CHAPTER 7

POST HOLE PREPARATION

7.1 Introduction
7.2 Possible complications associated with the use of posts in endodontically-treated teeth
7.3 Root canal filling
7.4 Timing of post hole preparation
7.5 The length and diameter of the post
7.6 Methods of post hole preparation
7.7 Precautions

7.1 Introduction

The indications for the use of root canal posts for the restoration of anterior (5.3.2) and posterior (5.3.3) pulpless teeth have been discussed. When there is substantial loss of coronal tooth structure in the endodontically-treated tooth, a post-retained core foundation is commonly used to provide support for the coronal restoration. Therefore, during the obturation of the root canal system, allowance should be made for the accommodation of the post in the root canal.

The preparation of the root canal for insertion of a post is a precise procedure and should be approached with care. Any complications at this stage may result in a difficult restorative problem which may seriously jeopardize the prognosis of the pulpless tooth. The procedure essentially involves the removal of a coronal portion of the root canal filling to a pre-determined level, and the subsequent internal shaping of the root canal to the same level, so that a post-core foundation can be constructed according to sound bio-mechanical principles.

7.2 Possible complications associated with the use of posts in endodontically-treated teeth

Several complications may arise from the preparation of the root canal and the use of posts in endodontically-treated teeth.

Root perforation

This is a complication more commonly encountered in the preparation of the post hole with motor-driven rotary instruments. It usually occurs because of a failure to determine the proper inclination of the tooth (Rosenberg and Antonoff, 1971) or gross over-instrumentation of the root canal (Fig. 7.1).

Root fracture

This may be the result of overzealous removal of root structure, poor post design, excessive pressure during post insertion (Wechsler et al, 1978) or overcontouring of the post-core foundation and coronal restoration, with resultant occlusal overloading (Henry and Bower, 1977, a). (Fig. 7.2).

Post-core dislodgement

Lack of retention of the post-core foundation may be attributed to factors such as poor choice of post design, inadequate post length (Fig. 7.3), failure to retain sound coronal tooth structure, poor fit of post and faulty cementation technique.

Disturbance of the apical seal

The loss of apical seal is a major cause of endodontic failures (Schnell, 1978). This may occur during post hole preparation in a tooth with an inadequately condensed root filling, or from over-instrumentation in the apical portion of the obturated canal (Fig. 7.4 and 7.5).

7.3 Root canal filling

Gutta percha in combination with a root canal cement is generally accepted as the material of choice for the obturation of root canals, particularly for teeth that are to be restored with a post-core foundation (Luks, 1965; Rosenberg and Antonoff, 1971; Frank et al, 1976, p.779; Henry and Bower, 1977,a). Silver cone root fillings inserted by a "sectional-core" technique have also been considered acceptable (Yuodelis and Morrison, 1966; Kayser, 1969; Kantorowicz, 1970, p.93; Weine et al, 1973; Kafalias, 1975; Harper and Lund, 1976; Herschman et al, 1976, p.446;

Caruso et al, 1978, p.491-492) provided that sufficient space existed following root canal obturation for the insertion of a post of adequate length. The use of pastes alone for root canal obturation has been considered by many authors (Ingle, 1976, p.223-232; Nguyen, 1976, p.164-165; Weine, 1976, p.257-258) to be unreliable and is not recommended.

Neagley (1969) conducted an *in vitro* study on the possible effects of post hole preparation on the apical seal of endodontically-treated teeth. The use of rotary instruments to remove part of the silver point during post hole preparation invariably caused disturbance in the critical apical region and resulted in leakage. To protect the apical seal, he emphasized that the silver cone must remain undisturbed during the post hole preparation. The findings of a more recent study by Zmener (1980) supported Neagley's recommendation. Apart from the possibility of disturbing the apical seal, there is also a greater risk of lateral perforation because the harder silver root canal filling tends to divert the bur into the softer tooth structure (Yuodelis and Morrison, 1966). Unless there is sufficient space for the insertion of a post of adequate length without having to remove some of the silver root filling, attempts should be made to replace the silver point root filling with gutta percha (Rosenberg and Antonoff, 1971; Henry and Bower, 1977,a). If this is impractical or impossible, alternative methods of retaining the core foundation should be considered (for example, the use of pins).

Allowance should be made during endodontic treatment for the possibility that the tooth may require a post-core foundation at a later date. With prior planning, post hole preparation procedures may be simplified by using obturation techniques in which only the apical portion of the canal is filled, such as the sectional gutta percha method (Nguyen, 1976, p.160), the "Warm" gutta percha method introduced by Schilder (1967) or the thermatic condensation technique introduced by McSpadden (1979).

In addition to the unnecessary effort of filling the root canal completely and then reaming out the canal again during post hole preparation, the risk of dislodging the apical seal and/or perforating the root is largely eliminated (Harty and Leggett, 1972).

7.4 Timing of post hole preparation

It has been suggested that at least the initial preparation of the root canal for post insertion — that is, the removal of the gutta percha to the pre-determined level — should be carried out immediately after root canal obturation, at the same appointment, for several reasons.

1. At this time, the operator is still familiar with the root canal morphology of the particular tooth and the removal of the coronal portion of the root filling can be carried out with a much diminished possibility of lateral perforation (Baraban, 1967; Herschman et al, 1976, p.446; Colman, 1979).
2. The length of the root is well known at this stage and the instruments to be used for the post hole preparation can be conveniently calibrated using the same reference points, to correlate with the proposed post length (Herschman et al, 1976, p.445-446; Henry and Bower, 1977, b).
3. Proper isolation is already present from the preceding endodontic procedures.
4. Following the removal of the coronal portion of the root filling, the remainder of the gutta percha may be condensed further apically with vertical pressure. This vertical condensation, deep in the apical region of the canal tends to compress and spread the gutta percha and root canal sealer into the irregularities of the canal walls, thereby improving the chance of filling patent accessory canals and multiple foramina (Nguyen, 1976, p.158). This procedure also reduces the thickness of the root canal sealer, providing a more dense apical seal (Fig. 7.6).

5. If the apical root filling is accidentally disturbed at this time, it can be readily re-condensed while the tooth is still properly isolated.

Because some root canal cements require up to three or four days to achieve a permanent set (Heuer, 1976, p.361), Harper and Lund (1976) considered that there was a risk of dislodging the freshly inserted root filling if post hole preparation was carried out immediately after canal obturation. They suggested that the preparation be delayed until after this time. However, this is one of the main advantages of preparing the post hole immediately following root filling. Should the apical seal be disturbed during post hole preparation several days later, after the permanent set of the root canal cement, the entire root filling must then be removed and the whole obturation procedure repeated. If this occurs before the setting of the root canal cement, an effective apical seal can usually be obtained simply by re-condensing the gutta percha root filling apically with a root canal plugger.

The effect of post hole preparation immediately after root canal obturation was investigated in several laboratory studies. Using heated endodontic pluggers for the removal of the gutta percha, Schnell (1978) found that immediate preparation of the post hole had no effect on the apical seal. Zmener(1980,b)used the Gates-Glidden and the Elargisseur reamers for the post hole preparation, and reported no significant difference between the leakage of specimens with post hole preparation performed five minutes, and 48 hours, after root canal obturation, and the control specimens with no post hole preparation at all. Bourgeois and Lemon (1981) compared the leakage of specimens with post hole prepared by heated endodontic pluggers, either immediately or one week after obturation of the root canal. Although no significant difference was evident, their findings appeared to favour the immediate preparation of the post hole.

On rare occasions, the presence of accessory canals coronal to the desired level of post hole preparation deserves special consideration (Fig. 7.7). These accessory canals, when present, are usually only filled with root canal cement during root filling procedures. In these cases, it may be advisable to remove only the gutta percha coronal to the accessory canal immediately after root filling. Post hole preparation to the desired level may be completed several days later to allow the cement in the accessory canal to achieve a permanent set.

On the evidence available, therefore, it is recommended that, whenever possible, post hole preparation should be carried out immediately after root filling, followed by the routine re-condensation of the gutta percha apical seal.

7.5 The length and diameter of the post

Although many guidelines have been suggested for the length of the post, in order to achieve optimum stress distribution (5.4.12) and retention (5.4.22), it has been generally agreed that, clinically, the post should be made as long as possible consistent with the following requirements:

i. There is no danger of root perforation.

ii. The remaining root structure is not further weakened unnecessarily.

iii. An effective apical seal is maintained. It has been recommended that, under normal circumstances, at least 3-5 mm of apical root filling should be left undisturbed (Weine et al, 1973; Harper and Lund, 1976; Herschman et al, 1976, p.446; Nicholls, 1977, p.330). In exceptional cases, for example, teeth with very short roots, 2 to 3 mm of root filling may be sufficient (Kayser, 1969; Harper and Lund, 1976) in order to allow the use of a longer post. To date, research on apical leakage has only been performed on specimens with a minimum of 4 mm of root filling (Neagley, 1969; Zmener, 1980; Bourgeois and Lemon, 1981).

Whether a shorter root filling can seal the apical region of the root canal as effectively remains to be investigated.

iv. The length of the post, extending into the part of the root supported by bone, is at least equal in length to the clinical crown of the final restoration.

v. If there is curvature in the root canal, the post preparation should stop at the curve.

The clinician should only increase the diameter of the post sufficiently to achieve adequate internal adaptation for stress distribution and retention. Although increasing the diameter of the post beyond that required to produce intimate contact between the post and the dentine wall provides a slight gain in retention, the root is also further weakened unnecessarily. As Gilmore et al (1977, p.360) stated: "Perhaps the greatest limitation of length and size of the post preparation is the anatomy of the root, that is, its curvature and available tooth structure".

7.6 Methods of post hole preparation

As mentioned in 7.1, there are two basic steps in this procedure;

1. the removal of a coronal portion of the root canal filling to a pre-determined level, and
2. the shaping of the root canal walls to receive the post-core foundation.

The following discussion concerns the removal of a coronal portion of the root canal filling to a predetermined level in endodontically-treated teeth obturated with semi-solid materials such as gutta percha. The possible hazards of preparing a root canal obturated by a silver point were considered in 7.3. If a custom cast post is planned for a particular case, usually little shaping is required following the removal of the coronal root filling (Perel and Muroff, 1972). However, if a prefabricated post system is preferred, the root canal is generally

prepared with instruments provided in the post system selected. Some of these instruments actually remove the root filling and prepare the root canal walls simultaneously.

7.6.1 *The use of conventional motor-driven rotary instruments such as round, flat or tapered fissure burs in a low speed handpiece*

Because no special instruments are required, this method has been used for many years for preparing root-filled teeth for post-core foundations (Rosen, 1961; Barker, 1963; Nicholls, 1963; Gentile, 1965; Tylman, 1965, p.651-652; Kantorowicz, 1970, p.97; Sheets, 1970; Department of Operative Dentistry, University of Sydney, 1972, p.12; Scully, 1972; Gilmore and Lund, 1973, p.262; Hannah, 1973). In this technique the root filling material is initially removed to the desired level with the alternate use of round burs of two different sizes, for example, a No. 2 (1.0 mm diameter) and a No. 4 (1.4 mm diameter) round bur. The larger round bur is followed by a tapered or flat fissure bur to widen the canal and smooth the root canal walls.

Although the armamentarium required for this method is readily available, the inherent hazards of the use of these efficient rotary cutting instruments in intra-canal preparations have been the cause of concern for many clinicians (Gerstein and Burnell, 1964; Yuodelis and Morrison, 1966; Weine et al, 1973; Shillingburg et al, 1970; Harper and Lund, 1976; Herschman et al, 1976, p.446; Gutmann, 1977; Khan et al, 1977; Colman, 1979). Disadvantages of this method include:

a. the distinct risk of lateral perforation (Figs. 7.8 to 7.10)
b. rough undercutting of the post hole resulting in eventual poor adaptation of the post to the root canal wall
c. difficulty in controlling the length and diameter of the post resulting in lack of retention and further weakening of the root (Fig. 7.11).

7.6.2 *The use of standardized root canal reamers or files, with or without the aid of gutta percha solvents or chelating agents*

Endodontic reamers and files may be used to remove the gutta percha; more commonly, however, they are only used to shape the root canal after the gutta percha has already been heated out to the desired level (Gerstein and Burnell, 1964; Weine et al, 1973). Prefabricated precious metal and plastic posts with the standardized taper are available for use with canals prepared by the endodontic reamers or files. If the gutta percha root filling has been in place for a long period of time and is difficult to remove, solvents such as xylol or chloroform may be used to soften the gutta percha ahead of the instrument. This will also reduce the possibility of embedding the endodontic instrument in the root filling and dislodging it. However, if only a very short length of root filling is left in the canal because of inadequate root length, the resultant shrinkage of the gutta percha caused by the solvent may jeopardize the apical seal (Kronfeld, 1967, p.170-171). Herschman et al (1976, p.446) have suggested the use of chelating agents or root canal irrigants to aid in the preparation of the root canal walls.

7.6.3 *The use of root canal drills*

When a set of root canal drills is supplied with a post system, post hole preparation should begin with the smallest of the set and, once the desired depth for the post is reached, successively larger instruments may then be used to widen the root canal. There are basically two groups of root canal drills:

i. Non-end cutting — (Gates-Glidden reamers, Peeso reamers, Elargisseur root canal drills, Girdwood burs with safety tip). This group of root canal instruments share the same basic design principles. By combining side-cutting flutes with a blunt, non-cutting tip, the heat of rotation will soften the gutta percha ahead of it and allows for its penetration into the filled canal

with minimal apical pressure. If handled properly, these type of drills may be used for the simultaneous removal of the gutta percha and the shaping of the root canal with little danger of root perforation (Fig. 7.12).

ii. End-cutting — (Busch tapered fissure bur, Mooser bur, Dentatus reamers, Degussa Endo-Post drill, twist drills such as the Para-Post drill, Schenker drills and the Panadrills). This group of root canal instruments have end-cutting action and will readily cut apically as well as laterally. Care must be exercised during the use of these instruments to avoid any deviation from the root canal. Examples of some of these rotary instruments are illustrated in Chapters 10, 11 and 12.

7.6.4 *The use of a heated instrument such as an endodontic plugger or a lateral condenser*

This has been considered by many (Gerstein and Burnall, 1964; Yuodelis and Morrison, 1964; Weine et al, 1973; Federick and Serene, 1975; Harper and Lund, 1976; Herschman et al, 1976, p.446; Gutman, 1977; Henry and Bower,1977,b;Khan et al, 1977; Colman, 1979) to be the safest method of gutta percha removal. The technique involves the placement of a heated instrument (Fig. 7.13) into the gutta percha root filling to begin the post hole preparation. On removal, portion of the softened gutta percha will adhere to the instrument and this procedure is repeated until the desired level of post insertion is reached. The root canal is then shaped according to the post system selected; calibration of the root canal drills with a rubber stop will assist in preventing the contact of the motor-driven instrument with the remaining gutta percha apical seal (Fig. 7.14).

7.7 Precautions

In order to reduce the risk of complications during the post hole preparation procedures, several precautions have been suggested:

1. Prior to actual intra-canal preparation, careful examination of a periapical radiograph of the root filled tooth should be carried out to determine the dimensions of the root and the canal, the presence of any mesial or distal root curvature and accessory canals, the axial inclination of the tooth, and the adequacy of the root canal filling.
2. In teeth where most of the clinical crown is destroyed, it is advisable to probe subgingivally to help determine root inclination (Rosenberg and Antonoff, 1971). Isolation with rubber dam in such cases may not be advisable. The bony contours of the root covered by the rubber dam, may provide hints as to the long axis of the root.
3. During intra-canal preparation with rotary instruments it is important to ensure that it is gutta percha that is being removed at all times. A radiograph should be taken if obstruction is encountered during preparation to detect any deviation from the root canal.
4. A radiograph should be taken to check the integrity of the apical seal and the accuracy of fit of the post-core foundation before final cementation.

Fig. 7.1 The distal wall of the root canal was perforated during post hole preparation with round and fissure burs. Because of its relatively small size, the perforation was repaired with amalgam from within the root canal.

Fig. 7.2 Note the typical "halo" appearance of a longitudinal root fracture in the distal aspect of the lateral incisor. The root was grossly weakened due to the extent of root caries and the root fractured 3 years after endodontic treatment and restoration.

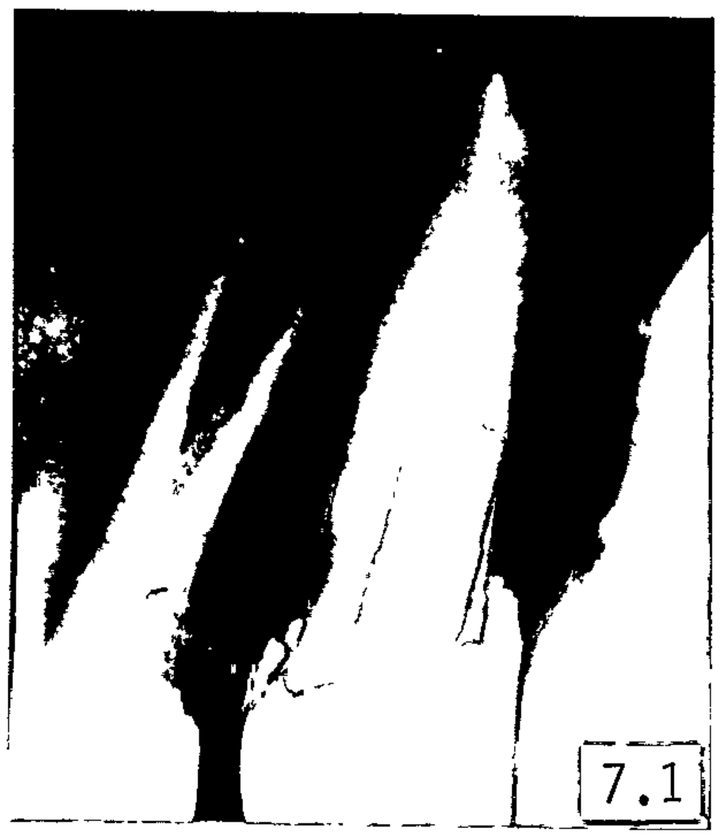
Fig. 7.3 a. Repeated attempts to restore this incisor with post-crowns of inadequate post length.

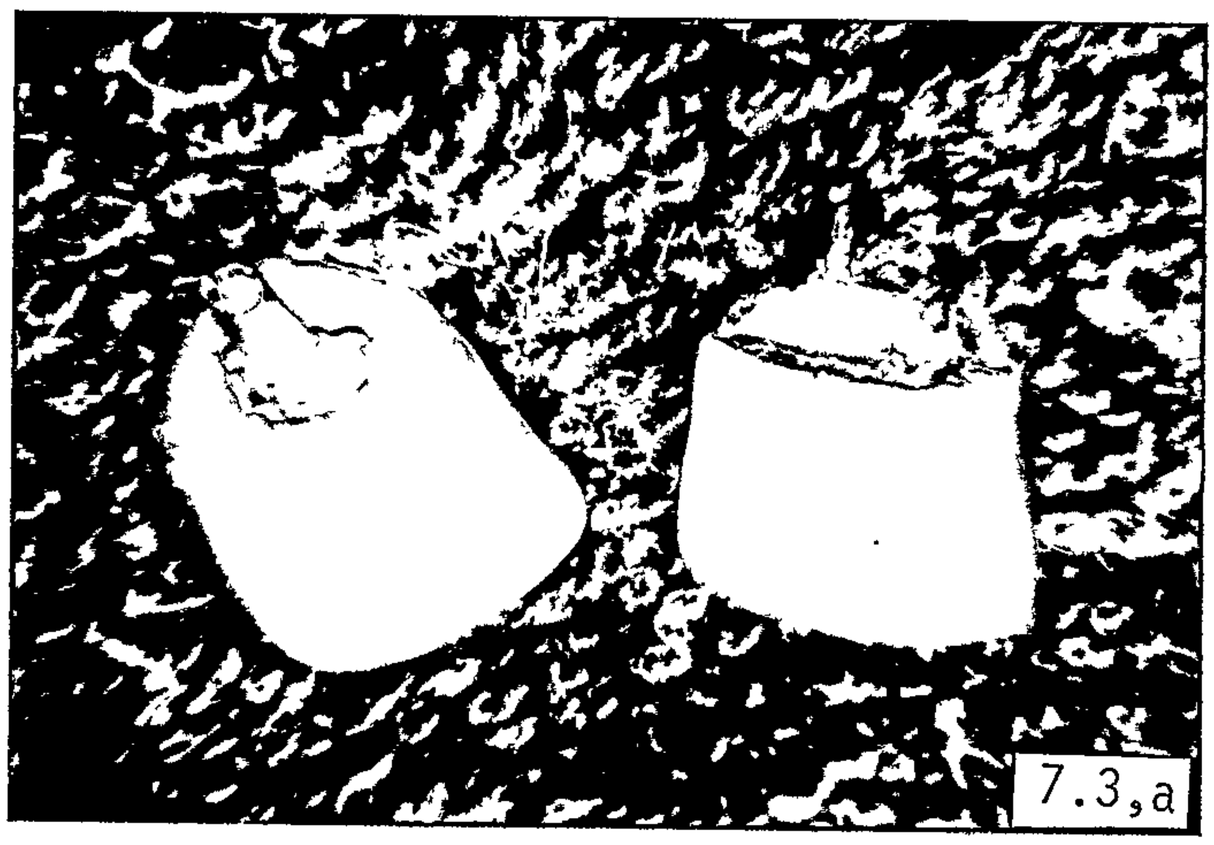
b. The same tooth 2 years after re-treatment of the root canal and placement of a cast gold post-core foundation and a ceramo-metal crown.

Fig. 7.4 The apical seal may have been disturbed in this case due to the excessively long post.

Fig. 7.5 To prevent this type of complication, a radiograph should be taken to check the apical seal before final cementation of the post-core foundation. Note that the space between the apical seal and the post in the central incisor should ideally have been filled with cement.

Fig. 7.1; 7.2; 7.3; 7.4; 7.5





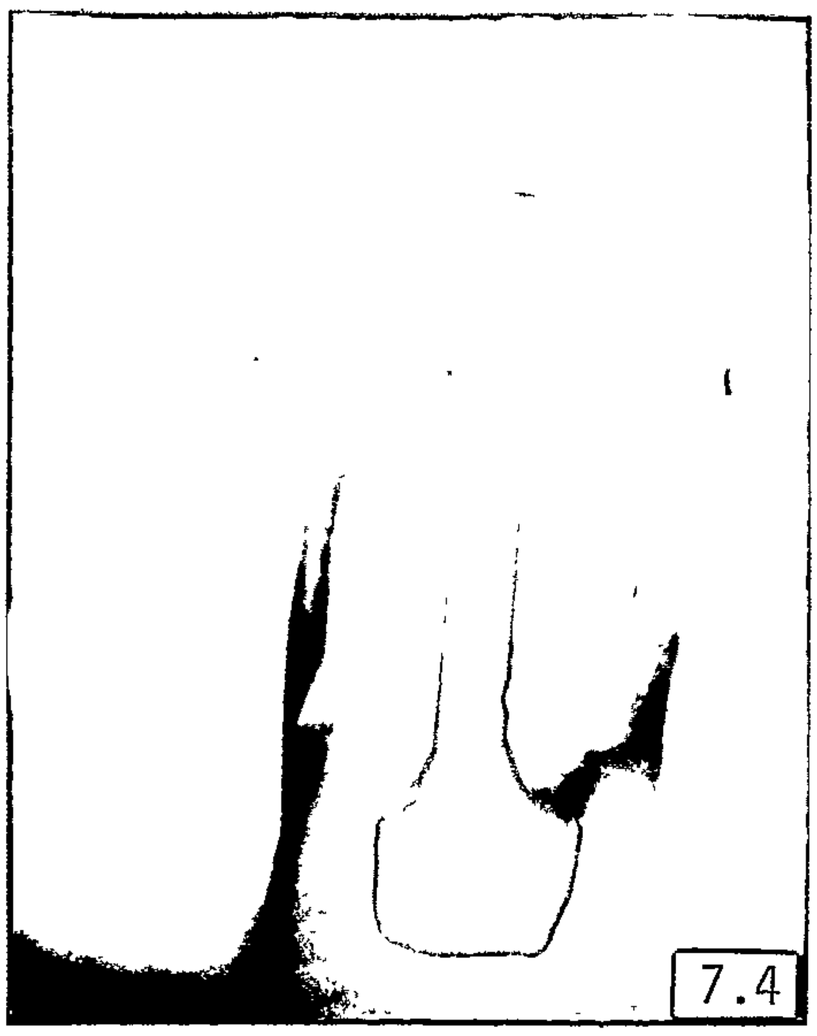


Fig. 7.6 a. Post space created immediately after obturation of the root canal.

b. The apical root filling is re-condensed before the setting of the root canal sealer, in order to provide a more dense apical seal (refer to 7.4).

Fig. 7.7 In the presence of accessory canals coronal to the desired level of post hole preparation, the procedure should be delayed for several days to allow the cement in the accessory canals to achieve a permanent set.

Fig. 7.8 and 7.9 Lateral perforations of the roots during post hole preparation with round and fissure burs.

