annealed in the same way, with care being taken to limit the final batch to the estimated number of pieces still required to complete the restoration.
The mica tray has obvious advantages over the sheet of mica held with pliers. For one thing, it allows more pieces to be annealed at a time. Secondly, its slower heating tends to reduce variations in the degree of heat reaching the different pieces, thus reducing the hazard of simultaneous overannealing and underannealing. Furthermore, carrying the annealed Foil from the tray direct to the cavity — without first removing it, in a mass, elsewhere — excludes the handling that could cause some pieces to stick together. And keeping the Foil warm till it is used up, safeguards it against moisture and volatile gases. Acid gases, however, are still a danger. So is of course also dust.
The care with respect to the cleanliness of the mica and the condenser should obviously be exercised here too.

There are also other annealing devices for mounting on an alcohol lamp or a Bunsen burner. Instead of a mica tray, they have a tray of PORCELAIN, ENAMELED METAL, or SOAP-STONE. The procedure is the same as that with the mica tray in all respects but one. Being less conductive of heat, these trays require, variously, both a stronger flame and longer heating. The annealing time ranges from 10 to 20 minutes, when the flame is turned down so as merely to keep the Foil warm.

ELECTRIC ANNEALER: Still another and the latest means of annealing in bulk is that of an electrical device designed expressly for the purpose. Electric annealers vary, but they all have in common, principally, an outer metal shell housing a heating element, a tray over the latter to hold the Gold Foil, and a lid that fits over the tray. They all operate directly from an ordinary electric outlet.

As many pieces of Gold Foil may be placed on the tray as it will hold loosely — without any two pieces touching each other. To prevent their sliding and sticking together, the tray of a recent electric annealer provides individual compartments for each piece of Foil.
The current is turned on after the Foil is in place, and, with the lid off, is left on till the Foil turns a dull red or begins to adhere to the clean condenser on mere contact. The actual annealing time is, variously, from 10 to 20 minutes, depending on the maximum degree of heat the particular make of annealer is capable of generating and on the time required to attain it. One, for example, capable of attaining a maximum temperature of 650 degrees centigrade in six minutes, will drive off all moisture and volatile gases, even of the larger pieces, in about 10 minutes. The annealed Foil is carried from the tray, piece by piece, direct to the cavity.

As with the other means of annealing in bulk, it is advisable to keep the annealed Foil warm till it is used up. Some electric annealers have for the purpose a rheostat, which permits the current to be regulated downward. But even one that has no rheostat, provided that its maximum temperature does not exceed 700 degrees centigrade, may be left on — in full — without any hazard of overannealing. In the latter case, however, it is necessary that the current be turned off altogether in ample time for the tray to cool before annealing the next batch. Laying out Foil on a tray that is hot, is extremely difficult. Regardless of a rheostat, an excellent way of using up a batch of annealed Foil is to start at one end of the annealer and pick up each piece in a regular order, until there remains only about a quarter of the batch. Then lay out a new batch and again turn the current on in full. While the remainder of the annealed Foil is being condensed in the cavity, the fresh Foil is thus getting annealed.

Annealed Foil that remains after the restoration is completed, is left on the annealer for the next restoration. Such Foil cannot be returned to its usual container, because it would stick together beyond separation. Reannealing does it no harm. But there is of course the hazard of its being contaminated by gases that are deleterious irretrievably. Since the only protection from them, even though not altogether unfailing, is that afforded by the lid that fits over the tray, it is important to replace it, tightly, as soon as the annealer is not in use. And if the tray has no individual compartments for each piece of Foil, there is the further hazard that even a slight jarring of the annealer may cause some pieces to slide and stick together.

Of all the means of annealing in bulk, the electric annealer is far and away the best; and, in consequence, is steadily gaining in favor. It is the simplest, the neatest, and by far the most convenient. Because its heat can be controlled more accurately, there is no hazard of underannealing. For this reason and particularly because its heat is less intense, there is also no hazard of overannealing. For both these reasons and particularly because its heat is uniform throughout, there is likewise no hazard of simultaneous overannealing and underannealing.

However, not even the electric annealer is wholly free from the disadvantages common to the other means of annealing in bulk. Some are inseparable from heating a number of pieces at a time, and then using them piece by piece, and so are inherent in the method itself.

For one thing, there is the hazard of contamination after annealing, while the Foil is on the tray, waiting to be used. As has already been noted, it may be contaminated even when hot — by dust or acid gases.

Secondly, there is the difficulty of estimating in advance the exact quantity of Gold Foil that will be required to make a given restoration. In the words of a leading operator: "It is difficult, if not impossible, to predetermine the exact quantity of gold, in the various sizes, that will be required for a given operation. If the quantity annealed at first is insufficient, there is a decided likelihood, since both my assistant and myself are but human, of our yielding to the urge of getting the restoration completed and the patient dismissed, and so of failing to heat some of the additional pellets long enough to anneal
them fully. This may sound like a confession, but I believe that an investigation of this point would disclose that we should be running only true to form."

On the other hand, if the quantity annealed is more than what is actually needed, there is the disadvantage of having to leave the unused part on the tray, protected from airborne contaminants only by its lid. While far less of a hazard than with any other means of annealing in bulk, this is obviously some disadvantage still.

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is the symbol of a century-old firm devoted to making one thing only—Filling Golds. Since 1820, to five generations of dentists, it has been more than a trade-mark. It is a faith-mark and a guide-mark. Dentists believe in it, and look for it when buying Filling Golds, because it identifies the finest products of their kind — world-famous, and the best that sound standards, pride in quality, and over a century of experience can produce.

Scanned and edited by Dr. John R. Sechena
MATERIAL SOURCE INDEX

INSTRUMENTS (cutting and condensing)

Have to find used instruments until can find manufacturer.

DISCS (pin holes or brass center and Tucker mini discs)

E.C. MOORE CO.
Dearborn, Michigan  48126
U.S.A.
Phone:  1-800-331-3548

POLISHING POWDERS (aluminum oxide WCA 15 micron, WCA 1 micron)

MICRO ABRASIVES CORP.
P.O. Box 669
720 Southampton Road
Westfield, Massachusetts  01086
U.S.A.
Phone:  1-413-562-3641

MALLETS

Dr. Wendell Foltz
Phone: Home  1-503-472-1143
Email:  foltz@onlinemac.com

BOXES

Dr. Scott Barrett
1500 Shermer Rd.
202 W
Northbrook, Illinois  60062
U.S.A.
Phone: Office  1-847-480-0310
Email:  dr@bdental.net

GOLD E-Z GOLD

Dr. Clyde Roggenkamp
Lloyd Baum Dental Center
11339 Campus Street
Loma Linda, California  92354
U.S.A.
Email:  croggenkamp@msn.com

GOLD FOIL

Jensen Dental
50 Stillman Road
North Haven, Connecticut  06473
U.S.A.
Kevin Mahan
Phone:  1-800-243-2000
Fax:  1-203-239-7630
Email:  kim@jensendental.com
ACKNOWLEDGEMENTS

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DWT