Fig. 7.6; 7.7; 7.8; 7.9

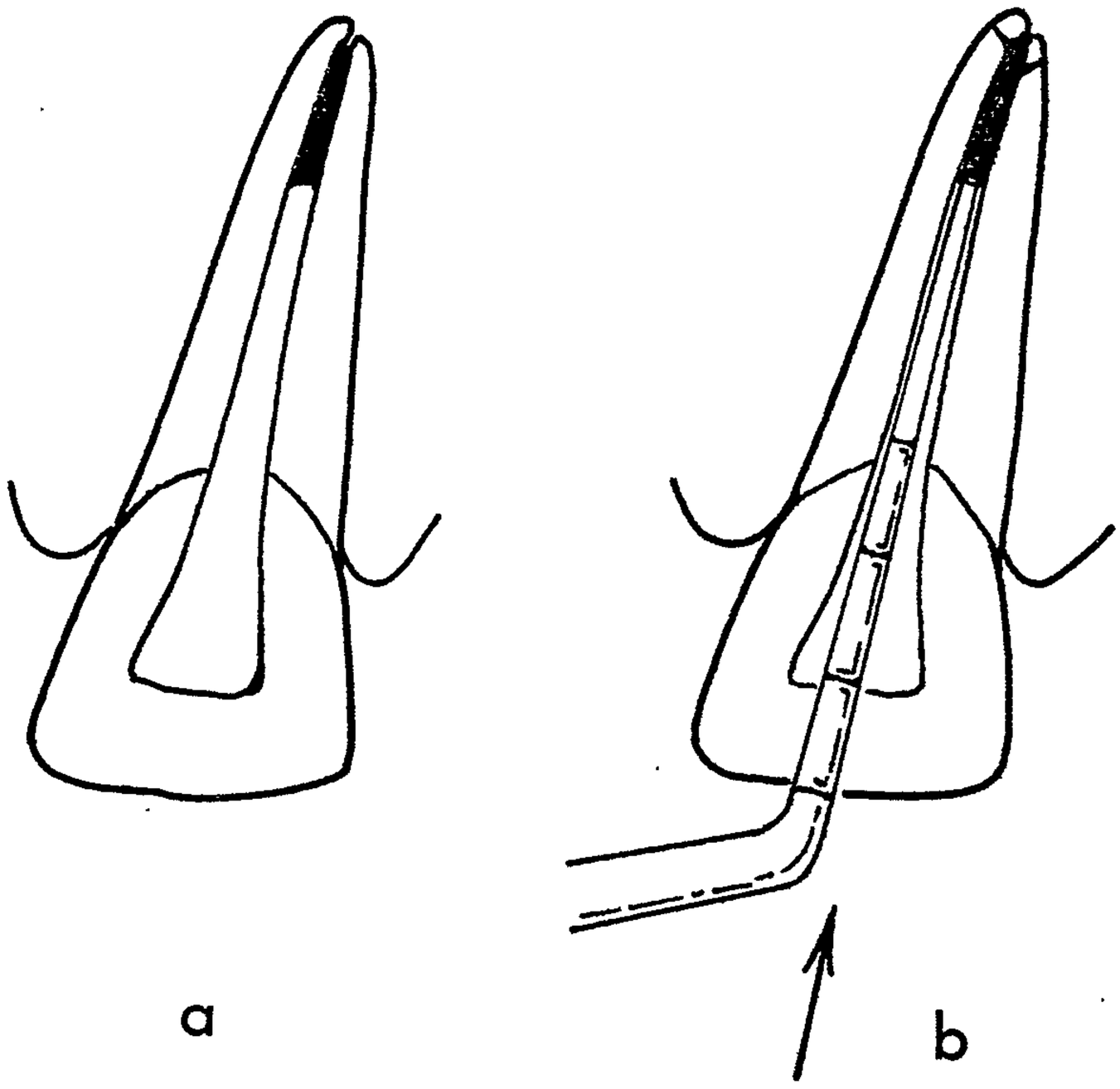
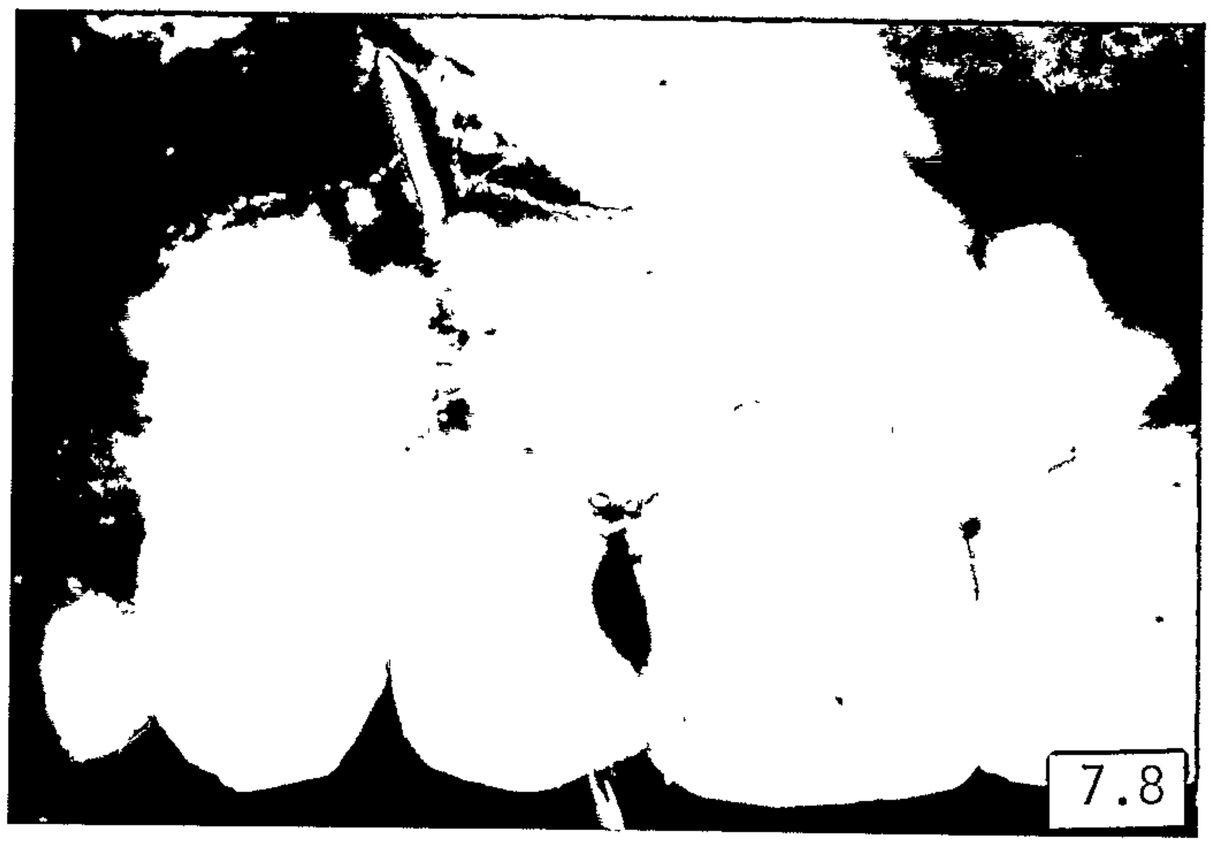


Fig. 7.6



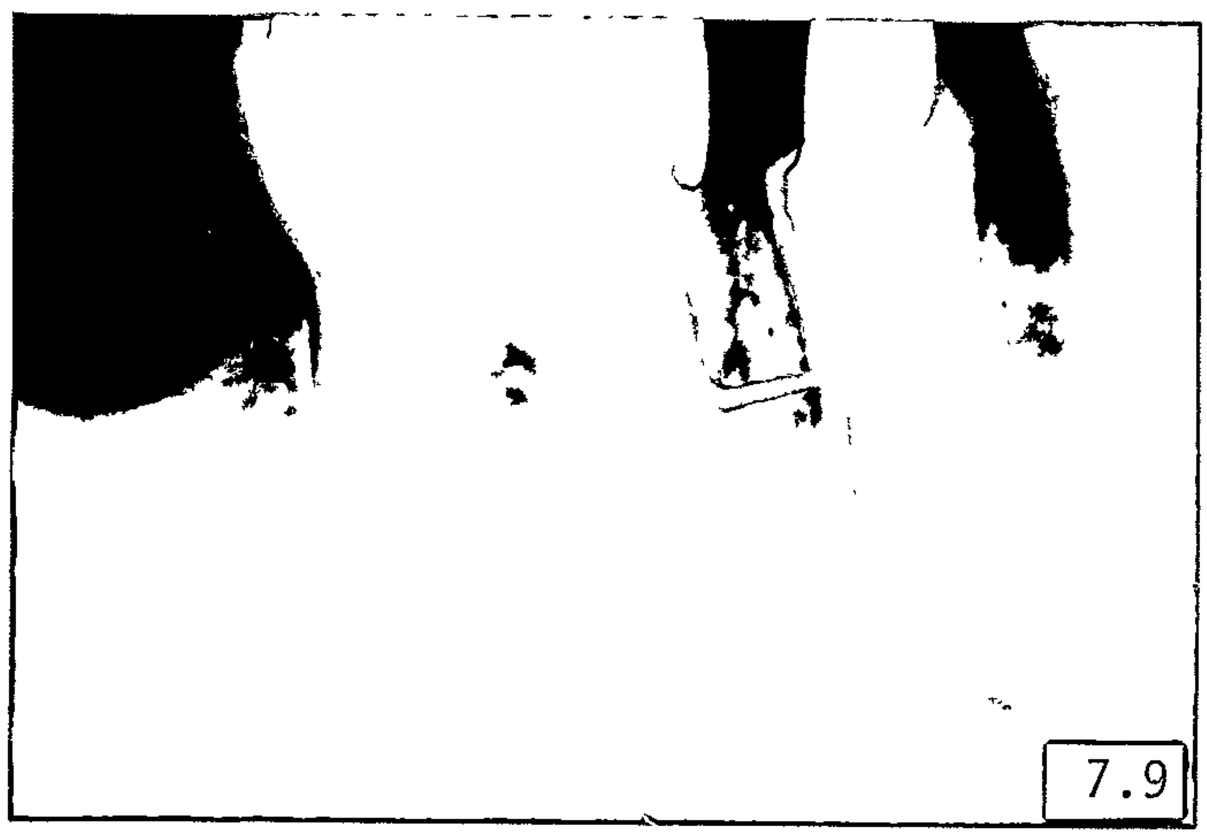


Fig. 7.10 Clinical failure due to lateral perforation of the root.

Fig. 7.11 This root was weakened due to the over-instrumentation of the root canal during post hole preparation.

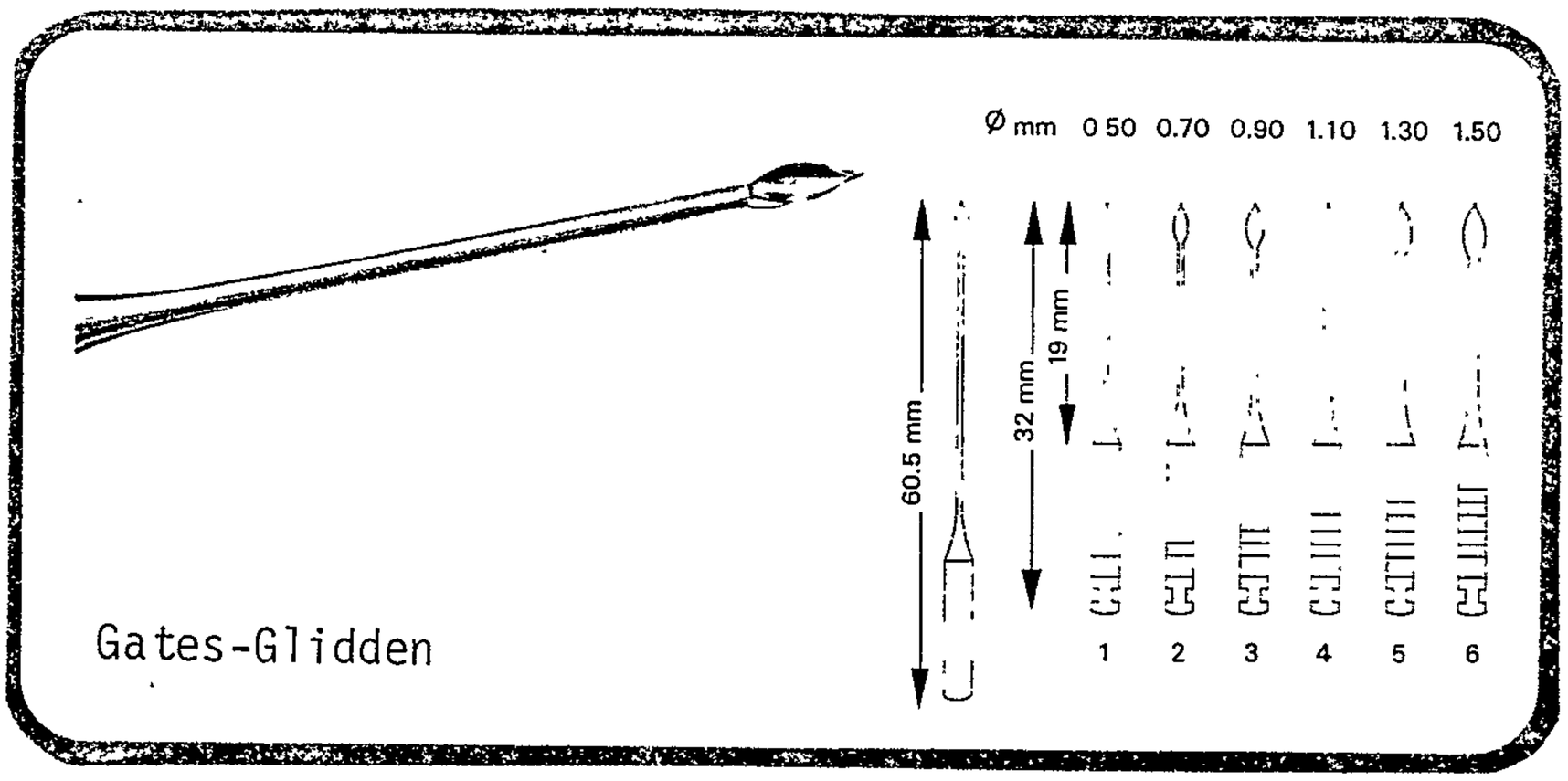
Fig. 7.12 a. Gates-Glidden reamers

b. Peeso reamers

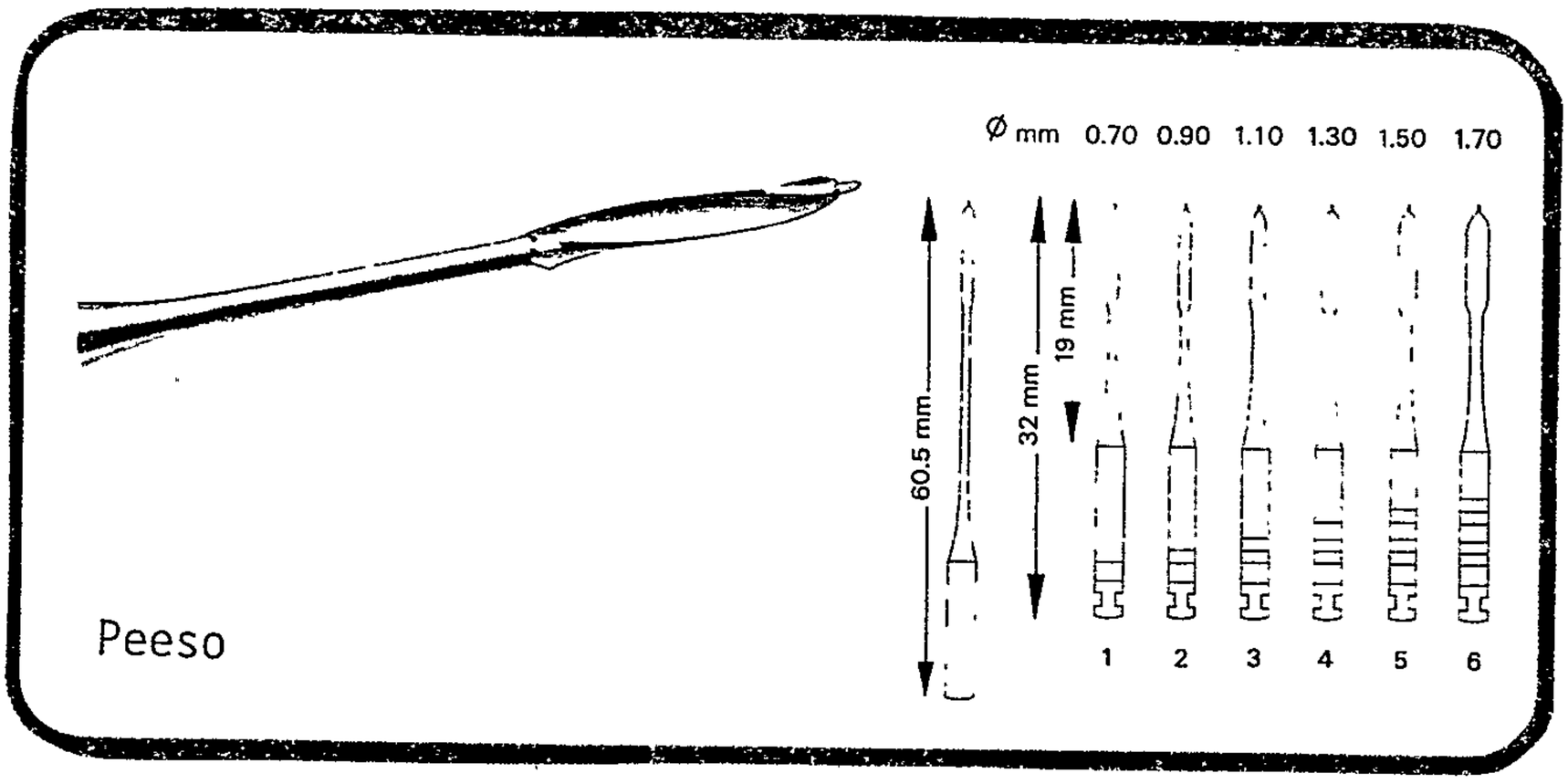
Fig. 7.10; 7.11; 7.12,a and b

7.10

7.11



7.12,a



7.12,b

Fig. 7.12 c. Elargisseur root canal drills.

Fig. 7.13 Instruments which can be heated to remove gutta percha during post hole preparation.

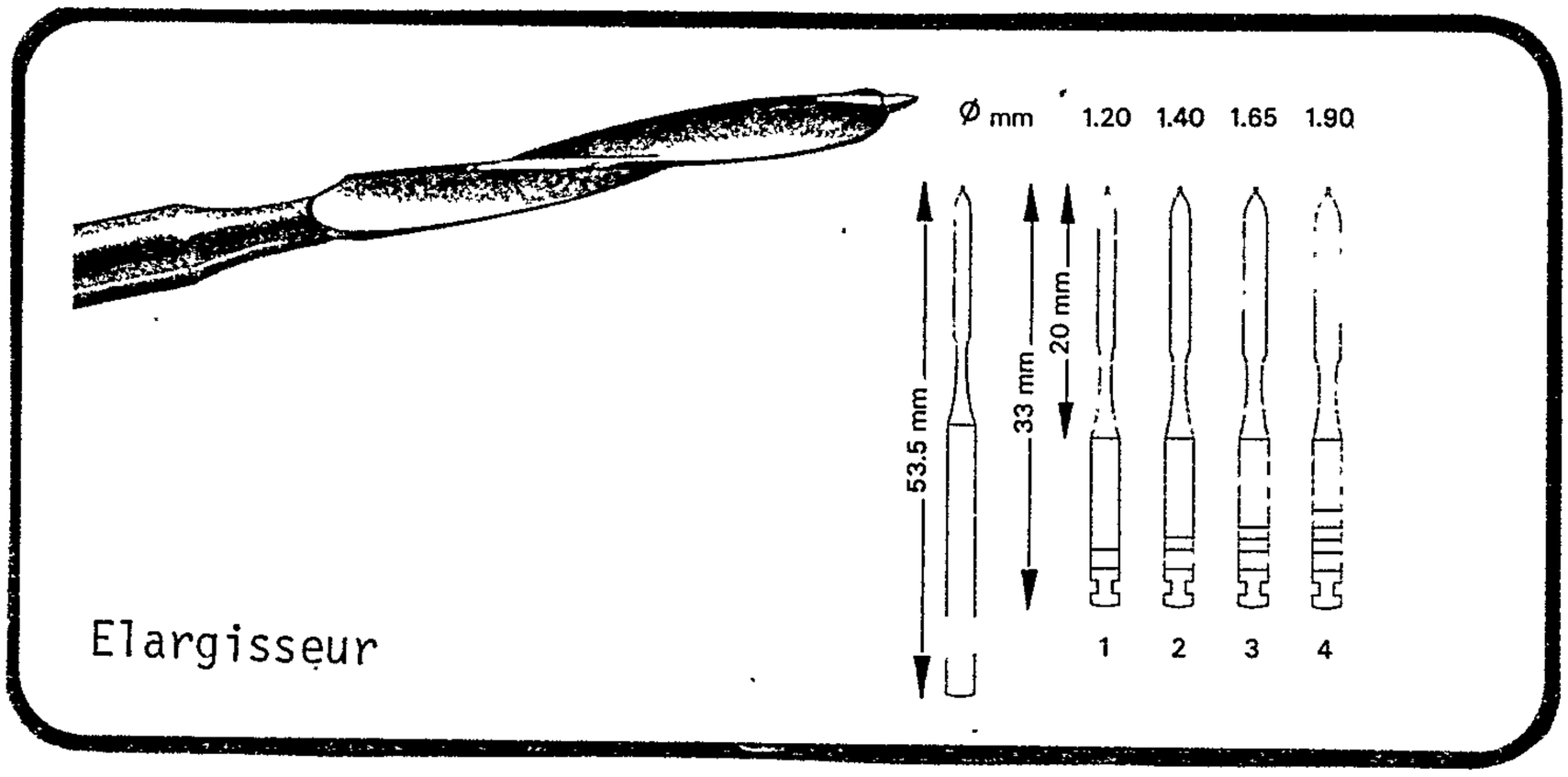
Root canal plugger (top)

Endospoon (middle)

Small long-shank, ball burnisher (bottom)

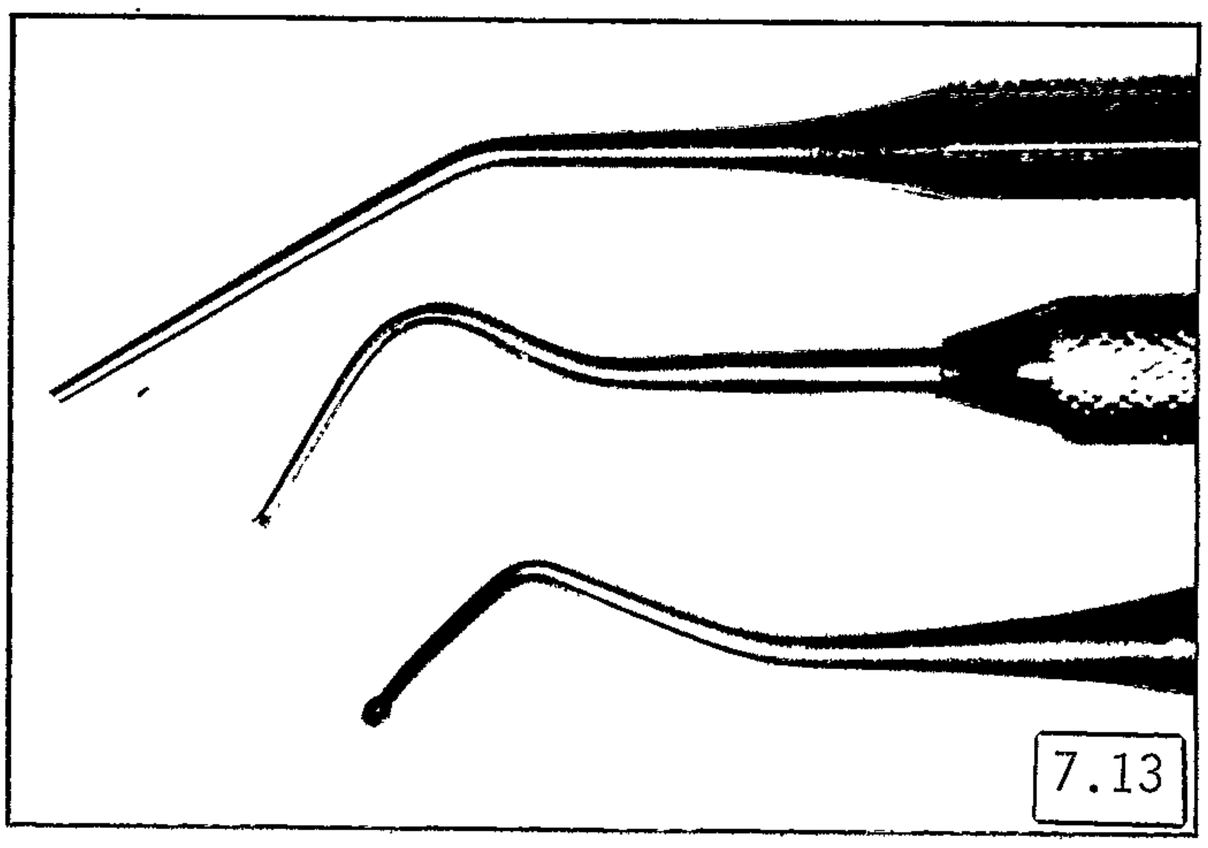
Fig. 7.14 For legend, refer to 7.6.4.

Fig. 7.12,c; 7.13; 7.14



Elargisseur

7.12,c



7.13

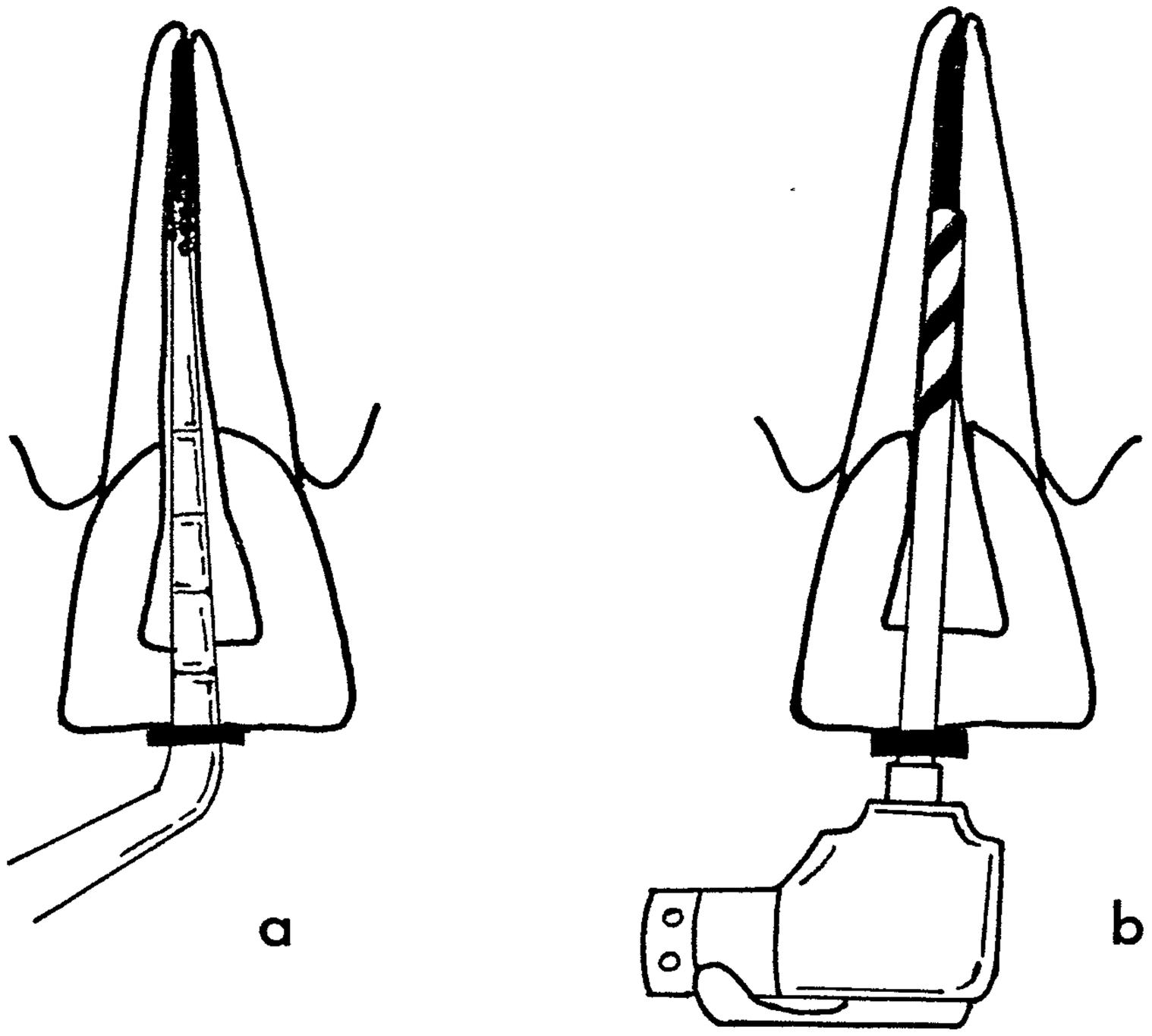


Fig. 7.14

CHAPTER 8

POST HOLE IMPRESSION

8.1 Introduction
8.2 Inlay wax
8.3 Self-curing acrylic resin
8.4 Copper ring and impression compound
8.5 Elastomeric impression materials
8.6 Pre-matched, plastic or metal impression posts

8.1 Introduction

The indications for the indirect method of pattern fabrication are considered in 9.3. The materials and techniques available for direct fabrication of a post-core pattern are limited by the requirements of a pattern material for casting. There are several impression techniques for recording the post hole and the prepared clinical crown. The choice of a particular technique is dependent on the demands of the clinical case. The presence of gross undercuts or multiple divergent canals generally precludes the use of a non-elastic impression material.

The impression of a post-core preparation is usually accomplished in two stages:

1. an impression of the post hole preparation
2. an impression of the prepared clinical crown incorporating the impression of the post hole.

Several materials have been suggested for making an impression of a post-hole preparation. These included wax (Silverstein, 1964; Gentile, 1965; Beheshti, 1979), self-curing acrylic resin (Rosenberg and Antonoff, 1971), impression compound (Kantorowicz, 1970, p.100) and elastomeric impression materials (Baraban, 1967). Regardless of the material and the method used for recording the post hole preparation, any undercuts in the post hole increase the possibility of distortion of the impression on withdrawal and should be eliminated. In fact, undercuts make the

withdrawal of an acrylic resin post impression very difficult, if not impossible. To complete the impression of the post-core preparation, elastomeric impression materials are commonly used in an impression tray; alternatively, some authors have suggested the use of impression compound supported by a copper band to record the overall post-core preparation.

8.2 Inlay wax

Using inlay wax, an impression of the post hole may be obtained in one of two ways.

A plastic post is trimmed until it fits loosely in the root canal to the full depth of the post hole, leaving a handle of sufficient length for removal of the post pattern. The end of the plastic post is then serrated and inlay wax is melted over it. This is then inserted into the root canal and removed when the wax has cooled. Additional wax is added, as required until an impression of the prepared canal and the anti-rotational preparation is obtained. The coronal end of the plastic post is then flattened with a hot instrument to enhance the retention of the post impression in the final, overall impression. If the direct method is preferred, the core pattern is completed by simply adding inlay wax to the post "impression", and is then shaped and cast in a suitable alloy in the usual manner.

As an alternative to the plastic post, a length of stainless steel wire or even a shortened, old root canal instrument (Shadman and Azarmehr, 1975) can be used with inlay wax. Softened blue inlay wax is packed firmly into the canal to fill up the post hole. The serrated stainless steel wire, with a loop at one end, is heated over a flame and inserted into the wax. This is held firmly until the wax hardens. The post impression is removed, inspected and, if satisfactory, is replaced in the root canal and the final impression of the tooth preparation is completed.

8.3 Self-curing acrylic resin

A self-curing acrylic resin such as Duralay* offers the advantages of higher strength and rigidity when compared to inlay wax. However, it is essential to eliminate undercuts in the post hole preparation and to ensure that the canal is adequately lubricated during the impression procedures (Rosenberg and Antonoff, 1971). With this material, a plastic post may be preferable to a length of stainless steel wire because the acrylic resin will bond directly onto the post. The Duralay resin may be applied to the plastic post using a "brush on" technique; this is then inserted into the lubricated canal to the full depth of the post hole. The post impression should be removed for inspection before the acrylic resin is polymerized; if it is satisfactory, it is then repositioned in the prepared canal until the acrylic resin is set. The impression of the coronal preparation may then be completed in an elastic impression material. While this is a reliable and convenient method of recording the post hole preparation when making a post-core pattern directly in the mouth, it has a major disadvantage when used as part of a post-core impression because of the tendency for the post impression to resist removal from the die; when a stone die is used, removal of the impression may cause damage to the die even when the post hole impression is well lubricated. Separation of the post impression from an electro-plated die may also be difficult (Crocker, 1982).

8.4 Copper ring and impression compound

Several clinicians (Greenwald, 1965; Baraban, 1967; Kantorowicz, 1970, p.100-103) have described the technique of recording a post-core preparation using impression compound supported by a copper ring. According to Kantorowicz (1970, p.100-103), the first step is to trim a copper ring to fit the periphery of the prepared tooth. A piece of wire or a segment of a paper clip is adjusted to the appropriate length and a loop is placed in

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*Reliance Dental Mfg. Co., Worth, Ill., U.S.A.

the coronal end. The wire is serrated and coated with sufficient softened compound to fill the root canal and allow a little excess. The wire together with the compound are then forced into the lubricated root canal and allowed to cool before being withdrawn for inspection. If satisfactory, the root canal impression is replaced. The copper ring is then filled with softened compound and pushed into position over the looped end of the wire and the coronal preparation. After cooling, the post hole impression becomes an integral part of the compound impression of the entire post-core preparation. If the copper ring impression is to be removed (for copper-plating) from the over-all impression (of the arch), a groove should be cut in the coronal aspect of the copper ring impression before the overall impression is taken, to ensure that accurate relocation is possible.

This impression technique offers several advantages (Kantorowicz, 1970, p.100-103):

1. a copper-plated die can be made from it
2. the post hole impression can be inspected and rectified before the overall impression is taken
3. the copper ring assists in gingival retraction during the impression procedure.

Baraban (1967) found that if the compound impression was not withdrawn from the post hole before it hardened, it often became locked in the root canal. However, this procedure would most likely introduce inaccuracy into the impression because of the "drag" in the unset compound. Baraban also warned that the post hole impression may fracture or chip on removal from the tooth if the long axis of the tooth preparation and that of the post hole were not parallel. Because more accurate alternative methods are available, the use of this material is generally not recommended (Sandrik and Sawyer, 1978, p.231).

8.5 Elastomeric impression materials

Techniques involving the use of elastomeric impression materials are most useful when multiple post-cores are indicated (Baraban, 1967). The selection of a polysulphide, polyether or a silicone impression material is often a matter of personal preference. Clinicians have claimed that each of these materials can be used with success.

The technique is basically the same regardless of the type of material used. A combination of the light and heavy bodied materials that are used in routine impression procedures for crown and bridgework, provides consistently satisfactory results. The light bodied material may be introduced into the post hole preparation with a syringe (Crocker, 1982) or with the assistance of a slowly revolving Lentulo spiral (Baraban, 1967). Using a large gauge needle (18 gauge), the light bodied material is injected into the post hole preparation slowly and the needle is withdrawn out of the root canal as the post hole is filled up taking care not to trap any air in the post hole impression (Fig. 8.2). Alternatively, a Lentulo spiral may be used to pick up a small quantity of the light bodied impression material which is spun into the post hole; this procedure is repeated several times until the post hole is completely filled (Fig. 8.3). The Lentulo spiral is slowly withdrawn while it is still spinning. Another method of taking an impression of a post hole has been suggested by Baum et al (1981, p.540-541) in which air trapped in the post hole by the injected impression material was bled out through a needle placed in the root canal. This method is illustrated in Fig. 8.1. Because of the length of the post hole impression, some form of internal support for the impression material has been recommended, and for this purpose, a serrated segment of a paper clip or a loose-fitting acrylic resin post have been found to be effective (Silverstein, 1964; Baraban, 1967; Harper and Lund, 1976). However, in the experience of other

clinicians (Hicks, 1978; Crocker, 1982) and the author, reinforcement of the post hole impression is unnecessary in most cases.

Following the insertion of the light bodied material, the tray with the heavy bodied material is positioned. On removal, when set, an accurate impression of the post hole and the prepared clinical crown is obtained. The impression may be poured in die stone or else, depending on the elastic impression material used, the impression obtained may either be copper-plated or silver-plated to make an accurate, durable die and working model.

8.6 Pre-matched, plastic or metal impression posts

According to the manufacturers, one of the advantages of prefabricated post systems is the simplification of the impression procedures for cast post-cores. It is claimed that pre-matched metal or plastic impression posts have virtually eliminated the need for injecting impression material into the prepared root canal; the post is incorporated into the over-all impression by means of mechanical retention. A major disadvantage of rigid, pre-matched, impression posts, however, is that removal of the impression post from the die must be carried out with great care if damage to the die is to be avoided (Crocker, 1982).

Fig. 8.1 Impression of a post hole using an elastic impression material (from Baum et al, 1981, p.540-541)

a. The sharpened tip of a 25 or 27 gauge needle is cut to provide square open ends.

b. Insert the needle into the prepared post hole.

c. Inject elastic impression material into the post hole.

d. As the impression material travels upward into the post hole, entrapped air is bled out through the needle.

e. When the post hole has become filled, the impression material occludes the lumen of the needle which is then pulled out slowly and discarded.

f. A large gutta percha point which has been cut to length and painted with tray adhesive, may be inserted into the post hole for support.

g. On removal of the retraction cord, impression material may be injected into the gingival sulcus and the impression of the clinical crown preparation is then completed in the usual manner.

Fig. 8.2 Impressions of multiple post-core preparations using an 18 gauge needle and an addition-cured silicone impression material*.
(courtesy P. Crocker)

* Permagum, ESPE Dental Products, Lynbrook, N.Y., U.S.A.

Fig. 8.3 An impression of four post-core preparations for a patient using a Lentulo spiral and a polysulphide impression material @.

@ Permlastic, Sybron/Kerr Mfg. Co., Romulus, Michigan, U.S.A.

Fig. 8.1; 8.2; 8.3

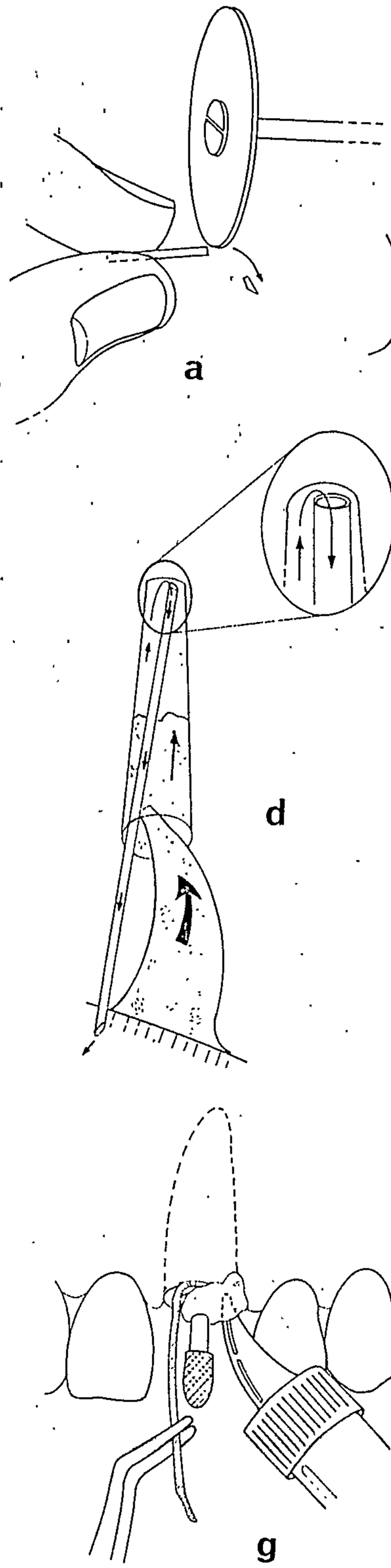
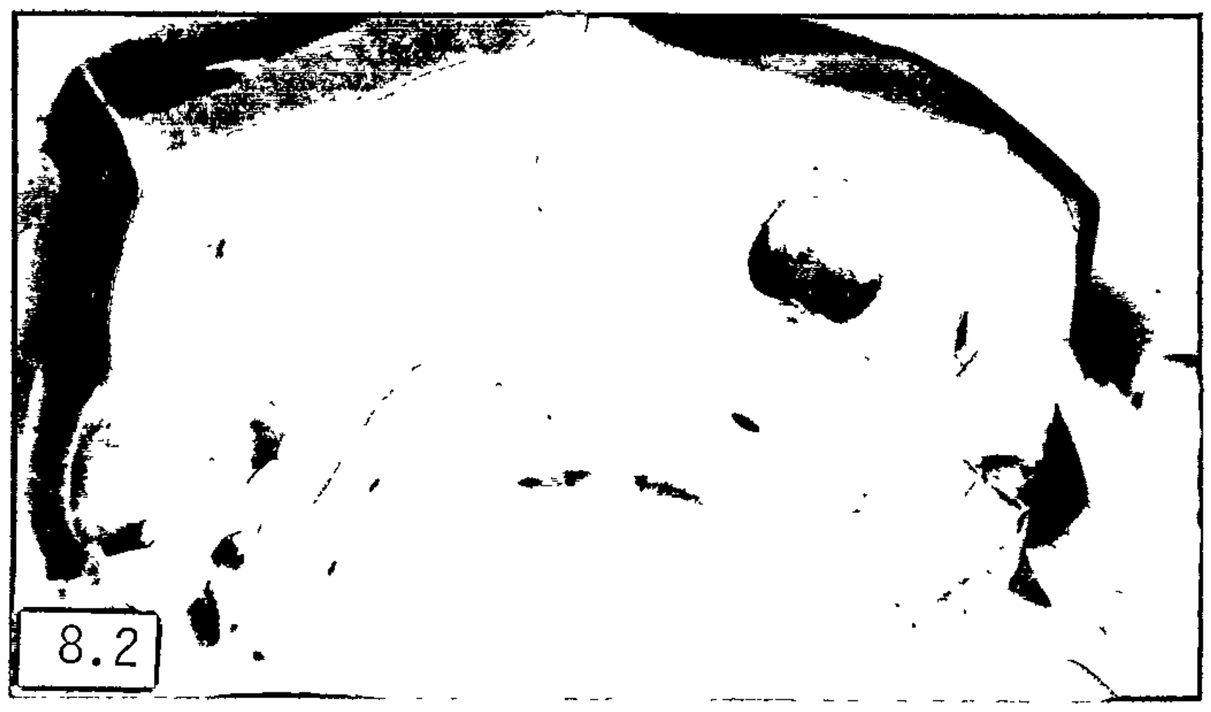


Fig. 8.1



CHAPTER 9

POST SYSTEMS

9.1 Introduction
9.2 Classification
9.3 Methods of fabricating a post-core pattern — indications
9.4 Outline of chapters 10, 11 and 12

9.1 Introduction

Until the 1960's, the custom-made cast gold post-core was the time-proven accepted method of providing a foundation for the coronal restoration in an endodontically-treated tooth. Since then, many prefabricated post systems of various designs have been developed. These have sought to simplify the clinical procedures necessary for the construction of an accurately fitting post-core foundation, to reduce chair-side time and to improve the retention of the post-core foundation. Although the custom-made cast post-cores are still commonly used, recent research activity has focused principally on the prefabricated post systems. Variations in certain characteristics of the posts have been shown to have significant effects on their ability to distribute functional and non-functional stresses and provide retention.

Because of their circular cross-section, prefabricated post systems become less efficient as the root canal morphology becomes ovoid or ribbon shaped (Henry and Bower, 1977,a; McKerracher, 1981,a). In these teeth, and in young teeth with large root canals, the custom cast gold post-core is most useful (Figs. 9.1 and 9.2). In this technique, only a minimal amount of tooth structure needs to be removed from the root canal walls to eliminate any undercuts and a post may then be made to conform to the shape of any prepared canal. The main disadvantage of the custom post technique is the additional time and effort required for the construction of a post pattern, with inlay wax or burn out acrylic resin, to fit the particular pulpless tooth.

There are several advantages in the use of preformed posts

1. The matching of the instruments for post hole preparation with the post ensures optimum accuracy of fit and retention; this also eliminates the need for a root canal impression or for the fabrication of a post pattern in the prepared canal or in the model (Locke, 1977).
2. A stronger post can be obtained from wrought dental alloys than a cast alloy post of the same size (Courtade and Timmermans, 1971, p.145).
3. The operator has precise control of the length, diameter and the degree of taper of the post.
4. Serrations and venting of the post by means of a groove can be readily incorporated in the preformed post.
5. There is a wider choice of post material since the post does not have to be cast.

Prefabricated post systems also have several disadvantages

1. The root canal has to conform to the shape of the post which usually necessitates the removal of more dentine from the root canal walls (Perel and Muroff, 1972).
2. The use of rotary instruments increases the chance of root perforation.
3. Matching reamers and posts are only suitable for roots which can accommodate a post with a circular cross-section (Henry and Bower, 1977, a; Locke, 1977).
4. Special instruments and materials are required for each individual post system.

9.2 Classification

The overall shape of a root canal post may be described as parallel-sided (cylindrical) or tapered, or, in some instances, a combination of these two shapes. Their surfaces may be smooth, serrated or roughened,

or threaded. In the following chapters (Chapters 10, 11 and 12), the different post systems are broadly classified into two categories according to the method of their clinical application.

1. The post is *passively cemented* into the prepared root canal in a manner similar to the way in which an inlay restoration is retained in the prepared cavity.
2. The surface of the post is *threaded* and the post is screwed into the root canal wall; use is made of the resiliency of the dentine for retention. In some cases, threads are cut into the root canal walls with a special tap before the threaded post is inserted. A cementing medium may also be used with these systems to improve retention and to seal the prepared post hole.

9.3 Methods of fabricating a post-core pattern — indications

The pattern for the cast post-core foundation may be fabricated directly in the mouth or in a model made from an impression of the prepared tooth.

Indications for the direct technique

The direct method of fabricating a post-core pattern may be used in any single-rooted pulpless teeth and multi-rooted teeth in which the root canals accommodating the posts are parallel. This is a convenient method when up to two or three anterior or premolar teeth require cast post-core foundations. Using this technique, post-core pattern can be constructed simply and accurately in the pulpless tooth. Time consuming impression procedures and production of the working model and the accompanying possible source of inaccuracy can all be eliminated (Locke, 1977). Accuracy of fit and the amount of occlusal clearance in all excursions can be readily examined and corrected before the pattern is removed for casting thereby reducing the amount of adjustment required after the cementation of the post-core foundation (Henry and Bower, 1977,a).

The indirect technique is indicated:

a. when a partial or full gold coping must be constructed subgingivally due to extensive caries or root fracture (Courtade and Timmermans, 1971, p.155)

b. when cast post-core foundations are indicated for several anterior or premolar teeth

c. when parallelism of the coronal preparation of the post-core foundation with other abutment(s) is essential

d. when limited access make direct fabrication of the post-core pattern difficult

e. when multiple-unit post-core foundations are planned for teeth with divergent root canals (Caruso et al, 1978, p.499).

9.4 Outline of chapters 10, 11 and 12

In chapters 10, 11 and 12, in which individual prefabricated post systems are discussed, whenever the information is available, the design principles, the instrumentation, and the clinical and laboratory procedures for each of these prefabricated post systems are presented. Some of the post systems are relatively new and much of the information available was obtainable only from brochures distributed by the manufacturers. Instructions provided by the manufacturers on the clinical application of some of the post systems were often inadequate and the operator was clearly expected to rely upon his or her own experience with other similar post systems.

The desirable and undesirable qualities of each post design category are outlined and each member of the group is evaluated on this basis. Any known or likely problems associated with a particular material or technique are considered and, where appropriate, suggestions are made to assist in improving the clinical performance or to simplify the clinical application of a post system.

Fig. 9.1 Cross-sectional shape of root canals.

a, b - ideal for prefabricated post systems.

c, d - unsuitable for prefabricated posts.

Custom cast gold posts indicated.

e - root canal too wide for preformed posts.

Fig. 9.2 a. Endodontically-treated tooth with very wide root canal which is unsuitable for prefabricated post systems.

b and c. Burn-out acrylic resin post-core pattern.

d. Custom cast gold post-core foundation cemented in the pulpless tooth.

Fig. 9.1; 9.2

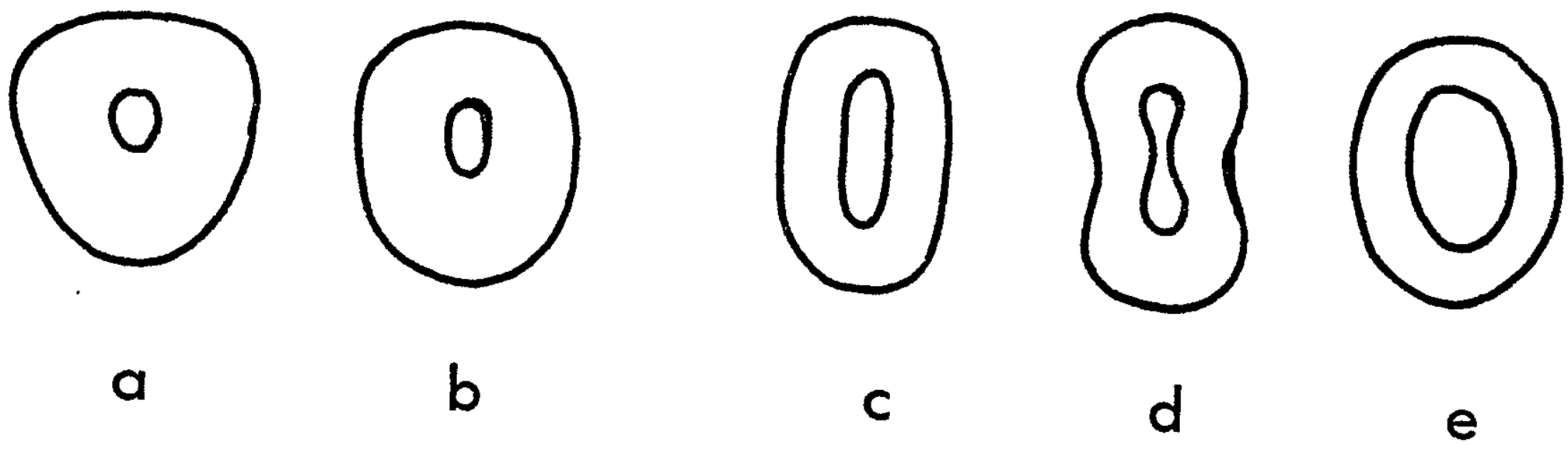
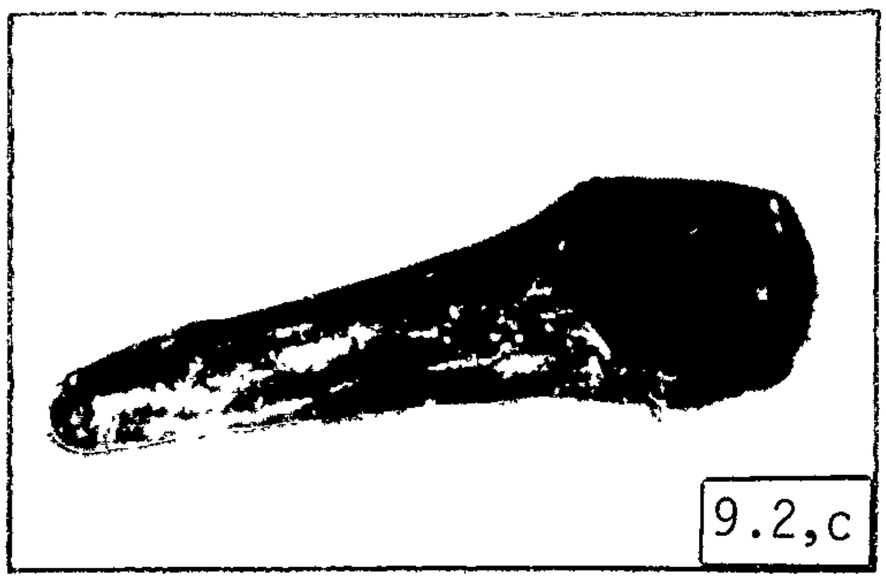
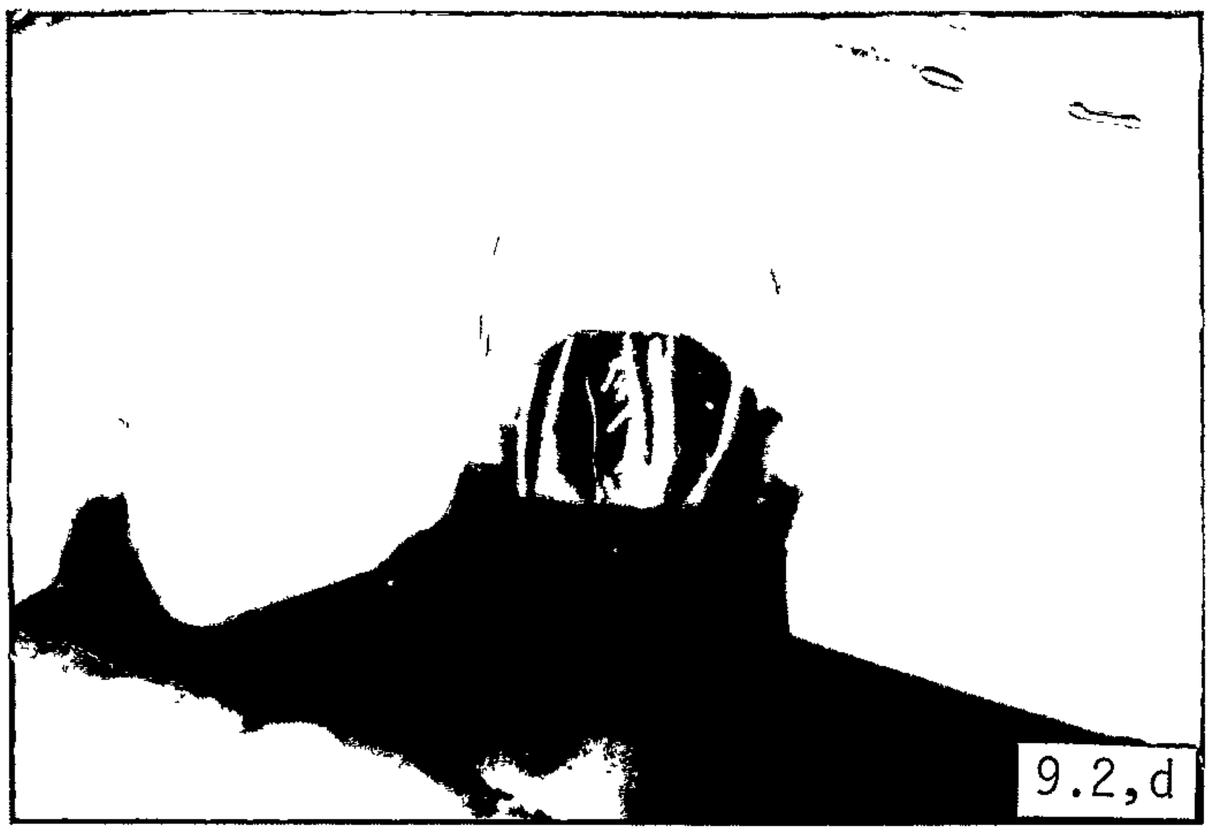


Fig. 9.1





CHAPTER 10

PASSIVELY-CEMENTED POST SYSTEMS (PART 1)

Parallel-sided post systems

10.1 Para-Post System
10.2 Wiptam Post System
10.3 Sargenti Post System
10.4 Cendres & Métaux Wires
10.5 Hannah Post-Core Pattern System
10.6 K.D. Gold Post System
10.7 Charlton Post-Core System

Parallel-tapered post systems

10.8 Cendres & Métaux Cylindrical-Conical Post System
10.9 Schenker Post System
10.10 Para-Post System (tapered end)

10.11 Discussion

10.1 Para-Post System*

10.1.1 *Design principles*

Since the introduction of the Para-Post System just over ten years ago, it has become one of the most widely used prefabricated post systems. The design of this prefabricated post system was based on a number of principles:

1. Cylindrical posts are more retentive than tapered posts of similar dimension.
2. Cylindrical posts transmit occlusal forces in line with the long axis of the tooth whereas the tapered posts transmit forces to the walls of the root canal, resulting in wedging, which may split the root.
3. Wrought gold alloy posts are stronger than cast gold alloy posts of equal diameter.
4. Serrated posts are more retentive than smooth posts.

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* Whaledent International, New York, N.Y., U.S.A.

5. Venting the post, by means of a groove or channel, permits cement to escape, resulting in complete seating during cementation, a more closely fitting post in the root canal, and a reduction in apical stress concentration during post insertion.

6. Short auxiliary pins attached to the post-core foundation provide a guide to seating, prevent rotation of the post-core in the root canal, and increase retention and lateral stability.

7. All posts are slightly smaller in diameter than the enlarged root canal to allow space for the thin cement layer.

The serrated and vented design of the stainless steel and the wrought gold Para-Posts was developed by Courtade (Baraban, 1970).

10.1.2 *Instrumentation*

The posts and drills available in this system are listed in Table 10.1.

TABLE 10.1

Instrumentation for the Para-Post System

Code number	Code colour	Diameter of drill (inch)	Diameter of drill (mm)
3	brown	0.036	0.9
4	yellow	0.040	1.0
5	red	0.050	1.25
6	black	0.060	1.5
7	green	0.070	1.75

The Para-Post System has a number of components. Refer to Fig. 10.1.

1. Serrated, vented, wrought gold alloy posts in five sizes that are suitable for "cast on" gold cores — using precious alloys with melting range up to 1371°C (2500°F).
2. Serrated, vented, stainless steel posts in five sizes that are suitable for the retention of amalgam or composite resin core foundations. (The stainless steel and the wrought gold posts are identified by the letters "S" and "G", respectively, on one side of the flattened coronal portion and the code size number (3, 4, 5, etc.) on the other).
3. Colour-coded, serrated and vented plastic burnout casting posts (in five sizes).
4. Colour-coded, smooth plastic impression posts (in five sizes).
5. Colour-coded, smooth aluminium posts for the retention of temporary resin crowns only (in five sizes).
6. Colour-coded, matching twist drills in five sizes.
7. Cylindrical Metforte* platinum-iridium pins (0.028 inch or 0.7 mm diameter) that may be used to provide additional retention for the cast post-core foundation.
8. Cylindrical plastic impression pins (0.028 inch or 0.7 mm diameter).
9. Aluminium pins for temporary use (0.028 inch or 0.7 mm diameter).
10. Matching Paramax* drills 27 mm long (0.028 inch or 0.7 mm diameter).
11. Paralleling jigs to assist in the preparation of auxiliary pin channels — available only in the larger three sizes (No. 5, 6, and 7).

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*Whaledent International, New York, N.Y., U.S.A.

12. Nickel-silver posts in five sizes that may be used for the fabrication of cast precious metal cores in endodontically-treated teeth with divergent root canals.

10.1.3 *Techniques*

With the large number of components available, the Para-Post System offers a degree of flexibility that enables it to be used in a wide variety of clinical situations (Henry and Bower, 1977). The system is commonly used for the construction of:

1. cast metal post-core foundations by the direct technique or the indirect technique (10.1.31),
2. amalgam or composite resin core foundations retained by stainless steel posts, with or without the aid of self-threading pins (10.1.32),
3. temporary post-retained acrylic resin crowns (10.1.33).

10.1.31 Cast metal post-core foundations

The construction of cast metal post-core foundations using the Para-Post System is discussed in four sections.

i. Preparation of the pulpless tooth for the Para-Post System.
ii. The direct technique.
iii. The indirect technique.
iv. Cast post-core foundations for multi-rooted teeth with divergent canals.

i. Preparation of the pulpless tooth for the Para-Post System

The technique of tooth preparation outlined here is that described by Baraban (1970) and Courtade and Timmermans (1971, p.148-152), and is the method recommended by the manufacturer (Fig. 10.2,b-d and 10.3,a-d). However, alternative methods of gutta percha removal described in 7.6 may be preferred by other clinicians.

Prior to the preparation of the post-hole, the pulpless tooth is approximately prepared for the final coronal restoration. Any irregular

and unsupported tooth structure is removed. According to Courtade and Timmermans (1971, p.148-152), the post hole preparation should always begin with the narrowest drill (0.9 mm diameter) that will easily follow the gutta percha filling at ultra-low speed (300-500 rpm). Baraban (1970), however, suggested the use, initially, of Gates-Glidden drills (Fig. 7.12,b) to remove the gutta percha root filling to the desired depth, before the final shaping of the root canal walls with the successively larger Para-Post drills.

When very little sound coronal tooth structure remains, the use of accessory cylindrical pins, parallel to the post, has been suggested for additional retention and also to prevent rotational movement. When the cross-sectional area of dentine permitted, Courtade and Timmermans (1971, p.152) suggested the incorporation of two accessory pins on the lingual half of the tooth — located to the mesial and to the distal of the central cingulum area (Fig. 5.11,e), as far lateral as possible but not closer than 1.5 mm to the external surface of the root.

The paralleling of the accessory pin channels can be done either with a jig or by direct vision. Paralleling jigs corresponding to the root canal post sizes No. 5, No. 6, and No. 7 are available. The colour-coded jig is placed in the root canal and rotated to the proper position. The guide channel that will locate the pin hole at the desired distance from the post is selected. The pin hole is drilled with the 0.7 mm Paramax drill to a depth of 2 to 2.5 mm. The jig is then rotated to the proper position for the second pin hole if required.

Experienced operators may elect to drill the accessory pin holes by direct vision. The precious metal or plastic burnout post is inserted into the post hole, and sites for the pin holes are marked with a No. ½ round bur. The pin holes are prepared to the desired depth while carefully observing parallelism by looking alternately in two planes.

Final preparation of the shoulder and bevels slightly subgingivally may be deferred until the post-core foundation is cemented (Courtade and Timmermans, 1971, p.152).

With this prepared tooth, the fabrication of the cast post-core foundation may be carried out by either the direct or the indirect technique.

ii. The direct technique (Fig. 10.3)

After the preparation of the post-core foundation is completed, the root face and the post and pin channels are lightly lubricated. If a one-piece cast alloy post-core foundation prepared from one material is desired, a serrated, vented, plastic burn-out post (Fig. 10.2,c and Fig. 10.3,e) corresponding to the largest drill used is inserted into the prepared canal. Alternatively, the stronger wrought iridium-platinum post (serrated and vented) may be used to support a cast precious metal core foundation. The 0.7 mm Metforte iridium-platinum pins are inserted into the accessory pin channels. If the precious metal post or pins are too long, they should be removed and shortened at the incisal end with a wire cutter before fabricating the pattern. A thin mix of self-curing, burn-out acrylic resin* is then applied to the tooth surface incorporating securely the extending post and pins and allowed to set. Having checked the withdrawal of the now connected post and pins, a copper band or a plastic Coreform@ may be used as a matrix and additional burn-out resin is used to complete the core pattern. Because of the strength of the self-curing acrylic resin, once set, the pattern with the incorporated post and pins may be carefully removed from the tooth and shaped to the approximate desired form before being re-inserted for final refinement. Alternatively,

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*Duralay, Reliance Dental Mfg. Co., Worth, Ill., U.S.A.

@Coreform, Sybron/Kerr Mfg. Co., Romulus, Michigan, U.S.A.

high-speed rotary instruments may be used to prepare the acrylic resin core to the form required for the preparation for the final restoration before being removed, sprued and invested in a conventional manner. If desired, inlay wax may also be used for the fabrication of the core pattern instead of the self-curing acrylic resin.

iii. The indirect technique

If, for reasons outlined in 9.3, the indirect technique is preferred, a smooth plastic impression post (corresponding to the largest drill size used) is inserted into the root canal and the 0.7 mm Paramax plastic impression pins are inserted into the accessory pin channels. An impression is taken with a material of choice; the post(s) and the pins are securely positioned and embedded in the impression material by means of a retention head created with a heated instrument.

Because of the complexity of the preparation and the length of the posts and pins, a very strong die material should be used (Crocker, 1982). After the dies have been sectioned and the models mounted on an articulator, the dies are removed and trimmed in a conventional manner. The plastic impression posts and pins are carefully removed in order to prevent damage to the channels. Electro-plated dies may be advantageous for this reason.

The margins are carefully defined and the die and channels lightly lubricated. The corresponding serrated and vented plastic burn-out post or precious alloy post is inserted into the canal. The 0.7 mm Metforte iridium-platinum pins are placed in the pin channels and the core pattern is completed using inlay wax or self-curing resin. The pattern is invested, and cast by conventional methods using precious dental alloys. The cast post-core foundation is shaped, finished, and checked for fit and accuracy on the model before being returned to the dentist. It has been recommended in a number of techniques that wrought precious alloy posts and pins should be used; certain precautions have been suggested.

1. Due to the high melting range of the non-precious alloys, they should not be used in combination with the wrought precious metal posts and pins. When casting with non-precious alloys, the plastic burn-out posts and pins should be used.

2. Investments containing chloride should not be used when casting alloys to the prefabricated wrought precious metal posts and pins. They have been found to be injurious to these posts and pins which may become brittle; cases of fracture of such posts have been reported by Behrend (1980). The following investments, as advised by the manufacturer* of the Para-Post System, are known to contain chloride: Beauty Cast, Hygrotrol, Novocast, Shiny Brite, Divestment and Superhold; these should not be used in conjuction with wrought precious alloy posts or pins. Investments which do not contain chloride include: Ceramigold, Ceramigold 2, Hi-Temp, Hi-Temp 2, Hydrovest, Chrome Investment, WM 80, Cristobalite Inlay, Cristobalite Model, Speed-E Soldering, and Hi-Heat Soldering. Investments for high fusing alloys and golds usually do not contain chloride.

iv. Cast post-core foundation for multi-rooted teeth with divergent canals

When two or more canals are used for the support of a cast core foundation in a multi-rooted pulpless tooth with divergent canals, the techniques described previously may be modified for use in these situations. A separate post-core unit is constructed for the individual root canals used and together, these multiple interlocking units will form the final tooth preparation. Figure 10.4 shows some variations in the design of these multiple-unit cast core foundations. Because of the complexity of the interlocking patterns and the increased difficulties associated with access to the posterior region of the mouth, the indirect

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*Whaledent International, New York, N.Y., U.S.A.

technique is most often used for the construction of cast post-core foundations in these teeth. However, Wearn (1974) described a relatively simple method of fabricating the core pattern which may be applied in a direct technique without undue difficulty.

Following tooth preparation, the technique recommended for the Para-Post System indicated that a wrought gold 'master' post (or a plastic burn-out casting post) is selected, cut to length, and inserted into the canal most parallel to the path of withdrawal of the core foundation (Fig. 10.5). Plastic accessory posts are lubricated and positioned in the other canals. These posts should protrude from the top of the pattern for easy withdrawal. Alternatively, matching nickel-silver posts recently introduced by the manufacturers of the Para-Post System for this purpose can be used. The lubricated nickel-silver posts are placed into the divergent canals and a core pattern is constructed using a burn-out acrylic resin. Once the core pattern material has set, the protruding accessory posts may be withdrawn carefully and the core pattern trimmed and prepared for the final restoration. The core pattern with the master post is then removed from the tooth and the nickel-silver posts replaced into the divergent channels in the acrylic resin core pattern. Some operators may prefer to use thick pencil carbon to maintain the opening for the accessory posts during casting (Leggett, 1979). The post-core pattern is sprued, invested and cast in a precious metal alloy. The pencil carbon may be removed easily with rotary instruments. If the nickel-silver posts are used, they are dissolved in warm, concentrated nitric acid. The manufacturer of the Para-Post System has warned that only precious metal alloys should be used for the post-core casting when the nickel-silver posts are used. Non-precious alloy and high content silver-platinum alloy are known to dissolve in nitric acid.

The cast post-core foundation is finished and polished and returned to the tooth for cementation. The accuracy of the fit of the cast post-core foundation and the divergent posts is evaluated; either gold or stainless steel posts may be used for the divergent canals. After cement has been spun into all the canals using a Lentulo spiral, the cast post-core foundation is placed into position first followed by the divergent posts using the same mix of cementing medium. Once the cement has set, the divergent posts may be cut off in line with the contour of the completed post-core foundation. A clinical case using the nickel-silver post technique is shown in Fig. 10.6.

The method described above may also be used with the indirect technique with very little modification. However, multiple interlocking post-core units are usually constructed individually starting with the canal most parallel to the long axis of the tooth. When that portion of the post-core foundation is completed, the remaining post-core units are constructed in sequence to form a single interlocking cast post-core foundation. A two-unit cast gold post-core foundation in a maxillary premolar abutment for a ceramo-metal bridge is shown in Fig. 10.7.

10.1.32 The stainless steel post technique

The serrated and vented stainless steel posts in the Para-Post System are commonly used to support amalgam or composite resin core foundations in endodontically-treated anterior and posterior teeth (Courtade and Timmermans, 1971, p.158-161; Baraban, 1972; Wearn, 1974). The wrought gold posts are less frequently used in this technique presumably because of their higher cost.

The post holes are prepared as described in 10.1.31(i). The length and diameter of the posts may be verified radiographically by placing the stainless steel posts corresponding to the largest drills used into the prepared canal. The stainless steel Para-Post selected

is then shortened to the desired length. In multi-rooted teeth, the coronal portion of the post may be bent to the most advantageous position prior to permanent cementation (Figs. 10.9,a and b). If sufficient tooth structure remains, one or two retentive pins may be used to provide additional retention and to prevent rotational movement in single-rooted posterior teeth or multi-rooted teeth where only one root canal post is used (Fig. 10.9,c). In premolar teeth where the coronal one third of the root canal is usually ovoid in cross-section, the root need not be weakened further by the preparation of the pin holes. There is usually ample resistance to torsional forces provided that the luting cement is adequately removed from this area and the amalgam or composite resin core material is well condensed around the stainless steel post, and that as much as possible of the sound coronal tooth structure is preserved (Fig. 10.8). In molar teeth, where two or three canals are used to support the core foundation, additional retentive pins are seldom indicated. The number and the length of posts used depends on the anticipated load of the final restoration. As a general rule, all the root canals should be used to provide support for the core foundation and the posts should be as long as possible within the limits of the root anatomy and the apical seal (7.5).

The cementing agent of choice is delivered into the root canal(s) with the aid of a Lentulo spiral. The canals are filled with the cement and the stainless steel posts are inserted slowly to the full depth of the post hole preparation in order to avoid a sudden build up of hydraulic pressure. Light pressure is maintained on the posts for at least one minute to prevent lifting of the posts from the base of the post hole by the hydraulic pressure. After the removal of the excess cement in the pulp chamber and around the coronal portion of the post, a well-adapted matrix or copper band is used for the building up of an amalgam or

composite resin core (Fig. 10.9,d). At an appropriate time, the matrix is removed and the core is prepared for the final restoration (Fig. 10.9,e).

10.1.33 Temporary, post-retained acrylic resin crown

Following the fabrication of the post-core pattern, or after the impression has been taken, temporary coverage is required to protect the prepared pulpless tooth from further damage. The Para-Post System provides components designed to assist at this stage.

A temporary crown form is selected, trimmed and adapted to the prepared root. An aluminium post and pins are used to secure retention and stabilization of the temporary crown. The tooth surface is lightly lubricated and an aluminium post, corresponding to the last drill size used is inserted into the root canal and the 0.7 mm aluminium pins are placed into the auxiliary channels (Fig. 10.10,a). The extending post and pins may be shortened in order to avoid interference with the seating of the temporary crown. Tooth-coloured self-curing acrylic resin is adapted over the tooth surface securely incorporating the extending post and pins (Fig. 10.10,b). The temporary crown form is then filled with the self-curing resin and placed in position. After the material is set, the temporary post-crown is removed, trimmed and finished. At the insertion of this temporary crown, temporary cement is only placed around the margins and in contact with the coronal portion of the crown (Fig. 10.10,c).

10.2 The Wiptam Post System*

10.2.1 *Instrumentation*

This is a technique that was developed, and has been taught, at the Institute of Dental Surgery, Eastman Dental Hospital, London, since 1962

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*Cottrell & Co., London, U.K.

(Harty and Leggett, 1972). The technique involves the use of Wiptam wires* which are smooth, parallel-sided, nickel-cobalt-chromium wires originally designed for the fabrication of wrought clasps, in cast cobalt-chromium partial dentures. According to Harty and Leggett (1972), its physical properties are unaffected by the high temperatures required to cast metal directly onto its surface.

The Wiptam wires are currently available in five diameters and matching hand-held twist drills are also commercially available as Panadrills@ (Fig. 10.11) (Leggett, 1979).

Diameter of Wiptam wire (mm)	1.0	1.1	1.2	1.3	1.5
Diameter of Panadrills (mm)	1.05	1.15	1.25	1.35	1.55

10.2.2 *Clinical and laboratory procedures*

Using the Wiptam post, the metal core foundation is cast directly onto the wrought, nickel-cobalt-chromium post. Although gold may be used for the cast core, a base metal alloy is more commonly used for this purpose. According to Harty and Leggett (1972), the post only has to fit accurately for 2 to 3 mm at the apical and the coronal ends of the canal.

The post-core pattern is most conveniently fabricated in the mouth. Removal of the coronal gutta percha root filling can be carried out with any of the methods described in 7.6. The root canal is then shaped with successively larger Panadrills until the desired diameter is obtained. The apical seat for the post is prepared carefully by hand using a twist drill with a diameter slightly greater than the diameter of the largest reamer used in the root canal therapy. The coronal portion of the pulpless tooth is prepared in the usual manner, preserving as much sound

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*Cottrell & Co., London, U.K.

@Panadent, London, U.K.

coronal tooth structure as possible. A suitable length of Wiptam wire, of the same diameter as the twist drill used in enlarging the apical portion of the post hole, is cut with a separating disc since wire-cutting pliers may distort the cylindrical shape of the wire. The apical end of the post is smoothed so that no sharp edges remain. If the wire has not been bent or damaged during cutting, no other adjustment should be necessary and the post should fit firmly into the apical portion of the post hole. The coronal portion of the post is notched for better retention of the core pattern material, or if the indirect method is preferred, the coronal end of the post may be bent to provide better retention and a positive lock in the impression material. Either wax or burn-out acrylic resin may be used for fabricating the core pattern.

(The Wiptam wire cannot act as a sprue for the casting as it forms an integral part of the post-core foundation and is not withdrawn prior to casting of the core foundation.)

The indirect method of fabricating the cast core on the Wiptam wire is relatively straight forward. However, it has been suggested that before the working models are constructed, a piece of stainless steel orthodontic tubing (with the same internal diameter as the diameter of the wire used in the impression) is selected and cut so that it fits over the Wiptam wire to within 1 mm of the end. The use of this sleeve enables the accurate seating of the post in the model and protects the model from damage during insertion and withdrawal of the post.

Being a parallel-sided post system, cast post-core techniques described in 10.1.31(iv) for pulpless teeth with divergent canals can be readily adapted for use with the Wiptam wires (Fig. 10.12,c). The Wiptam wires may also be cemented into prepared canals for the support of core materials such as amalgam or composite resin (Leggett, 1979) as described in 10.1.32 (Fig. 10.12,d).

10.3 Sargenti Post System*

10.3.1 *Instrumentation*

The Sargenti posts are smooth (sandblasted), parallel-sided, precious metal posts. They are available in two types of precious alloys, both suitable for the "cast on" core technique. Conventional cast gold alloy cores may be cast onto the Pivotor[@] posts. However, if the post-core and the porcelain-gold crown are to be constructed as one unit, the high-fusing Ceramicor[#] posts must be used. The posts have malleable wings which may be shaped to gain retention in the impression material if the indirect method is used. Two sizes of posts are available with matching engine-driven twist drills. The small Sargenti posts are 1.30 mm in diameter and have a total length of 12.80 mm. The medium posts have a diameter of 1.50 mm and are 15.00 mm long. Matching stainless steel posts in two sizes are also available for use with temporary post-crowns. For identification, the heads of the posts are marked with the letters "P" for Pivotor, "C" for Ceramicor, and "X" for stainless steel. The two sizes of precious metal posts and matching engine reamers are illustrated in Fig. 10.13.

10.3.2 *Clinical procedures*

Little information can be found in the dental literature on the clinical use of the Sargenti posts. However, in the experience of the author, like the other prefabricated precious metal posts, the Sargenti posts can be conveniently used in the direct technique of fabricating a cast post-core using the "cast on" technique. Either inlay wax or burn-out acrylic resin may be used for fabricating the core pattern. Because

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*Cendres & Métaux S.A., Biel-Bienne, Switzerland

[@]Pivotor, fusion range: 1100-1230°C

[#]Ceramicor, fusion range: 1360-1480°C

the surfaces of the Sargenti posts are smooth, they can also be used for recording the post hole when using the indirect technique of fabricating the cast post-core foundation.

10.4 Cendres & Métaux Wires*

These are prefabricated, wrought precious metal wires designed for use with the Whaledent Para-Post System and are normally supplied in 20 cm lengths. The wires are serrated and have a venting channel along the entire length and are available in either Pivotor or the high-fusing alloy, Ceramicor. Five sizes are available and are identical to those of the Whaledent Para-Post System. In fact, because only the length of the precious metal post required is cut and shaped, the cost for an individual post is generally lower than the wrought gold Para-Post. For this reason, the distributor has advised that the Cendres & Métaux wires are gradually becoming a popular substitute for the wrought gold Para-Post.

10.5 The Hannah Post-core Pattern System@

10.5.1 *Instrumentation*

These prefabricated nylon post and core patterns were introduced by Hannah in 1970, in an effort to simplify the fabrication of cast post-core foundations for anterior pulpless teeth by the direct technique. The post patterns are parallel-sided for maximum retention within the prepared root canal and are made of nylon because the physical characteristics of inlay casting wax limit their use in preparing parallel-sided post patterns (Hannah, 1973). The nylon post patterns are circular in cross section with a diameter 0.03 mm less than standard-sized flat fissure burs. The core patterns are also prefabricated in nylon and are a tight, sliding fit on the post. Two sizes of post

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*Cendres & Métaux S.A., Biel-Bienne, Switzerland

@C. M. Hannah, Manchester, England

patterns are available for clinical use. They match the No. 5 (1.60 mm) and No. 7 (2.10 mm) flat fissure burs and have a diameter of 1.57 mm and 2.07 mm, respectively.

10.5.2 *Clinical procedures*

To use the Hannah post and core patterns effectively, crown reduction and root face preparation are carried out as described by Kantorowicz (1970, p.96) to produce palatal and labial inclined planes converging to an apex line angle which bisects the orifice of the root canal (5.5.1). The post hole is prepared initially by using flat or tapered fissure burs that are at least two standard sizes smaller than that necessary for the selected post. The final preparation of the root canal is carried out with the No. 5 (016) or No. 7 (021) flat fissure bur to the determined depth. When the root face and canal preparation have been completed, an anti-rotational notch is added to the palatal inclined plane of upper anterior teeth or to the labial plane of lower anterior teeth.

After inserting the selected post pattern into the prepared canal, the nylon core is fitted onto the projecting end of the post. A small amount of uniformly softened inlay wax is added to the fitting surface of the core and the core is immediately drawn down the post until its root face surface contacts the apex angle of the root face. This procedure forces the softened inlay wax into the anti-rotational notch and expresses the excess over the planes of the root face beneath the core. The excess wax is trimmed away and the assembled pattern is withdrawn from the root by grasping the projecting free end of the post which later can serve as a sprue during the investing and casting procedures (Fig. 10.14). The nylon post and core patterns burn out completely when the casting temperature is reached. Any casting alloy acceptable for use as post-core foundations may be used.

As mentioned earlier, these prefabricated nylon post and core patterns were intended to simplify the direct fabrication of cast post-core foundations. However, if the indirect technique is preferred, the nylon post pattern is flattened at the coronal end to ensure retention in the impression material.

10.6 K.D. Gold Post System*

10.6.1 *Design principles and instrumentation*

Like the Hannah post-core patterns, the K.D. Gold Post System consists of prefabricated plastic post-core patterns designed for the construction of cast post-core foundations. As discussed in 5.5.5, one of the advantages claimed by some clinicians for the indirect technique is that both the post-core foundation and the overlying crown may be made on the same model. However, while the marginal fit of the post-core and the crown may be satisfactory on the model, after the cementation of the post-core in the tooth, there is usually a lifting of the crown from the margin of the preparation due to the intervening layer of cement. Thus, when the overlying crown is cemented, the thickness of cement at its margin is, theoretically, at least doubled. The K. D. Gold Post System is a technique that is intended to overcome this potential disadvantage of the indirect method by compensating for the thickness of cement between the post-core and the root.

10.6.2 *Clinical and laboratory procedures*

In this technique (Fig. 10.15), a plastic core and its smooth, parallel-sided plastic post are fitted to the root; only one size is available. Instructions for this technique are outlined in the legend for Fig. 10.15. Engine reamers supplied for the initial preparation of the canal are similar to the Peeso reamers described earlier. In order

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*Cottrell & Co., London, U.K.

to achieve close contact between the root face and the plastic "precision pattern", the root face is ground flat and the "root facer" (Fig. 10.16) is used to prepare a seat approximately 1 mm deep, into which the core is seated. A "key" is prepared in the root face to prevent rotation. The plastic post is shortened until the core is firmly seated in the root-face preparation. The plastic core may then be prepared to the shape of a jacket crown preparation either before an impression is taken or after the model has been cast from the impression. The completed plastic post-core pattern is then invested and cast as normal. A perforated "K" disc (cement spacer) is slid over the cast post until it contacts the under-surface of the core and the post-core casting is reseated in the model. The overlying crown is then made. At the next visit, the post-core foundation and the crown are tried in and cemented.

10.7 Charlton Post-Core System*

10.7.1 *Design principles*

Developed by Charlton (1965), these are prefabricated one-piece, post-core foundations made of stainless steel and are designed to support a porcelain jacket crown. It consists of a smooth, parallel-sided post and a partially shaped core blank with flat facets mesially and distally. These facets face the sides of a labio-lingual slot which is cut in the root face (Fig. 10.17), providing resistance to rotational forces. Several factors were considered in the design of these prefabricated post-core foundations (Charlton, 1965):

1. Wrought stainless steel would make much stronger post-cores than cast gold.
2. Parallel-sided posts offer maximum retention.
3. Parallel-sided posts offer maximum resistance to lateral forces.

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*G. Charlton, U.K.

4. A parallel-sided post transmits axial forces in line with the long axis of the tooth, but a tapered post also transmits forces to the walls of the root canal. If the core shoulder does not fit closely to the root face, the wedging effect will tend to split the root (5.4.11).

5. Rotational forces are best resisted by a flat plane in line with the 'radius' of the root face and parallel with the long axis of the root. This is discussed in 5.5.4.

10.7.2 *Instrumentation*

The one-piece post-cores are made from a rod of wrought stainless steel 4 mm in diameter, and is turned to shape by the manufacturer. The flat surfaces are produced by grinding or filing. The posts are available in three diameters corresponding to the diameters of standard flat fissure burs number 5, 7 and 9, which are 1.7 mm, 2.1 mm and 2.6 mm respectively. The standard version post-cores have a length of post 10 mm long; a shorter 7.5 mm post is also available for use in shorter roots.

10.7.3 *Clinical procedures*

A modified 'roof top' preparation — with a labial and a palatal incline plane — is made on the root face taking the edges almost to the base of the gingival sulcus. The labio-lingual line angle is rounded so that no further preparation of the mesial and distal shoulders will be necessary after the post is cemented. The anti-rotational slot is prepared with a large diamond wheel 3 mm thick and at least 17 mm in diameter. The slot need not be more than 0.75 mm deep. The canal is enlarged with tapered fissure burs and the apical portion finally squared off with a flat fissure bur of the appropriate diameter (No. 5, 7 or 9). The post-core is fitted by shortening the post and by grinding the root fitting surface of the core as required. The stainless steel post core is cemented and the construction of the jacket crown is carried out in

the normal manner. Charlton indicated that any inaccuracy in the internal adaptation of the preformed post-core could be compensated by the luting agent during cementation.

10.8 Cendres & Métaux Cylindrical-Conical Post System*

10.8.1 *Instrumentation*

These are smooth, parallel-sided posts with a 6^{o} taper in their apical one quarter. The posts are available in the high-fusing Ceramicor for cast gold cores or porcelain-gold post-crowns and have a venting channel along their lengths. The heads of the precious metal posts are not flattened but instead are coated with a layer of adhesive for retention in the impression material and have coloured plastic rings for size identification. In 1981, a new range of titanium posts was introduced for core build-up with amalgam or composite resin and for the construction of temporary post-crowns. According to the manufacturer, titanium was chosen because of its tissue compatibility and corrosion resistance in the oral environment, and because it was also likely to be compatible with amalgam and composite resin. Both the Ceramicor and the titanium posts are available in six sizes, with the diameter of the cylindrical portion ranging from 1.20 mm to 1.70 mm. A matching series of six engine reamers are also supplied for the preparation of the root canal for post insertion. The titanium posts are flattened at the coronal end and are identified with a "T" on one side of the flattened portion and the size number on the other. The engine reamers are marked with coloured grooves according to the size of the instrument. A Thomas spanner-key which fits the engine reamers is also available for manual enlargement of the root canal. Important items of instrumentation are illustrated in Fig. 10.18.

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*Cendres & Métaux S.A., Biel-Bienne, Switzerland

10.8.2 *Clinical procedures*

Very few instructions on the clinical use of these posts were provided by the manufacturer. Although designed for the indirect method of fabricating cast post-core foundations, the Ceramicor-posts can also be used in the direct method. The polished coronal end of the post may be serrated for retention of the core pattern material and the post-core pattern completed in inlay wax or burnout acrylic resin, and cast in gold by conventional methods.

For the indirect method, the coloured plastic ring is removed and the impression is taken with an elastic impression material of choice. According to the manufacturer, if the root canals are divergent, the impression may still be removed and the posts may be precisely reseated in the impression with gentle finger pressure until elastic resistance is felt. After the construction of the die and working model, the manufacturer suggested that the Ceramicor post is carefully removed and a precious metal core foundation is cast directly onto the post. The presence of the venting channel may make it very difficult to remove the post without damaging the die.

Although the manufacturers did not include instructions for the clinical application of the new titanium posts, it should be possible to use these posts clinically in a manner similar to the stainless steel post technique described earlier in 10.1.32 for the Whaledent Para-Post System.

10.9 The Schenker Post System*

10.9.1 *Design principles*

The Schenker posts have been used clinically for over fifteen years. The shape of the post is unique in that it is basically a parallel-sided post except in the apical quarter where the post is stepped down in

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*Cendres & Métaux S.A., Biel-Bienne, Switzerland

diameter to allow the use of a longer post without the unnecessary weakening of this critical area of the root; this is a common criticism of parallel-sided post systems. The surfaces of the post are sandblasted for better cement retention and a groove is provided along the entire length of the post to allow the escape of excess cement, thereby reducing the build-up of hydraulic pressure during post insertion and improving the likelihood of complete seating of the post. A set of reamers and burs, matched to the shape and dimensions of the post, are provided for the preparation of an accurately shaped canal; the need for root canal impressions is therefore eliminated by the use of the well-fitting prefabricated posts.

10.9.2 *Instrumentation*

The Schenker posts are available in only two sizes and in three different materials - Pivotor, Ceramicor and stainless steel. The flattened coronal end of the posts is serrated and stamped with the letters 'P', 'C' or 'X' respectively for identification of the post material. The indications for the use of the Pivotor and Ceramicor alloys were stated in 10.3 (Sargenti Post System). Matching stainless steel posts are provided for use in impression procedures or to retain temporary post-crowns pending cementation of the finished cast post-core foundation. The manufacturers recommended against the use of the stainless steel posts as permanent posts.

Both the small and the large size Schenker posts are 15 mm long. The diameter of the coronal portion of the small posts is 1.4 mm, while the apical 4 mm of the post is stepped down to 0.9 mm. The large size Schenker posts have a coronal cross-sectional diameter of 1.9 mm and is stepped down to 1.0 mm in the apical portion (Fig. 10.19).

10.9.3 *Clinical procedures*

The preparation of the root canal for post insertion is somewhat different from those described for the other parallel-sided post systems.

Following the removal of the coronal gutta percha root filling to the desired depth preliminary preparation of the canal should be carried out by reaming with a size 70 reamer to that level. Secondary preparation for the post is carried out by the use of the twist drills provided — 0.9 mm for the small posts, then proceed to the 1.0 mm diameter twist drill if the larger size posts are to be used. Final preparation of the wider coronal portion is effected by the use of the special Schenker bur which has a blunt tip to act as an apical stop and a guide.

In order to increase the stability of the cast post-core foundation and the retention of the cast core material to the post, the manufacturers recommended the incorporation of a "central inlay"; that is, to prepare an anti-rotational box into the occlusal entrance of the root canal.

The Schenker posts may be used like any other prefabricated precious metal posts in the direct or indirect methods of constructing cast post-core foundations. A precious metal core foundation is cast directly onto the post of the appropriate alloy.

10.10 Para-Post System (tapered end)*

10.10.1 *Design principles and instrumentation*

In order to reduce the risk of over-weakening or perforating the root in the apical region of pulpless teeth with a severe taper (while maintaining an ideal post length), a new range of stainless steel Para-Posts with a smooth, tapered apical section was introduced in 1980 (Fig. 10.20). These are available in four sizes — 1.0 mm, 1.25 mm, 1.5 mm and 1.75 mm diameter. The apical 3 mm of each size of post is tapered to a 0.9 mm diameter; to prepare matching post channels, a set of four colour-coded, tapered-end twist drills is provided.

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*Whaledent International, New York, N.Y., U.S.A.

10.10.2 *Clinical procedures.*

The root canal is initially prepared to the desired post length using the smallest (No. 3 — 0.9 mm diameter) twist drill in the kit. The coronal portion of the root canal is then enlarged with successively larger Para-Post dirlls to a level 3 mm short of the proposed post length. The appropriate tapered end twist drill is then used to shape the remaining apical 3 mm of the post hole. Apart from the post hole preparation procedures, the clinical application of these new stainless steel Para-Posts is identical to that described in 10.1.

10.11 Discussion

The principles for post design are discussed in detail in Chapter 5. The following is a summary of the different aspects relevant to the design of parallel-sided posts.

Posts that are passively cemented into the prepared root canals do not cause any undue stress concentration in the supporting structures in the unloaded state. When loaded, parallel-sided posts distribute occlusal stresses relatively evenly along their length, and stress distribution tends to concentrate in the shoulder and apical region.

Increasing the post length results in higher retention and more even stress distribution over a greater area of the root canal walls.

For a given post diameter, a wrought alloy post is stronger than a cast post made from the same material.

A parallel-sided post is more retentive than a tapered post of equal length.

A post with a serrated or roughened surface is more retentive than one with a smooth finish.

Despite their superior retentive and stress distributing properties, the main disadvantage of the parallel-sided posts is the necessity to remove more dentine internally, so that the post is supported by tooth structure along most of its length. This may further

weaken the already fragile structure and increase the potential for longitudinal fracture and root perforation (Burns, 1977). Considerable hydraulic pressure can build up during the cementation of this type of posts; venting by means of a groove or channel along the length of the post is therefore recommended. Pressure should be maintained on the post during the initial setting of the cement to prevent the parallel-sided post from lifting out of the post hole due to the hydrostatic back pressure of the cement (Standlee et al, 1972). According to the research by Jørgensen (1960), using zinc phosphate cement, an increase of cementation force up to five kilograms, reduced the cement film thickness. However, forces in excess of this did not result in further reduction. He suggested that the pressure be maintained on the cemented restoration for at least one minute. The benefits of venting a restoration (or a post) was demonstrated by Dimashkieh et al (1974). They found that, by means of venting, the time of final seating of a crown can be reduced from one minute (in a non-vented crown) to about 15 seconds.

The important features of these parallel-sided and parallel-tapered post systems are summarized in Table 10.2. It is apparent from the earlier description of the parallel-sided post systems that prefabricated post-cores such as the K.D. Gold Post System, the Hannah and the Charlton post-core systems, can simplify the construction of a post-core foundation considerably. However, all of these methods entail the removal of most or all of the clinical crown of the pulpless tooth. Therefore, unless there is already substantial loss of the clinical crown, this is achieved only at the expense of sound coronal tooth structure and a certain degree of accuracy of internal adaptation. This is particularly so with the Charlton post-core system where the clinician must rely on the luting cement to correct any deficiency in the internal adaptation of the prefabricated post-core to the prepared root. The size

range available for these systems may also be considered inadequate. The Hannah and the Charlton systems are designed for post holes prepared with standard size round and fissure burs. As discussed in 7.6, these rotary instruments have very efficient side-cutting as well as end-cutting action and working blindly against the soft dentinal walls of the root canal, the risk of complications is high. In general, the end result of such "time-saving" techniques leaves a lot to be desired.

According to Baraban (1970), the main advantage of the Para-Post System is the ease with which patterns for cast metal post-core foundations can be constructed directly in the mouth. The prefabricated plastic or precious metal posts and matching drills eliminate the often time-consuming task of fabricating a post pattern. With the large selection of post diameters and materials, this system "provides a wide range of flexibility and can be used in a myriad of clinical situations" (Henry and Bower, 1977,a). The serrated and vented post design by Courtade, is incorporated into the precious alloy, stainless steel and the plastic casting posts. Provision has been made for the use of auxiliary cylindrical pins in the cast post-core foundations and the system can be used conveniently in the anterior as well as the posterior region of the mouth. Smooth plastic impression posts and aluminium temporary posts simplify the impression procedures and the construction of temporary post-crowns. Because of the large number of components in the system, colour-coding for size identification has been found to be helpful. Although the manufacturer claimed that the Para-Post drills are "safe end" twist drills, this is not so. Their end-cutting action will lead to perforation if they are not used with care. The plastic impression post should be lubricated before pouring the stone model, to facilitate its subsequent removal. Henry and Bower(1977,a)recommended this system as the "general system of choice" when cylindrical posts are indicated.

The Sargenti Post System is a simple system with only two sizes available. It offers little advantage over the Para-Post System except for the choice of the two types of precious alloy — Pivotor and Ceramicor. The Wiptam and the Cendres & Métaux wires may be used to provide a more economical alternative to the cast gold core with wrought gold Para-Post. Because the Cendres & Métaux wires have the same size range as the Para-Post System and are cut to length as required, the cost per post is generally lower than that of a prefabricated wrought gold Para-Post. The Wiptam system is ideal for use with base metal cores when the cost of the precious alloy is a problem. These nickel-cobalt-chromium posts have the strength, corrosion resistance and the high melting temperature necessary for use in cast post-core foundations. Hand instrumentation of the root canals with the Panadrills reduces the risk of perforation. Serrating and venting the Wiptam posts should further improve the clinical performance of this "low cost" post system.

One of the constant criticisms of the parallel-sided post system is the necessity to widen the apical region of the root canal in order to gain adequate support for the post. Acknowledging this fact, some manufacturers of parallel-sided posts have introduced cylindrical posts with a modified apical section. The new Cendres & Métaux cylindrical-conical posts are available in six diameters and have a uniform 6^{o} taper in the apical quarter of the post. The wrought precious alloy posts are vented; the titanium posts are not. The new range of stainless steel Para-Posts are also tapered in the apical 3 mm. The degree of taper increases as the diameter of the coronal portion of the post increases. (All the posts have a diameter of 0.9 mm at the apical end).

The Schenker posts are perhaps the closest any prefabricated posts have come to conforming to the natural shape of the root canal while remaining basically a parallel-sided post. The decreased diameter in the apical section of the post makes it possible to use longer post length

without the risk of weakening the apical region of the root. The Schenker posts are available in Pivotor or Ceramicor alloys, and are vented and sandblasted. Although stainless steel posts are also available, the manufacturers recommended them as suitable only for use in temporary restorations; they appeared to have made no provision for the use of the Schenker posts in amalgam or composite resin core foundations. In addition, the Schenker Post System offers an inadequate size range in comparison with other systems. It is unfortunate that this system has received only relatively limited attention, presumably due to the above factors. Serrating the post surface for increased retention and, extending the range of post diameters and materials in the Schenker Post System may make it a versatile system adaptable for use in a wide range of clinical situations.

Summary

Whenever the anatomy of the endodontically-treated tooth allows, passively-cemented, parallel-sided posts should be used. If, even with the use of the parallel-tapered post systems, undue weakening of the remaining pulpless tooth is inevitable, an alternative design or a custom cast post should be considered.

PASSIVELY-CEMENTED, PARALLEL-SIDED AND PARALLEL-TAPERED POST SYSTEMS

	PARALLEL-SIDED POST SYSTEMS							PARALLEL-TAPERED POST SYSTEMS		
	Para-Post System (standard)	Wiptam Post System	Sargenti Post System	Cendres & Métaux Wire	Hannah Post-core Pattern System	K.D. Gold Post System	Charlton Post-core System	Cendres & Métaux Post System	Schenker Post System	Para-Post System (tapered end)
Surface finish	serrated	smooth	sandblasted	serrated	smooth	smooth	smooth	smooth	sandblasted	serrated
Venting	yes	no	no	yes	no	no	no	yes(gold) no(titanium)	yes	yes
Sizes	5	5	2	5	2	1	3	6	2	4
Material	iridio-platinum stainless steel plastic aluminium nickel-silver	nickel-cobalt-chromium	Pivotor* Ceramicor*	Pivotor Ceramicor	plastic	plastic	stainless steel	Ceramicor titanium	Pivotor Ceramicor stainless steel	stainless steel
Other features	colour-coding provision for auxiliary pins	post cut to length required hand instrumentation		available in 20 cm lengths	plastic core pattern	plastic core pattern	stainless steel core			

* Cendres & Métaux, SA, Biel-Bienne, Switzerland

TABLE 10.2

Fig. 10.1 Some components of the Para-Post System (refer to 10.1.2) — L. to R.

Size 7 root canal drill, stainless steel post, plastic burn-out casting post, aluminium post for temporary restoration, plastic impression post, paralleling jig, platinum-iridium pin, plastic impression pin, aluminium pin, Paramax drill for the pins.

Fig. 10.2 a. First premolar tooth requiring endodontic treatment and restoration.

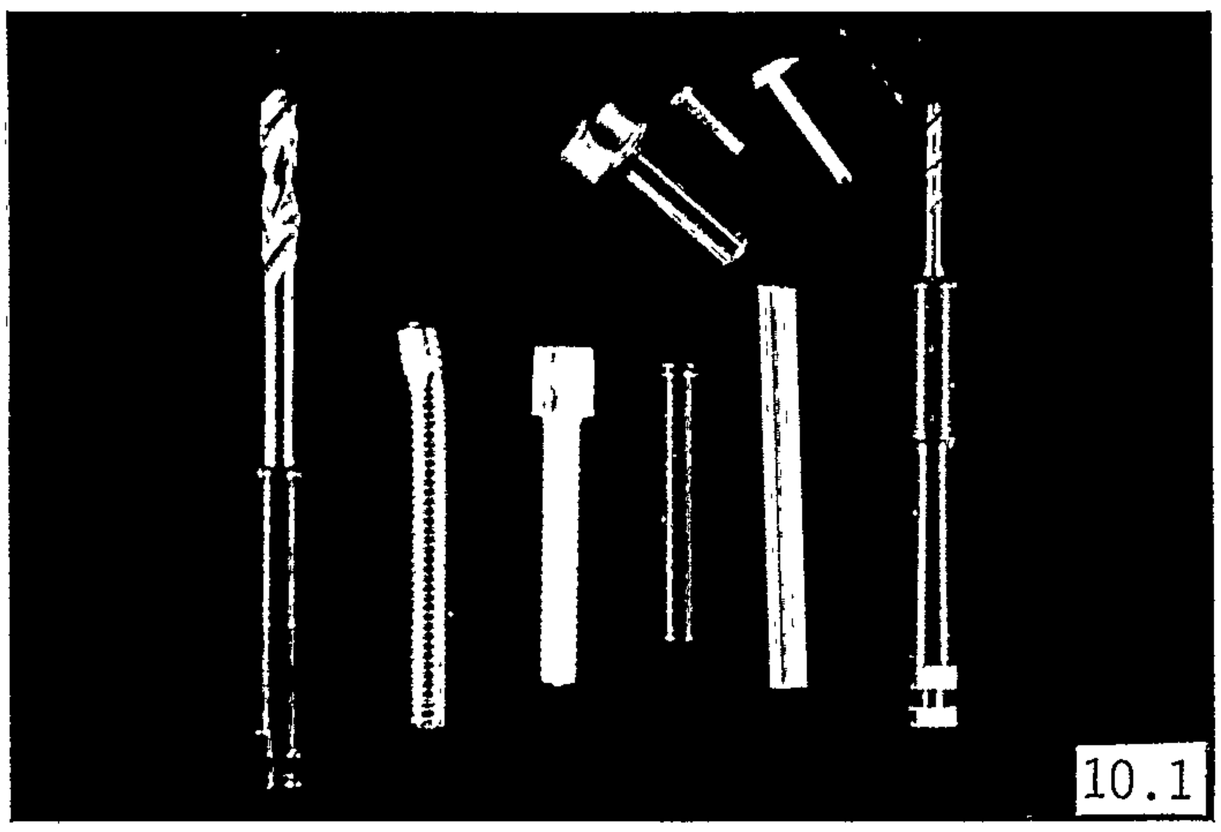
b. Preparation of the pin hole for the auxiliary pin with a paralleling jig.

c. Prepared tooth with appropriate pattern posts and pins in place.

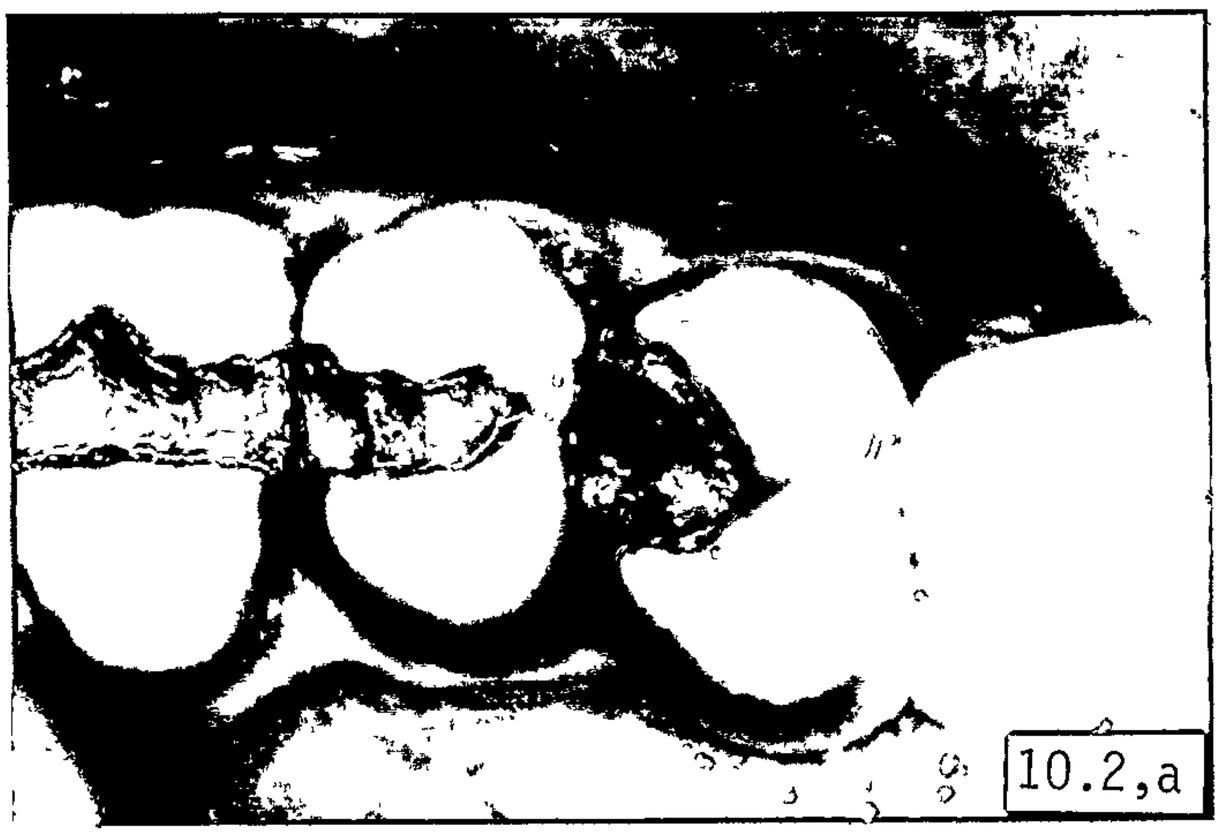
d. Burn-out acrylic resin post-core pattern.

e. Cast gold post-core foundation cemented in the pulpless tooth.

Fig. 10.1; 10.2



10.1



10.2,a

10.2,b

10.2,c

10.2,d

10.2,e

Fig. 10.3

(For Legend, refer to 10.1.31)

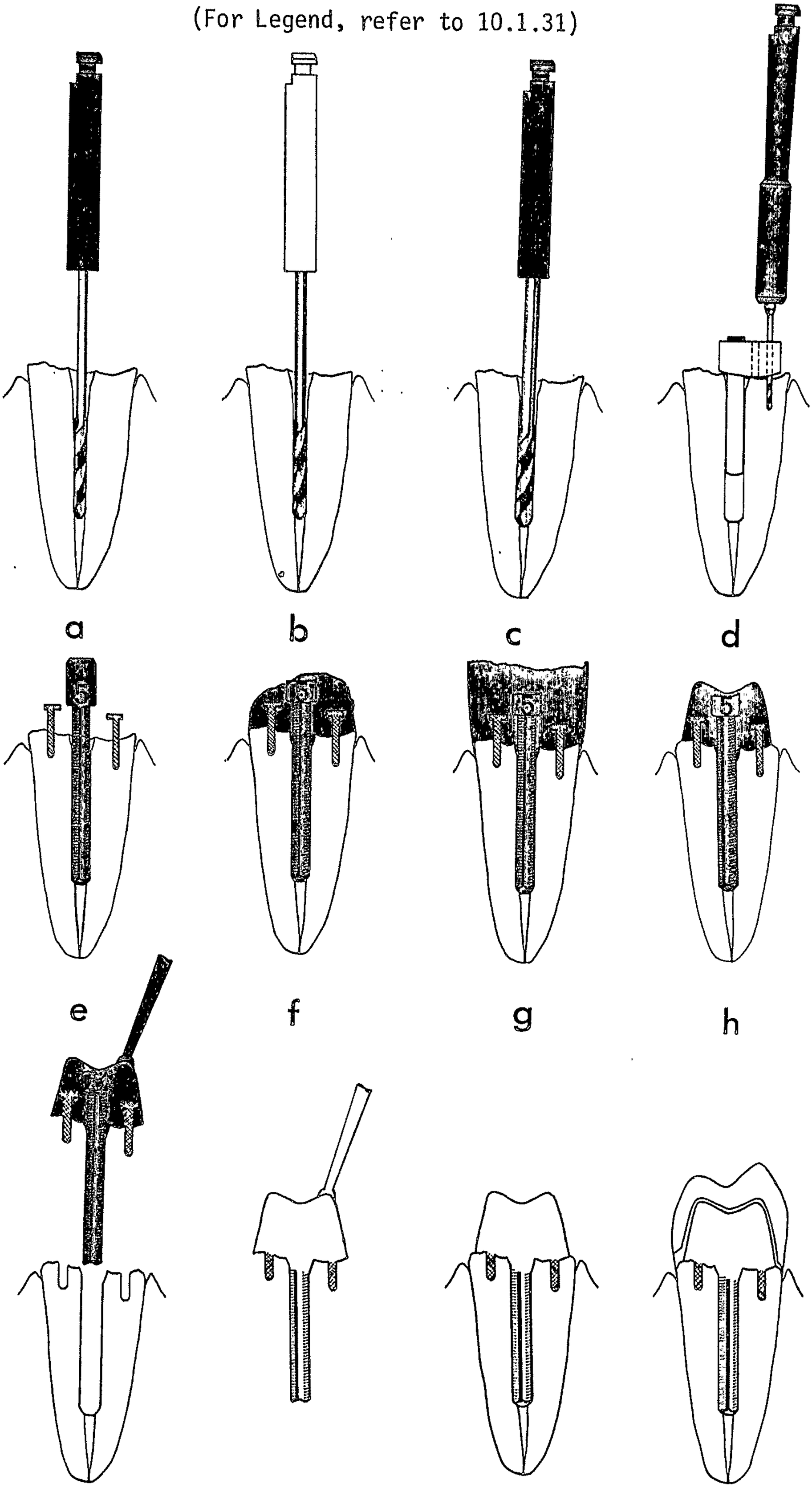


Fig. 10.4 Cast post-core foundations for pulpless teeth with divergent canals.

a. endodontically-treated molar tooth before preparation for cast post-core foundation.

b. cast gold core with cemented post in divergent canals.

c. interlocking dovetail design.

d. interlocking lug design.

e. horizontal bolt design.

f. cast metal core with divergent preformed channels.

Note: These designs may be modified for most prefabricated post systems.

Fig. 10.4

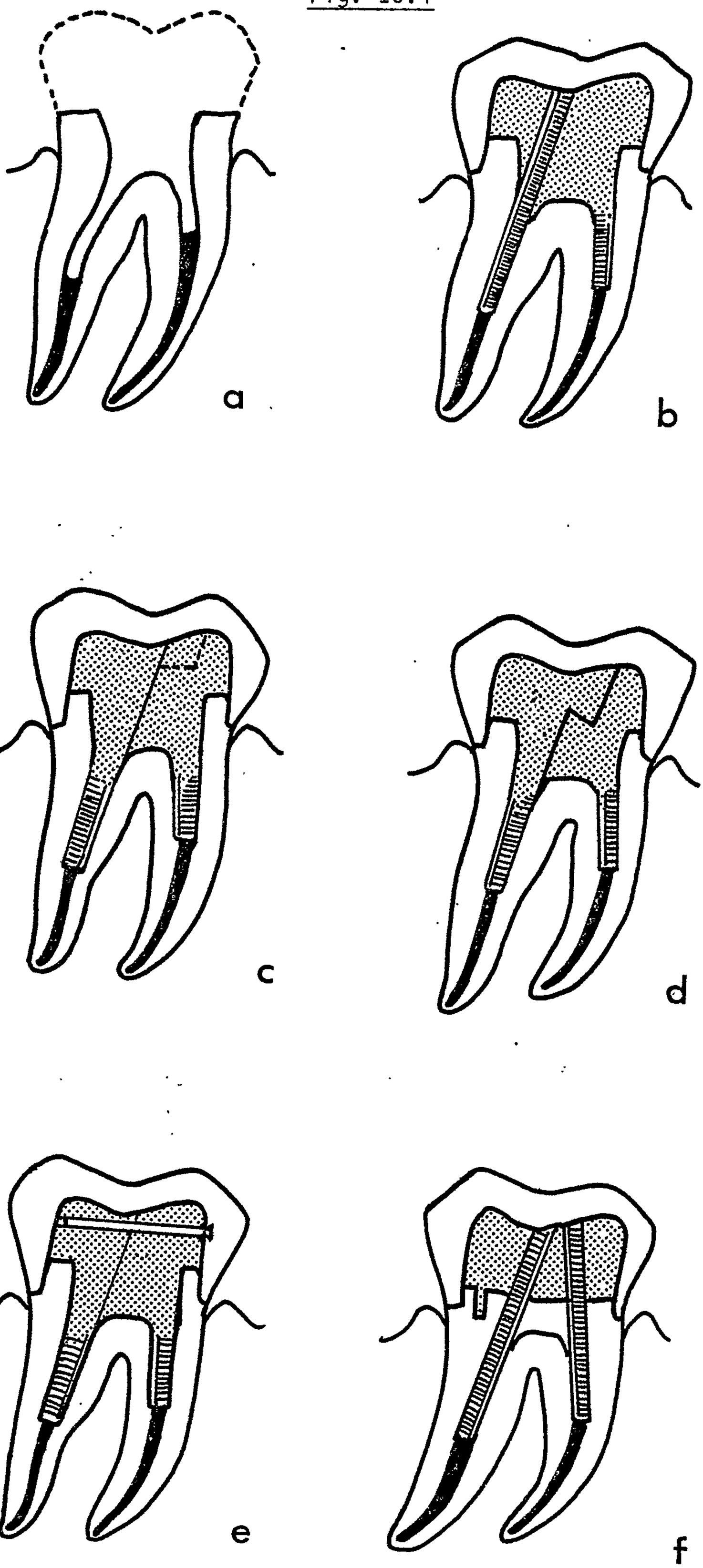


Fig. 10.5 a. Tooth preparation with lubricated nickel-silver post in divergent canal and wrought gold or plastic burn-out post in main canal.

b. Pattern for cast post-core foundation prepared in burn-out acrylic resin.

c. Nickel-silver post removed from canal to allow withdrawal of post-core pattern.

d. Nickel-silver post re-inserted before investing post-core pattern.

e. Gold post-core casting with nickel-silver post.

f. Nickel-silver post dissolved in warm concentrated nitric acid.

g. Cemented cast gold post-core foundation with divergent post (wrought gold or stainless steel post).

Fig. 10.5

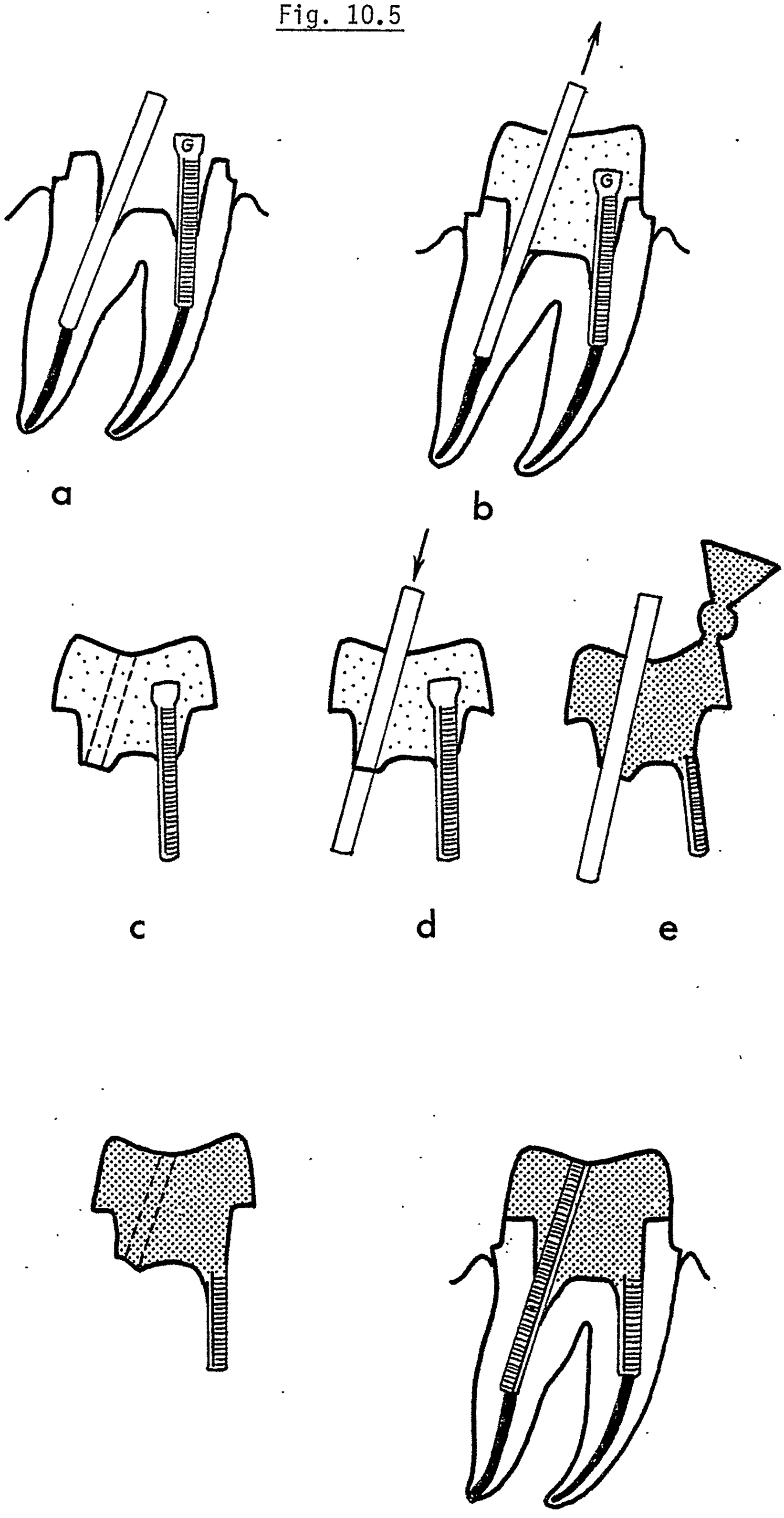


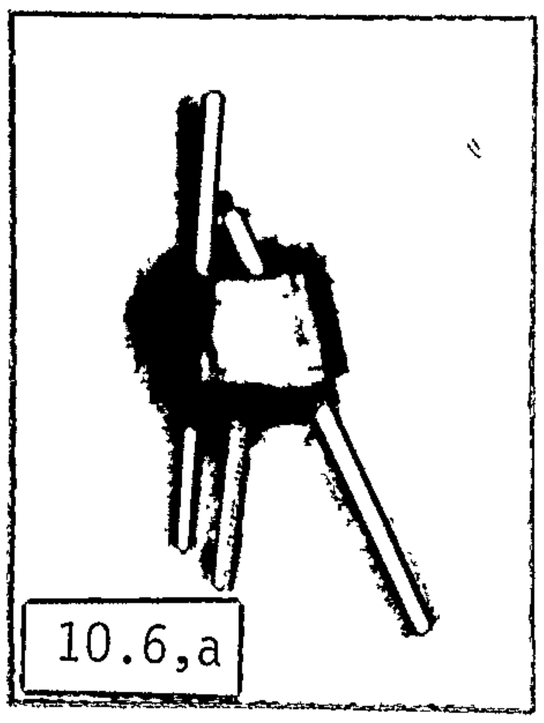
Fig. 10.6 a. Burn-out acrylic resin core pattern with an iridio-platinium "master" post and two nickel-silver posts incorporated in it.

b. Cast gold post-core foundation in place. Note that the nickel-silver posts have been replaced by the stainless steel posts.

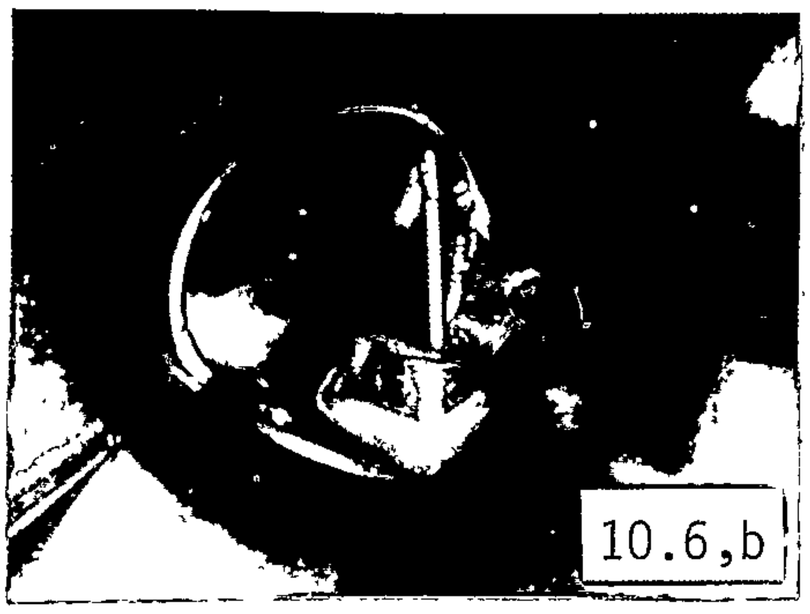
c and d. The completed post-core foundation.

Fig. 10.7 A two-unit cast gold post-core foundation in a premolar tooth with divergent canals.

Fig. 10.6; 10.7



10.6,a



10.6,b

10.6,c

10.6,d

10.7,a

10.7,b

Fig. 10.8 The stainless steel post-amalgam core foundation technique.

a. Pulpless premolar tooth with fractured palatal cusp.

b. Existing restoration removed and the fracture site exposed by electrosurgery.

c. Stainless steel post cemented into the root canal. Note that excess cement around the coronal portion of the post have been removed and that as much sound tooth structure as possible was retained.

d. Completed amalgam core foundation ready for the preparation for the final coronal restoration.

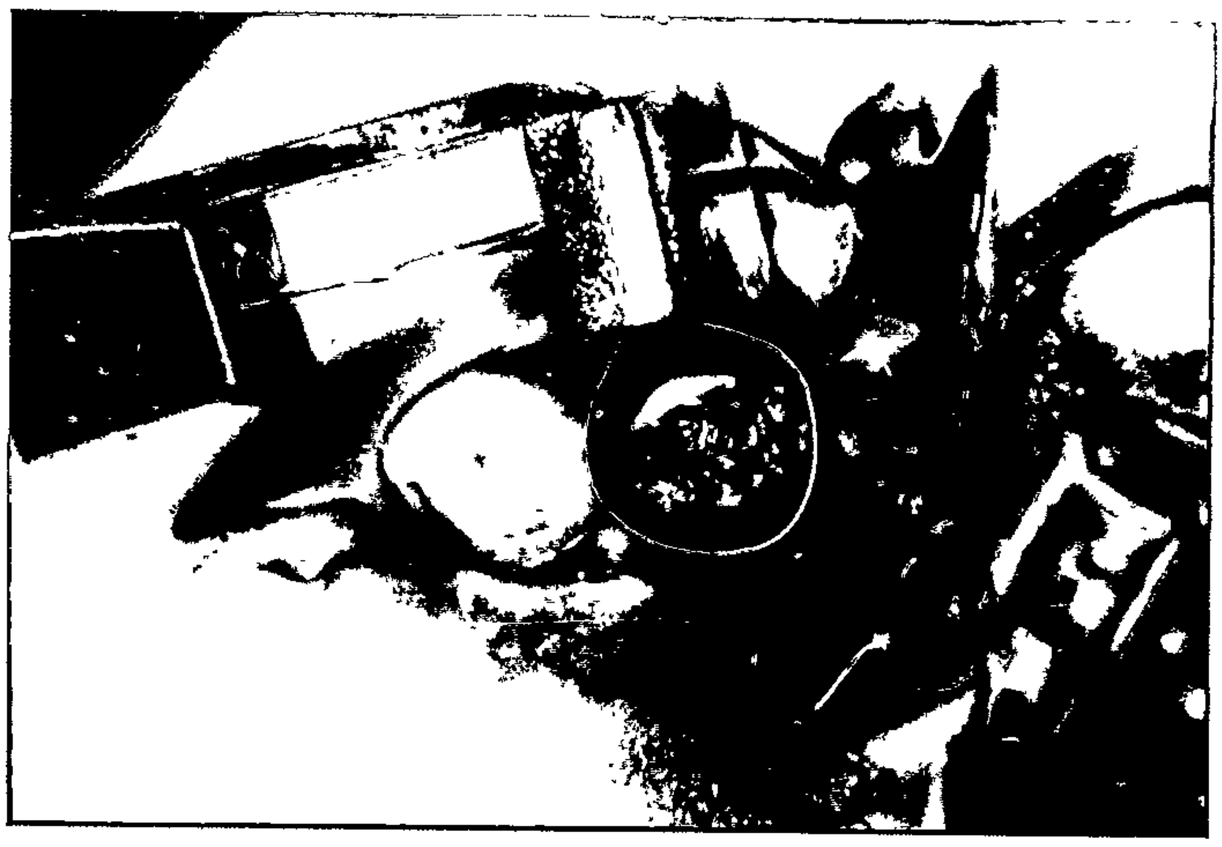
e and f. Porcelain fused to metal crown 2 years after insertion.

Note: The Para-Post System was used in this clinical case.

Fig. 10.8

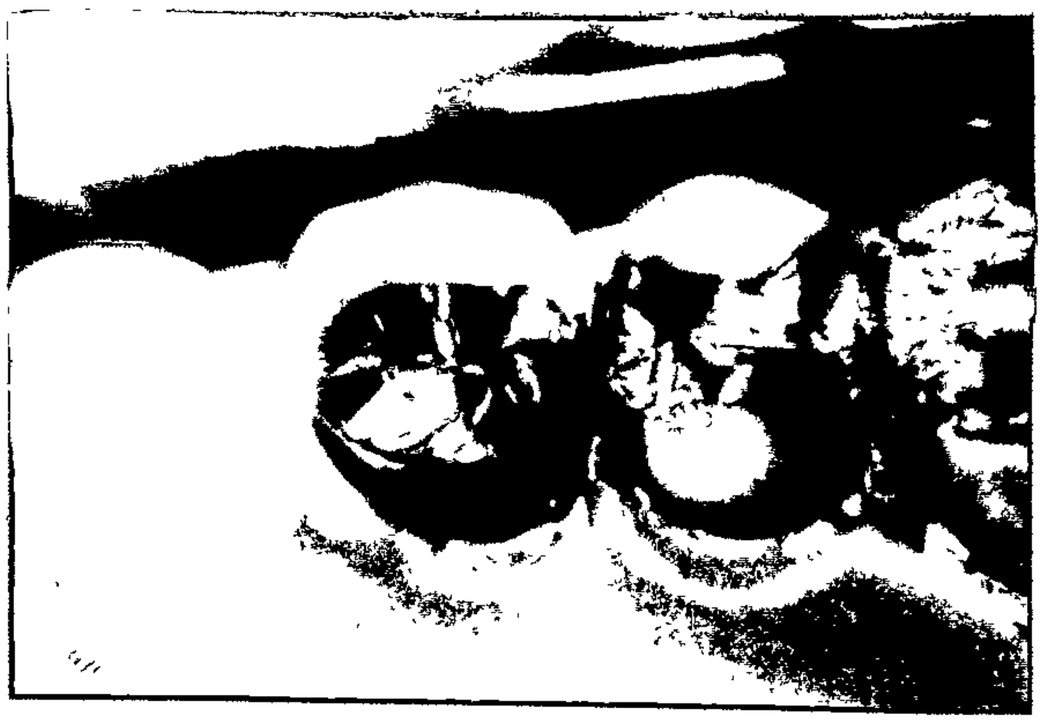
10.8,a

10.8,b



10.8,c

10.8,d



10.8,e

10.8,f

Fig. 10.9 For legend, refer to 10.1.32.

Fig. 10.10 For legend, refer to 10.1.33.

Fig. 10.11 Panadrills for use with the Wiptam Post System (refer to 10.2)

Fig. 10.13 The Sargenti Post System (refer to 10.3.1)

Fig. 10.9; 10.10; 10.11; 10.13

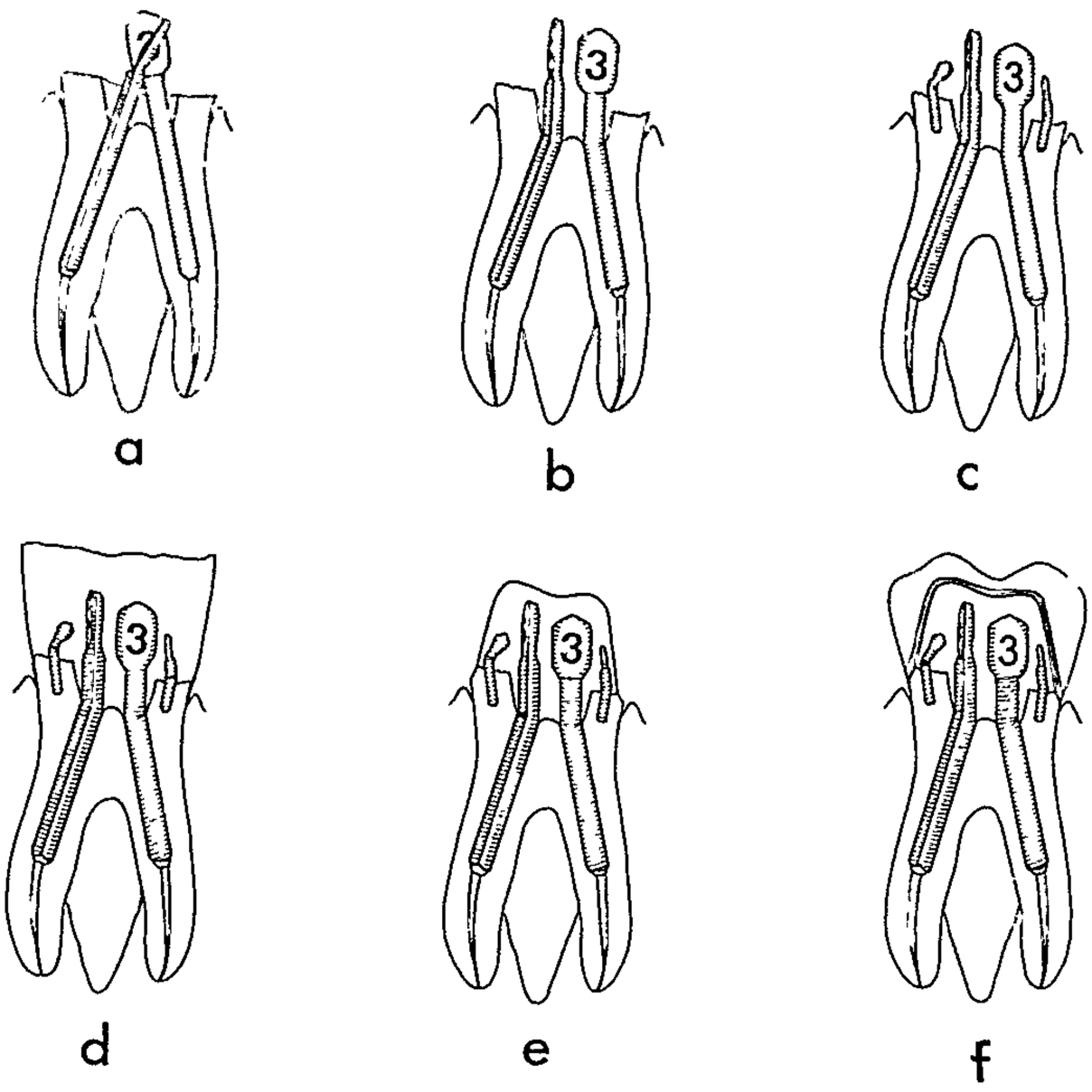


Fig.10.9

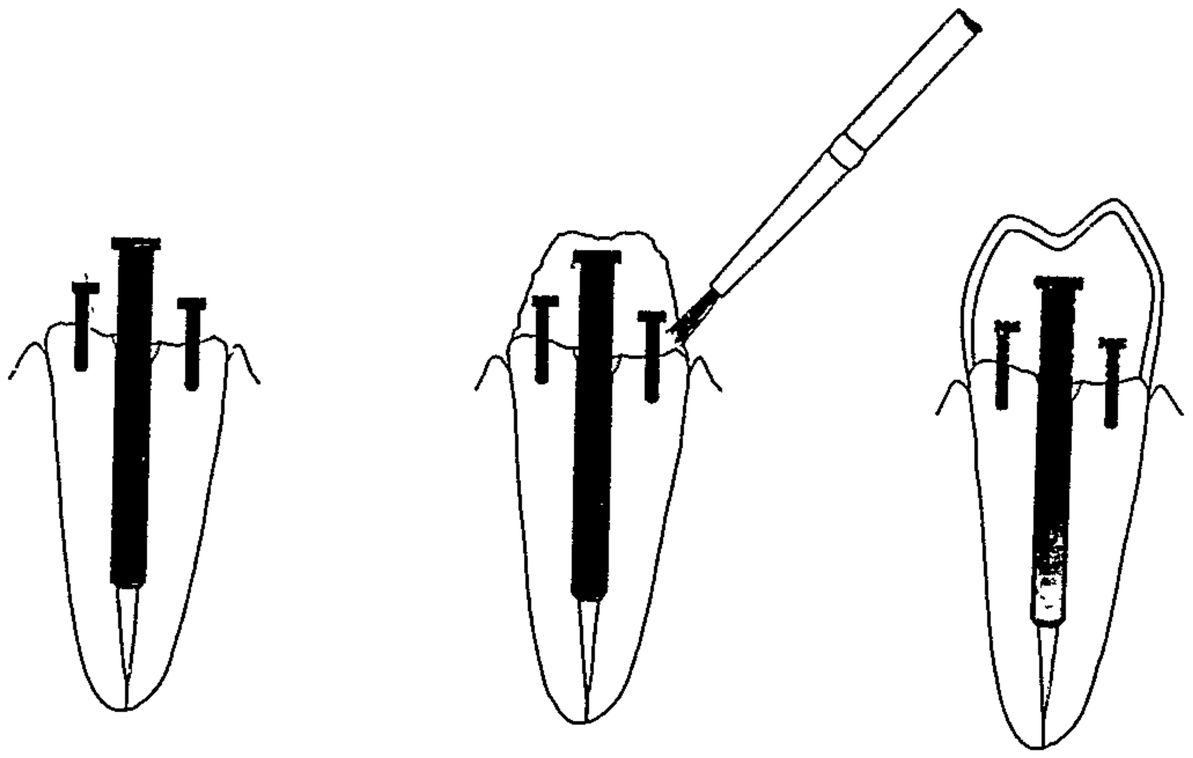
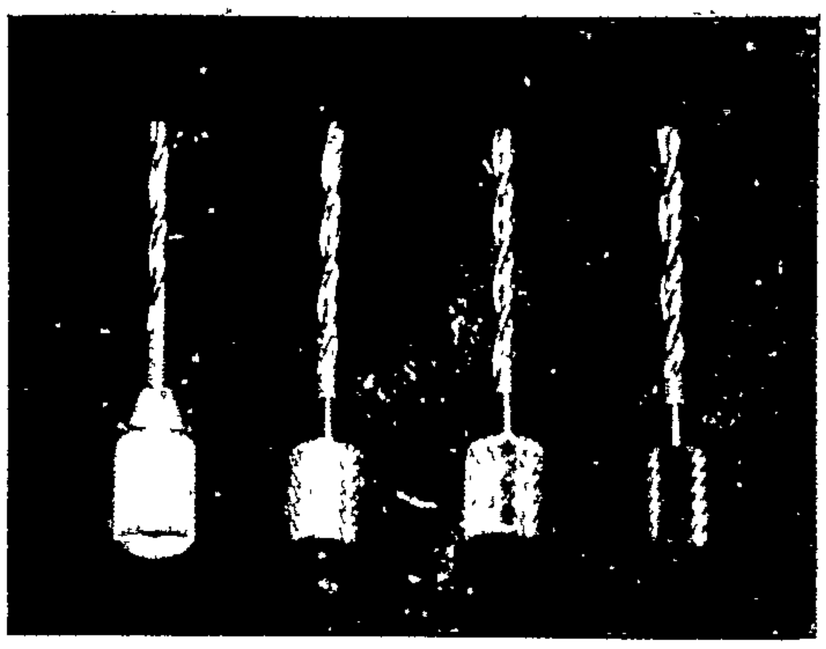
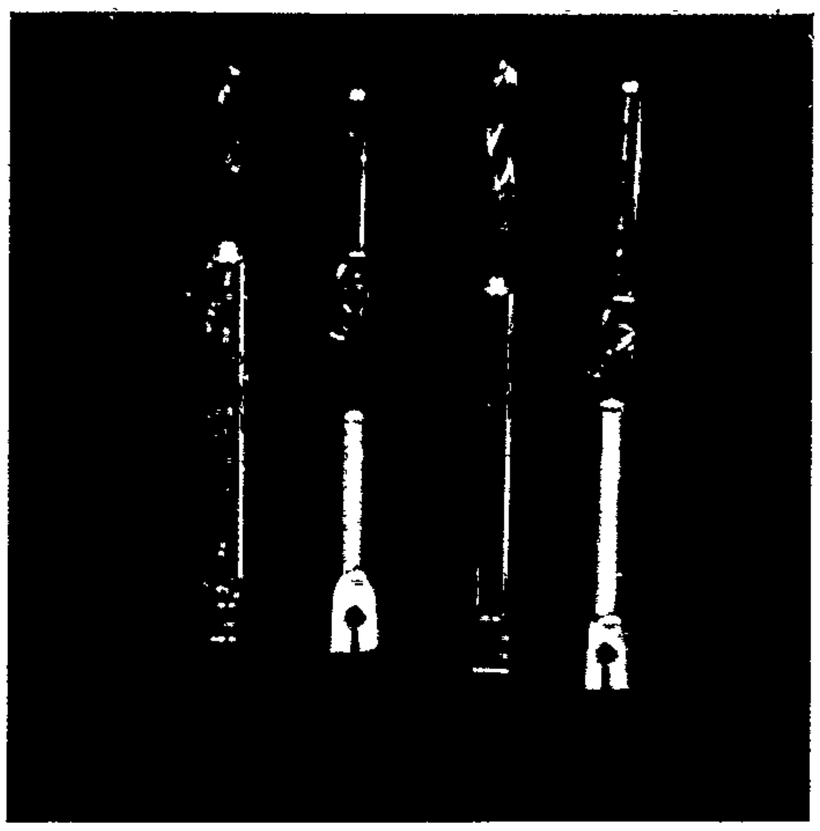


Fig. 10.10



10.11



10.13

Fig. 10.12 Wiptam Technique.

a. and b. Cast post-core foundations for single-rooted anterior and premolar teeth.

1. apical gutta percha filling.
2. apical seat of wrought post.
3. Wiptam post with serrations.
4. Cast anti-rotational device and core.
5. Coronal restoration.

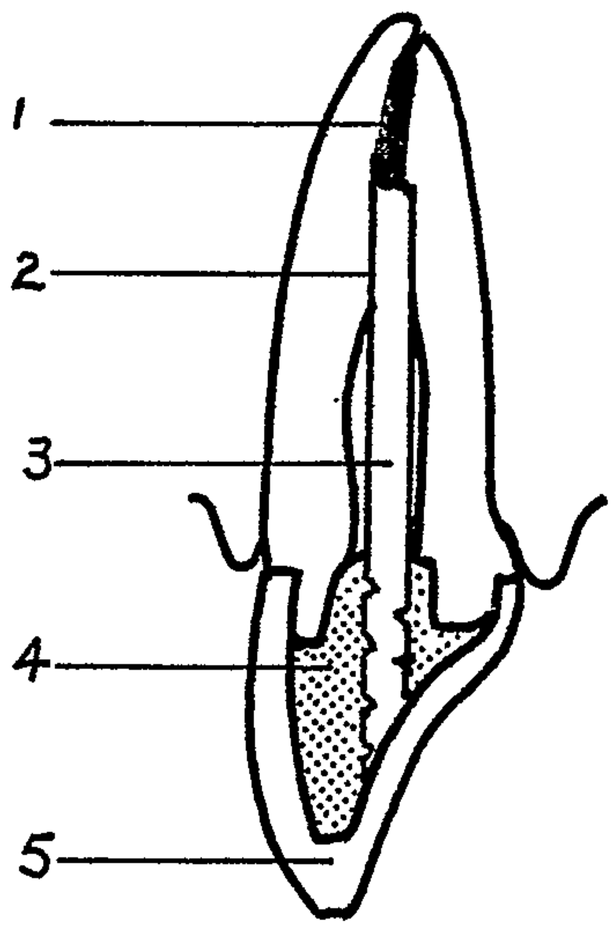
c. Cast metal post-core for pulpless tooth with divergent canals.

1. apical gutta percha filling.
2. cemented wrought Wiptam post.
3. cast metal core foundation.
4. coronal restoration.

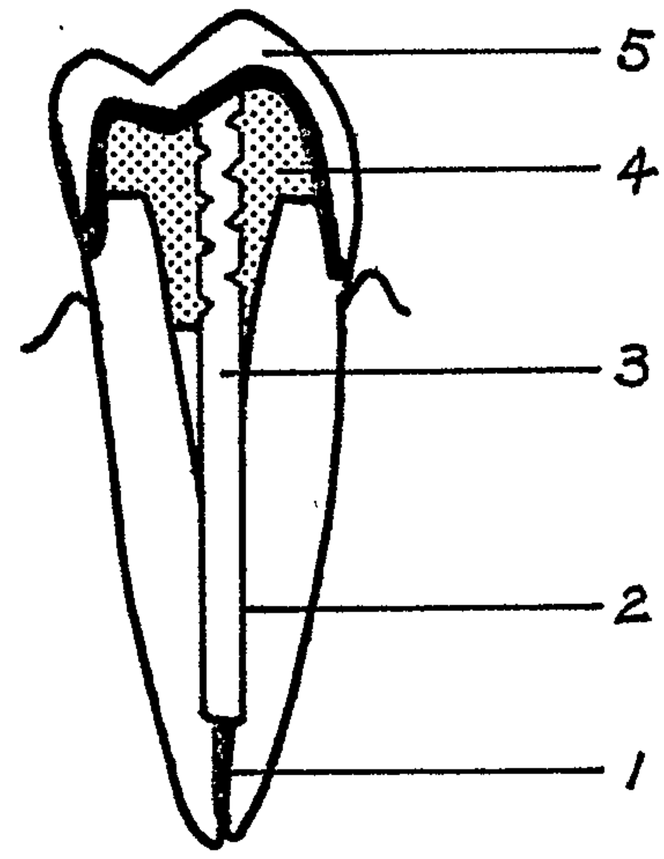
d. Amalgam or composite resin core foundation retained by cemented Wiptam wires.

1. apical seal.
2. wrought nickel-cobalt-chromium posts.
3. amalgam or composite resin core foundation.
4. coronal restoration.

Fig. 10.12



a



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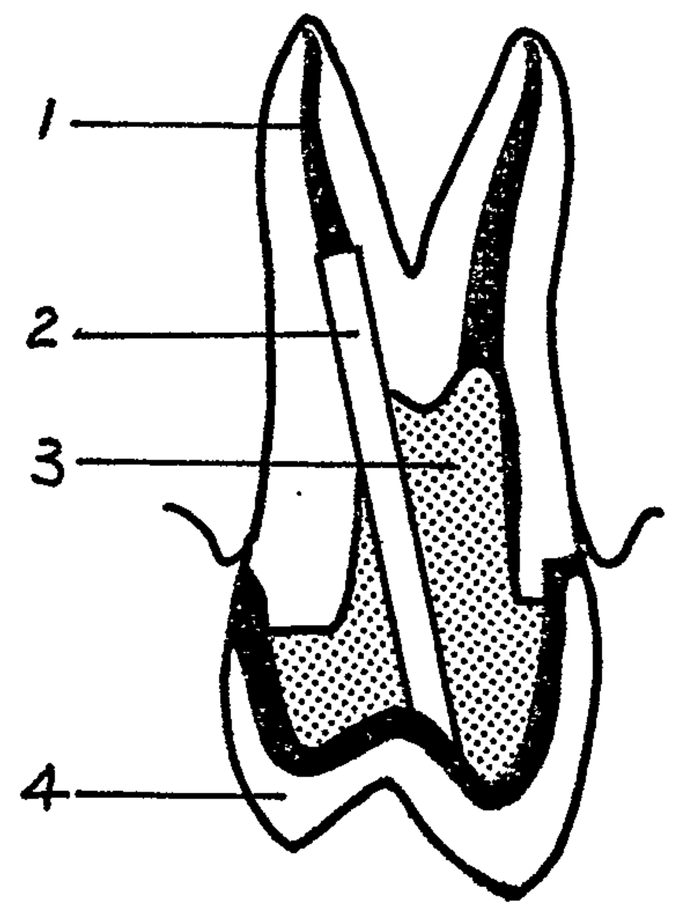
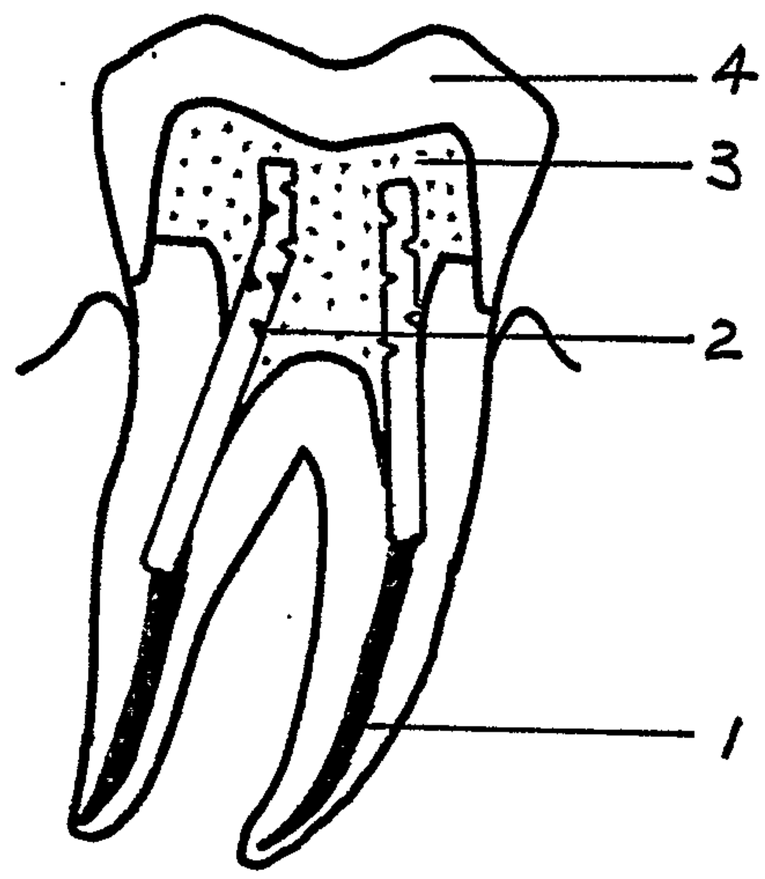


c



d

Fig. 10.14 The Hannah prefabricated post and core patterns.

1. Nylon post pattern.
2. Inlay wax.
3. Nylon core pattern.
4. Anti-rotational preparation.

Fig. 10.15 K.D. Gold Post System.

a. Using the engine reamers provided, the root canal is reamed to maximum depth with minimal widening.
b. With the "root facer" from the kit, the root face is prepared to form a "seat" approximately 1 mm deep into which the plastic core is seated.
c. The hand reamer provided is rotated into the canal. Firm pressure in an apical direction is required to extend the canal to the exact dimension of this instrument.
d. A "key" is prepared in the root face to resist rotational forces.
e. The plastic 'Precision Pattern' is tried in and the post is shortened as necessary until the core seats firmly on the prepared root face.
f. The plastic core and root face may now be prepared into a jacket crown preparation and an impression taken with the post-core pattern in position.
g. The plastic post-core pattern in the impression is well lubricated with Vaseline before the model is poured in stone. Inlay wax is added to the preformed post-core pattern to incorporate the anti-rotational key. The completed post-core pattern is then invested and cast in gold. A 'K' disc (arrowed) is slid over the cast gold post until it contacts the under surface of the core. The cast post-core foundation is returned to the model and the overlying crown is constructed.
h. The K.D. temporary post may be used to retain a temporary post-crown. With pliers, the angulation of the post can be adjusted if required. Compressing the post shank with pliers will ensure a firm fit in the root canal.

Fig. 10.14; 10.15

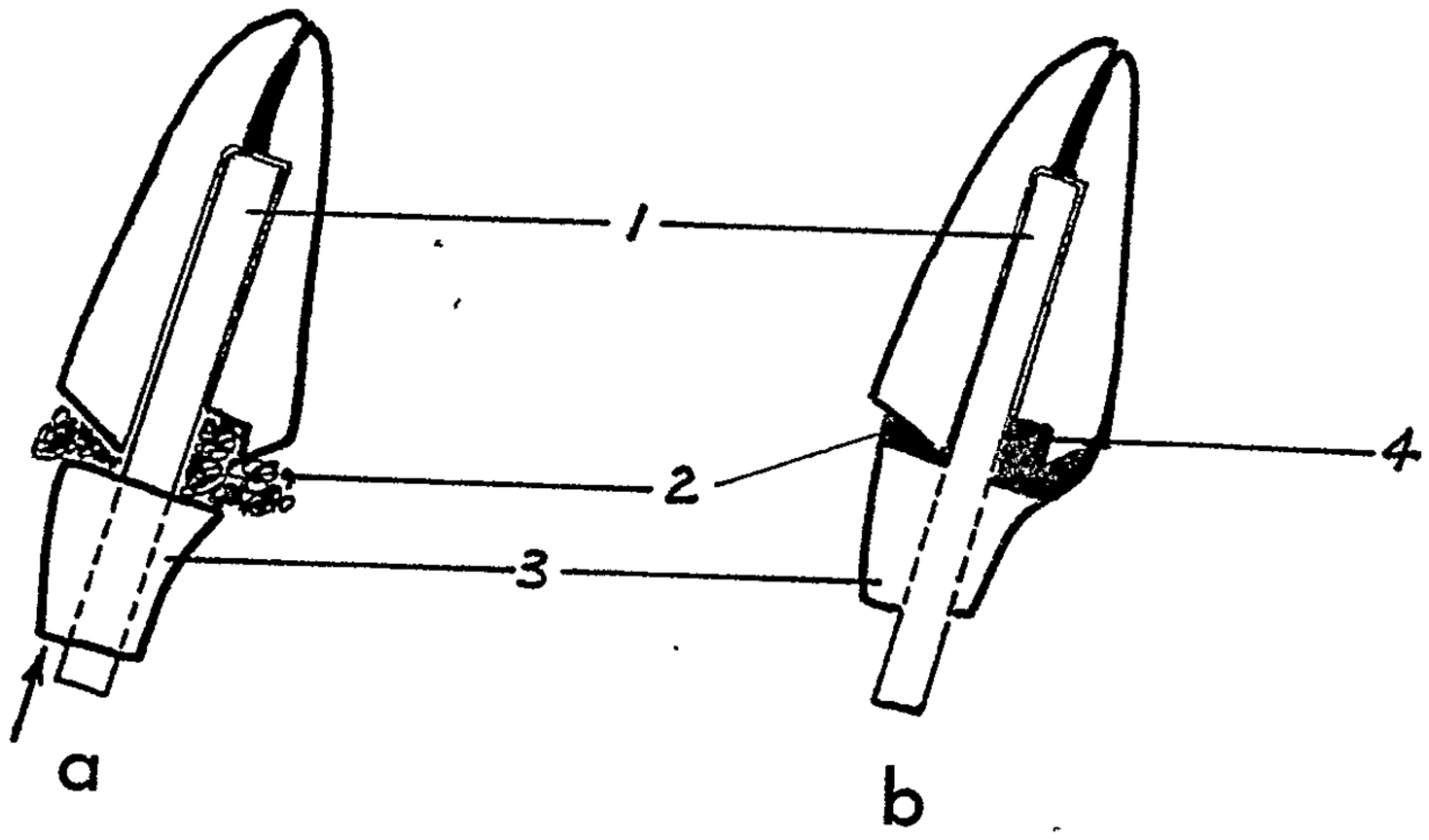
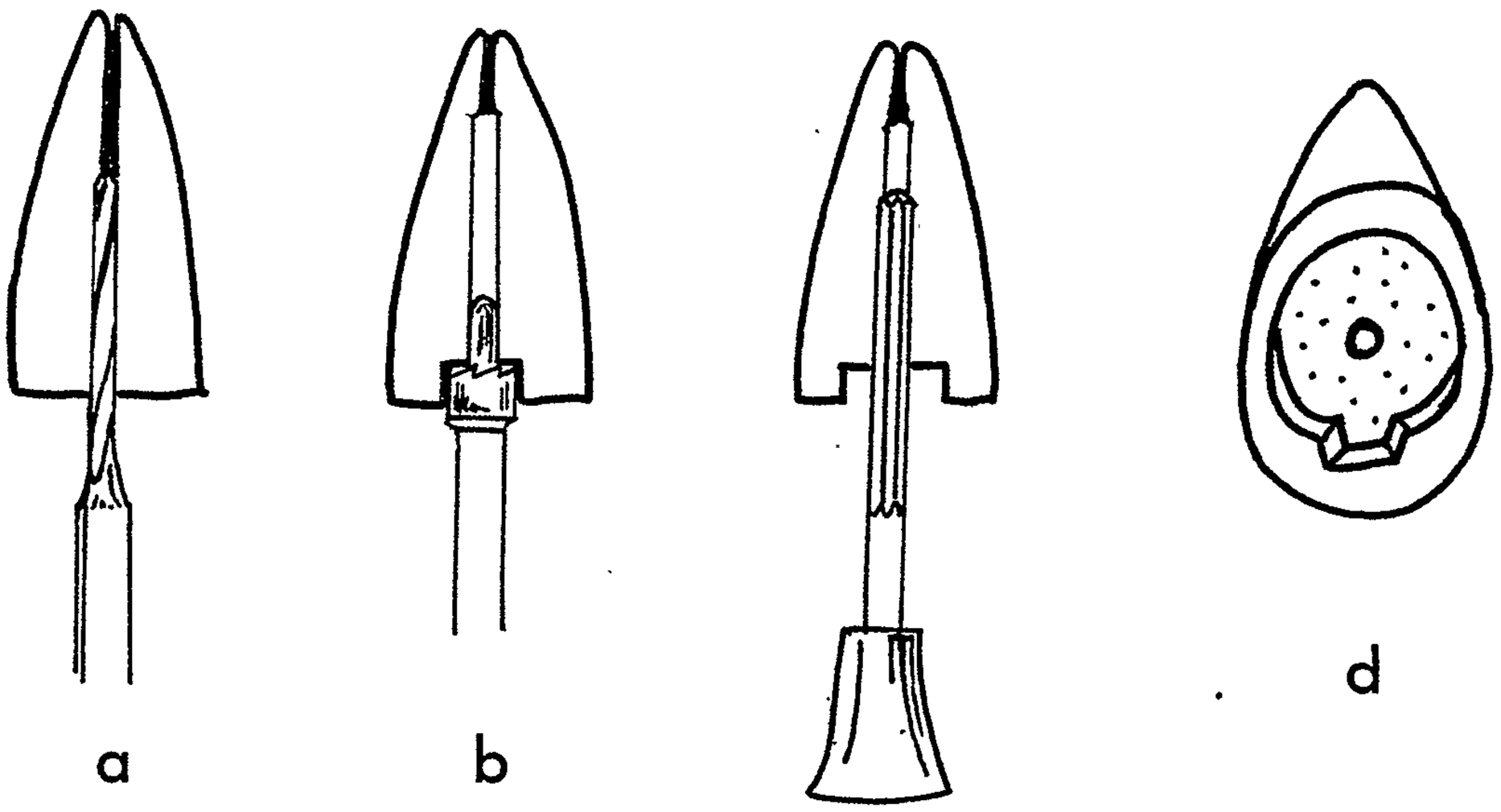


Fig.10.14



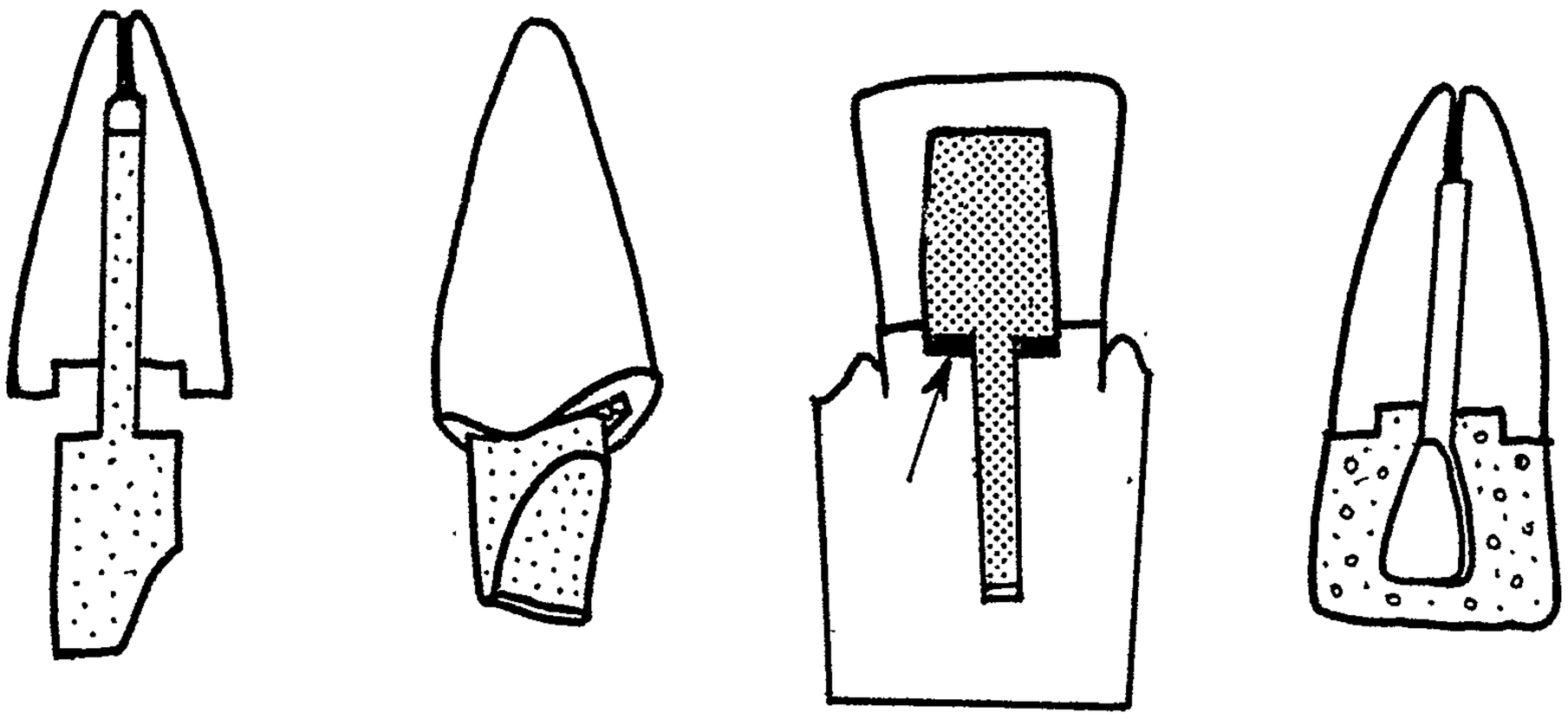


Fig. 10.15

Fig. 10.16 Components of the K.D. Gold Post System.
L. to R. hand reamer, root facer, engine reamers, plastic post-core pattern, temporary post, cement spacer ("K" disc), matching hand reamer.

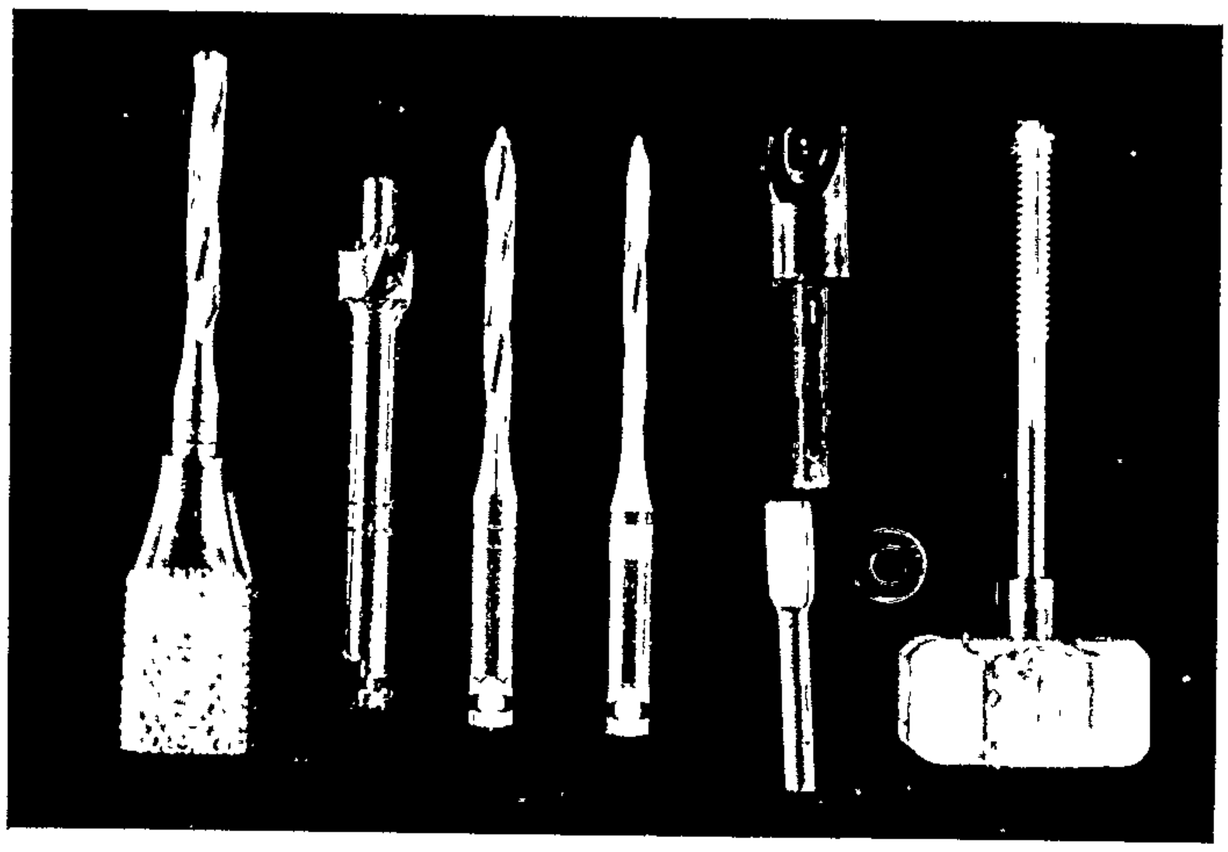
Fig. 10.17 A Charlton, prefabricated, stainless steel post-core foundation.

Fig. 10.18 Components of the Cendres & Métaux Cylindrical-conical Post System.
L. to R. titanium posts, ceramicor posts, Size #3 engine reamer, Thomas spanner-key.

Fig. 10.19 Schenker Post System.
L. to R. small engine reamer, Schenker bur and precious alloy post, large engine reamer, Schenker bur, precious alloy and stainless steel posts.

Fig. 10.20 Standard and tapered end Para-Posts.

Fig. 10.16; 10.17; 10.18; 10.19; 10.20



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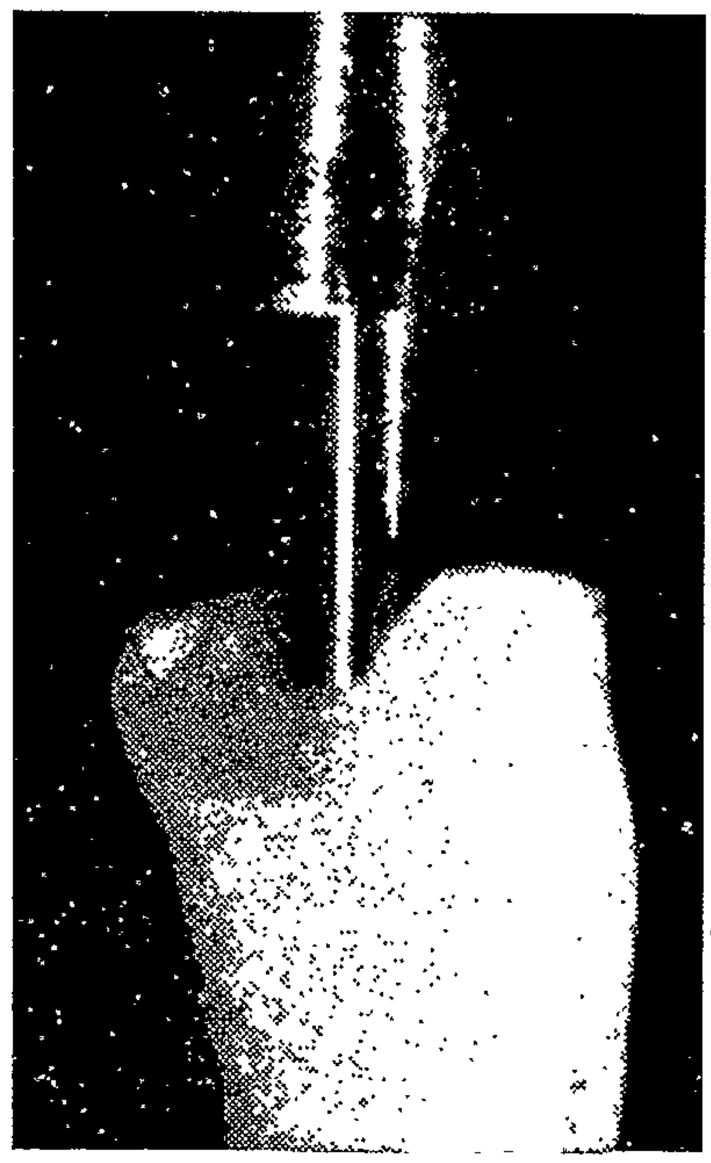

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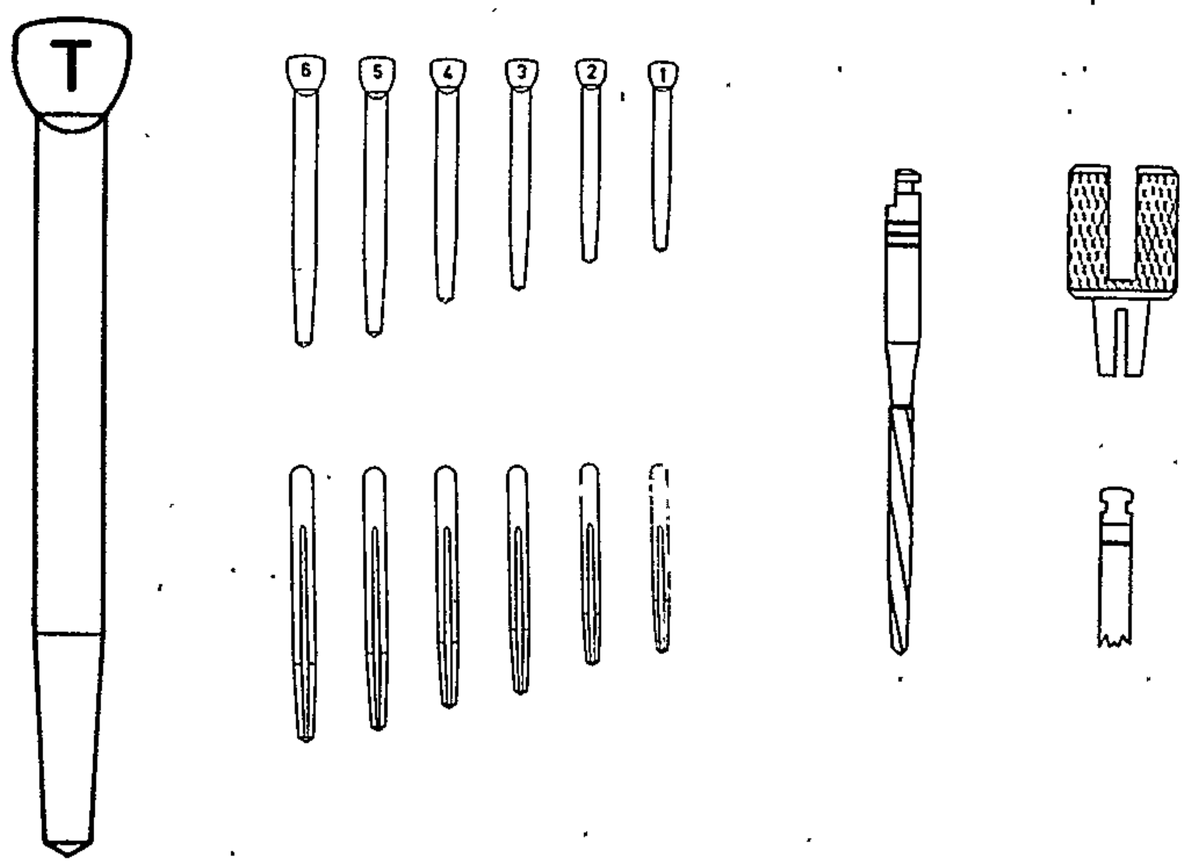
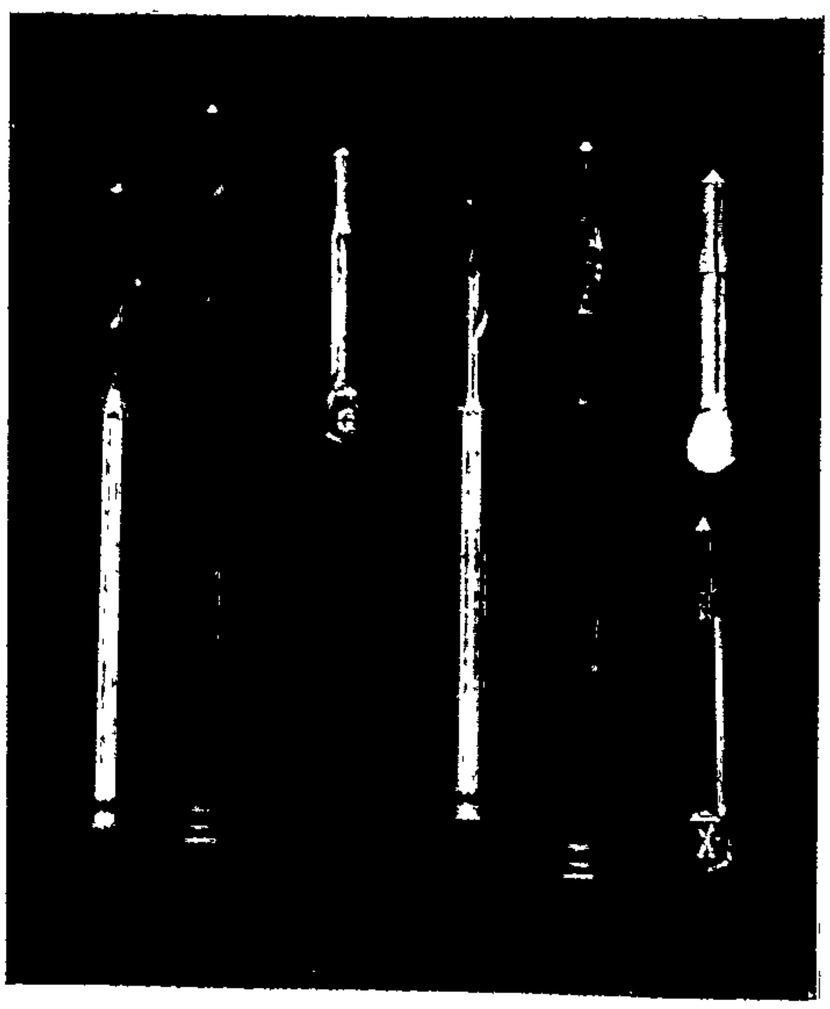
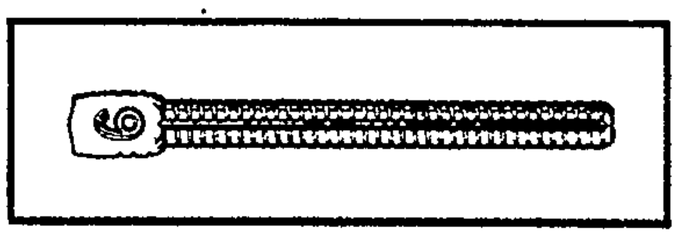


Fig. 10.18

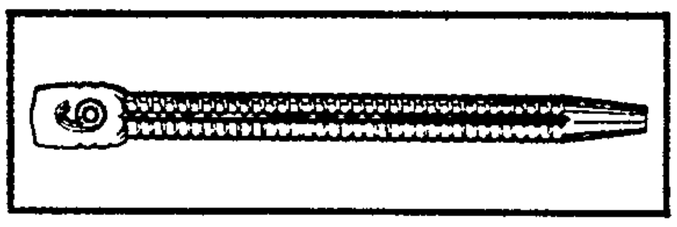


10.19

POST



TAPERED END POST



10.20

CHAPTER 11

PASSIVELY-CEMENTED POST SYSTEMS (PART 2)

Tapered post systems

11.1 Endo-Post System
11.2 Endowel Post System
11.3 Endodowel Post System
11.4 P.D. Post System
11.5 Mooser Post System
11.6 Calibrated Instrument System
11.7 Stutz Root Canal Shell-Post System
11.8 Colorama Endo Post System
11.9 Preci-Post System
11.10 Nu-Bond Post System

11.11 Discussion

11.1 Endo-Post System*

11.1.1 *Design principles*

The Endo-Post system, developed by Gerstein and Burnell (1964), consists of slightly tapered prefabricated precious metal posts, with a diameter and taper equal to the diameter and taper of the standardized endodontic reamers and files. Herschman et al (1976, p.455) considered this system to be the first of the practical manufactured aids to post fabrication that was "consistently reliable and afforded post length and fit". The main advantage of this post system, apart from the higher tensile strength of the wrought gold alloy, is that preparation of the root canal for the post may be carried out immediately after root canal obturation with standardized endodontic instruments. The level of post hole preparation and the diameter and taper of the post preparation are easily controlled by the operator. With hand instrumentation, the hazards of perforation and over-preparation are also minimized.

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*Sybron/Kerr Mfg. Co., Romulus, Michigan, U.S.A.

11.1.2 *Instrumentation*

The Endo-Posts are supplied in two types of precious metal alloy. The regular Endo-Posts have a melting range of 1835°F to 1960°F. The high-fusing Endo-Posts are made of a high-platinum-content gold which can withstand the higher burn-out and melting temperature necessary to cast gold alloys used in porcelain-gold restorations. They have a melting range of 2225°F to 2275°F. Eight sizes corresponding to the standardized endodontic files and reamers sizes 70 to 140 are available. The regular Endo-Posts are rounded on the coronal end to distinguish them from the high-fusing Endo-Posts which are flattened on the end (Fig. 11.1,a). Both types of Endo-Posts are notched in the coronal one third to provide better retention with gold cast against them. The clinical and laboratory technique for using the Endo-Post System has been described in detail by Gerstein and Burnell (1964).

11.1.3 *Clinical procedures*

With careful treatment planning during root canal therapy, the preparation of the root canal for post insertion can be simplified considerably. A root canal filled with gutta percha should have the coronal portion of the root filling removed with a heated fine endodontic plugger directed gently to the desired depth. This process is repeated until the required post length is reached. Alternatively, standardized reamers or files may be used to remove the gutta percha from the coronal two thirds of the canal. If a silver point root filling is desired, Gerstein and Burnell (1964) suggested the use of the "sectional cone" technique which will only obturate the apical one third or less of the root canal, leaving sufficient space for a post of adequate length (7.3).

The larger sizes standardized endodontic reamers or files are calibrated to the proposed post length and the root canal is enlarged. The amount of canal enlargement is determined by the size of the root

and stresses to which the restoration will be subjected. After the post hole has been prepared, a prefabricated post, corresponding to the largest reamer used, is selected and placed in the canal the length of the post hole preparation (Figs. 11.1, b and c). If the post is too tight, a smaller size post is tried. If it is too loose, it may be shortened from the apical end until a light frictional grip is obtained. This simple alteration is made possible because the Endo-Posts are similar to endodontic instruments in being standardized to have a uniform taper — a constant increase in diameter over a set length of root canal instrument or Endo-Post. According to Gerstein and Burnell (1964), this taper control is probably the most significant contribution of the standardized system. The degree of frictional resistance to withdrawal should not be so great that the post cannot be removed by digital manipulation.

Provision is made in this system for an endodontist treating the patient on referral, or if the preparation of the root-filled tooth and construction of the post-core foundation are to be left until a subsequent appointment. The selected Endo-Post is put aside for later use or sent to the referring dentist and the root canal is sealed with sterile cotton pellets and temporary cement.

After preparation of the coronal portion of the pulpless tooth for the cast post-core foundation (Fig. 11.1,d), the previously selected Endo-Post is adjusted to the proper length coronally and incorporated in a post-core pattern using inlay wax or burn-out acrylic resin. The pattern is then invested and cast in Type III or IV gold alloy. With the regular Endo-Post, a reducing investment is required to prevent oxidation of the precious metal post and to achieve a good bond between the cast core and the alloy post. The investment should not be overheated (above $1300^{o}F$) during burn out. The casting should be properly heat-treated to improve the tensile property by allowing the casting ring to bench-cool for 30 minutes before quenching in water. The cast post-core foundation may then

be pickled by boiling in hydrochloric acid; heating of the casting over a direct flame should be avoided.

If the indirect method is used, the serrated end of the Endo-Post is coated with adhesive and is inserted into the canal. Light-bodied impression material is injected around the post to include the prepared pulp chamber and the root canal orifice, followed by a heavy-bodied impression material supported by a tray. The Endo-Post will remain in the impression on withdrawal (Fig. 11.1,e).

11.1.4 *Laboratory procedures*

In the laboratory, the root end of the Endo-Post protruding from the impression material is lightly lubricated (Fig. 11.1,e). A soft wood or plastic toothpick is luted to the periphery of the impression and to the side of the post at the apex. A stone model is then poured to a level 5 mm above the end of the post (Fig. 11.1,f). After the model is separated from the impression, the plastic toothpick is removed and the hole is enlarged to form a window (Fig. 11.1,g). This enables the operator to verify the seating of the post after it has been removed and re-inserted into the model. Care should be taken not to remove any stone which forms the seat at the end of the Endo-Post. The post is removed from the model and the adhesive cleaned off with acetone or xylol. The stone die is lubricated around the post hole and the Endo-Post is re-inserted. Check the complete seating of the post through the window and the cast post-core foundation is completed in the normal manner (Fig. 11.1,h).

Although it has been suggested (Weine et al, 1973) that the final restoration may also be constructed on the same working model, generally, a crown fabricated from a second impression taken after the permanent cementation of the cast post-core foundation will give more predictable results.

11.2 Endowel Post System*

The Endowels are tapered, plastic burn-out posts that are colour-coded and calibrated to match endodontic files or reamers of sizes 80, 90, 100, 120 and 140 (Fig. 11.2,a). These plastic posts were developed by Weine and co-workers (1973) along the same principles as the Endo-Post System (11.1). One improvement on the Endo-Post is the incorporation of a longitudinal v-groove on one side of the Endowel, which, when reproduced in the final post-core casting, serves as a venting channel to allow the escape of excess cement coronally. The same technique described for the Endo-Post system may be applied. The plastic will burn out at approximately 500^{o}F, much below the casting temperature of any dental casting alloys and leaves no residue (Weine et al, 1973). Self-curing acrylic resin will attach directly to the Endowels, and similar to wax, will burn out without residue at a low temperature (Fig. 11.2,b). Colour-coding of the plastic posts allows ready size identification. Since the entire post burns out prior to casting, it may be used as a sprue if necessary, and the final post-core foundation is a one-piece casting, giving the clinician the freedom to use any casting alloy that is suitable for the purpose. Some clinicians (Gilmore et al, 1977, p.362) have suggested using the Endowel post patterns to cast a selection of cobalt-chromium posts of various sizes which can be cemented into the root canals for the support of amalgam or composite resin core foundations. This is a relatively simple and economical method of providing a sound foundation for the final restoration of an endodontically-treated tooth.

11.3 The Unitek Endodowel System@

This post system is basically identical to the Kerr Endo-Post and the Star Endowel systems except in the material of the posts. The Endodowels

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*Star Dental Mfg. Co., Inc., Conshohocken, PA., U.S.A.

@Unitek, Monrovia, CA., U.S.A.

are available in stainless steel in a wide range of sizes corresponding to standardized endodontic reamers or files of sizes 50 to 130. Being in stainless steel, these posts are not intended for use in cast post-core foundations.

Tooth preparation and post selection procedures are identical to that described for the other two endodontically-standardized post systems. Once the posts are selected and cemented into the root canals, construction of the core foundation using amalgam or composite resin is carried out in the normal manner as described in 10.1.32.

11.4 P.D. Post System*

This is a post system consisting of tapered, stainless steel, acrylic resin and gold-platinum-paladium alloy posts with a slightly greater degree of taper than the endodontically standardized post systems. The serrated P.D. Crown Posts are available in the three materials (Fig. 11.3,a) while the smooth P.D. Posts are available only in stainless steel and acrylic resin; neither type of post is vented (Nicholls, 1977, p.332-333). The posts are available in six sizes and matching engine-driven or hand reamers are provided (Figs. 11.3,a and b). These engine reamers are virtually identical to the Peeso@ reamers and are relatively safe to use for the preparation of the post hole. They can be calibrated to the proposed post length by simply moving the metal stopper along the shank of the reamer and securing it in position by tightening the small screw (Fig. 11.3,c). Like using the Peeso reamers, the canal is serially enlarged to the desired diameter by using successively larger reamers. The size of the posts and the engine reamers are readily recognized by the number of serrations on the shank of the individual item.

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*Produits Dentaires, S.A., Vevey, Switzerland

@Maillefer S.A., Ballaigues, Switzerland

Following tooth preparation and the preparation of the root canal with the reamers supplied, the stainless steel P.D. posts may be adjusted and cemented, and used in the same manner as the stainless steel Para-Post to support amalgam or composite resin core foundations. The plastic burn-out posts can be used in the direct or the indirect technique of pattern fabrication, in a similar fashion to that described for the Endo-Post System (11.1).

11.5 Mooser Post System*

The Mooser Post System consists of smooth or sandblasted, tapered metal posts. Compared to the endodontically standardized systems, these prefabricated metal posts have a considerably greater degree of taper — $5^{o}18'$. The difference in convergence between an Endo-Post and a Mooser post is illustrated in Fig. 11.4,a. These posts are currently available in three materials — Pivotor, Ceramicor and only recently, also in titanium. The precious alloy posts are for use in cast gold post-core foundations. The titanium posts are intended for amalgam or composite resin core foundations and support of temporary acrylic resin crowns. Apart from having either a smooth or sandblasted surface, the shank of these posts may be notched, flattened or polished and coated with adhesive for better retention in the impression material. Four sizes of posts are supplied with matching engine reamers for preparation of the root canal; these engine reamers may also be adapted for manual enlargement of the root canal with a Thomas Spanner-key. Examples of Mooser posts and reamers are illustrated in Fig. 11.4,b.

11.6 Calibrated Instrument (C.I.) System@

The armamentarium for the Parkell Calibrated Instrument System includes engine reamers and prefabricated posts of equivalent sizes (Fig. 11.5). The posts are available in two sizes and in plastic or stainless

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*Cendres & Métaux S.A., Biel-Bienne, Switzerland

@Parkell, Farmingdale, N.Y., U.S.A.

steel. The small posts have a diameter of 0.9 mm at the apical end and 1.25 mm at the incisal end; the large posts have a diameter of 1.25 mm and 1.5 mm at the apical and the incisal ends, respectively. The plastic posts are intended for the fabrication of cast metal post-core foundations. Two configurations of stainless steel posts are supplied — one for use in temporary crowns and impression procedures, the other is designed for the retention of composite resin core foundations and may also be used with amalgam.

The post hole preparation is initiated with a double-bladed bur and followed by a reamer bur to establish the depth of the post hole. The preparation is finished with a tapered fissure bur calibrated to match the plastic and stainless steel posts. The plastic posts are used for the direct method of fabricating the post-core pattern with self-curing resin or inlay wax. The stainless steel post serves as a transfer post when the indirect technique is preferred. The metal post is lubricated before the stone model is poured; when set, the metal post is replaced by the corresponding plastic post and the cast post-core foundation is constructed in the normal manner.

11.7 The Stutz Root Canal Shell-Post System*

11.7.1 *Instrumentation*

The Stutz Root Canal Shell-Post System consists of a shell 10.3 mm long and matching precious metal posts either 14.35 mm or 18.35 mm in length. According to the manufacturer's instruction, the silver shell is cemented in the prepared root canal to provide a hermetic seal. The finished cast post-core foundation is then cemented into the fitted shell. Since the posts only differ in length, the shell will fit any post. Components of this system are shown in Fig. 11.6,a.

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*Cendres & Métaux S.A., Biel-Bienne, Switzerland

11.7.2 *Clinical procedures*

The root canal orifice is enlarged with the calibrated Stutz reamer (Fig. 11.6,b). The shell is then trial seated and cemented. A carrier tool is provided to facilitate the introduction of the silver shell into the root canal and to prevent the flow of cement into the shell (Fig. 11.6,c). A Pivotor or Ceramicor post of the appropriate length may now be seated and an acrylic resin core pattern shaped. Self-curing acrylic resin is preferred to wax, because the post fits precisely into the cemented shell, and there is less chance for distortion of the core pattern when the post is withdrawn. If the indirect technique is preferred, self-curing acrylic resin should be used to form a retentive head to ensure adequate retention of the post in the impression material (Fig. 11.6,d). Routine laboratory procedures may then be used for construction of the cast gold foundation (Fig. 11.6,e).

11.8 Colorama Endo Post System*

Introduced in 1978, the Colorama Endo Post System is another prefabricated, plastic, tapered post system. It is not to be confused with the Kerr Endo-Post System described in 11.1 as these smooth, tapered posts do not conform to the diameter and taper of the standardized endodontic reamers and files. The coronal one half of the post is cylindrical and the apical portion has a greater degree of taper than the endodontically standardized posts (Fig. 11.7,a).

Posts of two materials are supplied — colour-coded plastic posts for the construction of cast post-core foundations, and stainless steel posts for temporary post-crowns. Both these posts are available in five sizes together with matching, colour-coded engine reamers (Fig. 11.7,b).

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*Degussa Corporation, Teterboro, New Jersey, U.S.A.

With the good range of post sizes available, this precision-matched post system can be readily adapted to most established post-core techniques.

11.9 Preci-Post System*

Introduced in 1981, this is one of the latest additions to the increasing number of prefabricated plastic post systems currently available. It is a fairly simple system with only two sizes available. These plastic posts have a 2.5^{o} taper, a smooth surface and are not vented. The small Preci-Posts are yellow in colour, 0.8 mm in diameter at the apex and 14.5 mm in length; the large posts are coloured blue, 1.0 mm in diameter at the apex and 16.5 mm long. The plastic posts are matched to conform precisely to a canal prepared with corresponding, colour-coded reamers. According to the manufacturer, the plastic impression posts are "self-separating" and will not adhere to any die material.

11.10 Nu-Bond Post System@

The Nu-Bond Posts are knurled, tapered, stainless steel posts of six different diameters. Self-limiting, tapered reamers with non-cutting "pilot" tip, similar to the Peeso reamers, are provided to match each post size. Procedures for their clinical application are identical to those for the stainless steel Para-Posts described in 10.1.32. However, the manufacturer suggested the use of a cyanoacrylate cement (Cyanodent@) for the cementation of the posts because of its low viscosity and the use of the Cyano-Veneer@ resin material for core construction. Aspects of their use are illustrated in Fig. 11.8.

11.11 Discussion

One of the most common reasons for using a tapered post in an endodontically-treated tooth is that this type of post matches more

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*Preat Corporation, San Mateo, CA., U.S.A.

@Ellman Dental Mfg. Co., Inc., Hewlett, N.Y., U.S.A.

closely the natural shape of the canal and the root. This is important especially in the apical region where excessive widening of the root canal to accommodate a post increases the risk of root perforation and makes the pulpless tooth more vulnerable to subsequent root fracture (Burns, 1977).

In general, tapered posts exhibit a greater tendency for wedging than parallel-sided posts because occlusal stresses are distributed mainly to the "shoulder" region and the walls of the root canal (Standlee et al, 1972). This wedging tendency is much more pronounced if the shoulder of the core does not fit closely to the root face and may eventually split the root.

It was noted in Chapter 5 that, for a given post length, the degree of taper of a post has significant effects on its retentive properties and that they are the least retentive of the three types of posts tested — parallel-sided, tapered and threaded. Increasing the angle of convergence usually results in considerable reduction in the retention of the post in the root canal. A longer post (tapered and parallel-sided) is not only more retentive, but also distributes occlusal stresses more evenly over a wider area in the root canal. It has been the experience of the author that, when using prefabricated plastic pattern posts for the direct fabrication of the post-core pattern, the plastic post should not be inserted too tightly into the prepared canal. The post may be compressed during the fabrication of the core pattern and subsequently return to its original shape on removal from the root canal. If this happens, it is unlikely that the oversized casting will fit the prepared tooth accurately. For this reason, and because of the greater strength properties of the wrought alloy posts compared to the cast posts, it may be preferable to use a wrought alloy post in the direct method of fabricating a post-core pattern.

Of all the tapered post systems currently available, the endodontically-standardized systems — the Endo-Post, Endowel and the Endodowel systems — probably offer the widest range of flexibility. Since they are basically interchangeable, these three systems together offer an excellent selection of post diameters and materials; they may be used for the construction of cast metal as well as amalgam or composite resin post-core foundations. The uniform taper of these post systems simplifies the post selection procedures and hand instrumentation of the root canal with standardized endodontic instruments greatly reduces the potential for root perforation. The incorporation of serrations and venting channels in all the endodontically-standardized posts should further improve this efficient "post system". (The plastic Endowel posts are vented).

The P.D. (Produits Dentaires), the Colorama Endo Post, the Mooser and the Nu-Bond post systems are similar in that preparation of the post hole is carried out with matching engine reamers supplied with each system. The degree of taper varies between the different systems; the Mooser posts appear to have the greatest angle of convergence amongst the tapered post systems. There is a reasonable range of sizes available for these post systems and the selection of any one of these systems is largely a matter of personal preference.

There is little to be gained from the use of systems such as the Preci-Post, the C.I. (Calibrated Instrumentation) and the Stutz Shell-Post systems. The limited size range and choice of materials prohibits their use in many clinical situations. It is doubtful whether there is any real benefit in the cementation of a silver shell into the root canal as suggested in the Stutz Shell-Post technique. The situation would certainly be unnecessarily complicated should excess cement be accidentally introduced into the silver shell prior to the fitting of the cast post-core foundation.

TABLE 11.1

PASSIVELY-CEMENTED, TAPERED POST SYSTEMS

	Endo-Post System	Endowel Post System	Endodowel Post System	P.D. Post System	Mooser Post System	Parkell C.I. System	Stutz Shell-Post System	Colorama Endo-Post System	Preci-Post System	Nu-Bond Post System
Endodontically standardized	yes	yes	yes	no	no	no	no	no	no	no
Surface finish	smooth	smooth	smooth	serrated (stainless steel) and smooth (plastic)	sandblasted	smooth	smooth	smooth	smooth	serrated
Venting	no	yes	no	no	no	no	no	no	no	no
Sizes	8	5	9	6	4	2	1	5	2	6
Materials	wrought precious alloy - high and low fusing temperature	plastic	stainless steel	stainless steel plastic	Pivotor* Ceramicor* titanium	stainless steel plastic	shell - silver. post - Pivotor Ceramicor	stainless steel plastic	plastic	stainless steel

* Cendres & Métaux, SA, Biel-Bienne, Switzerland

Fig.11.1

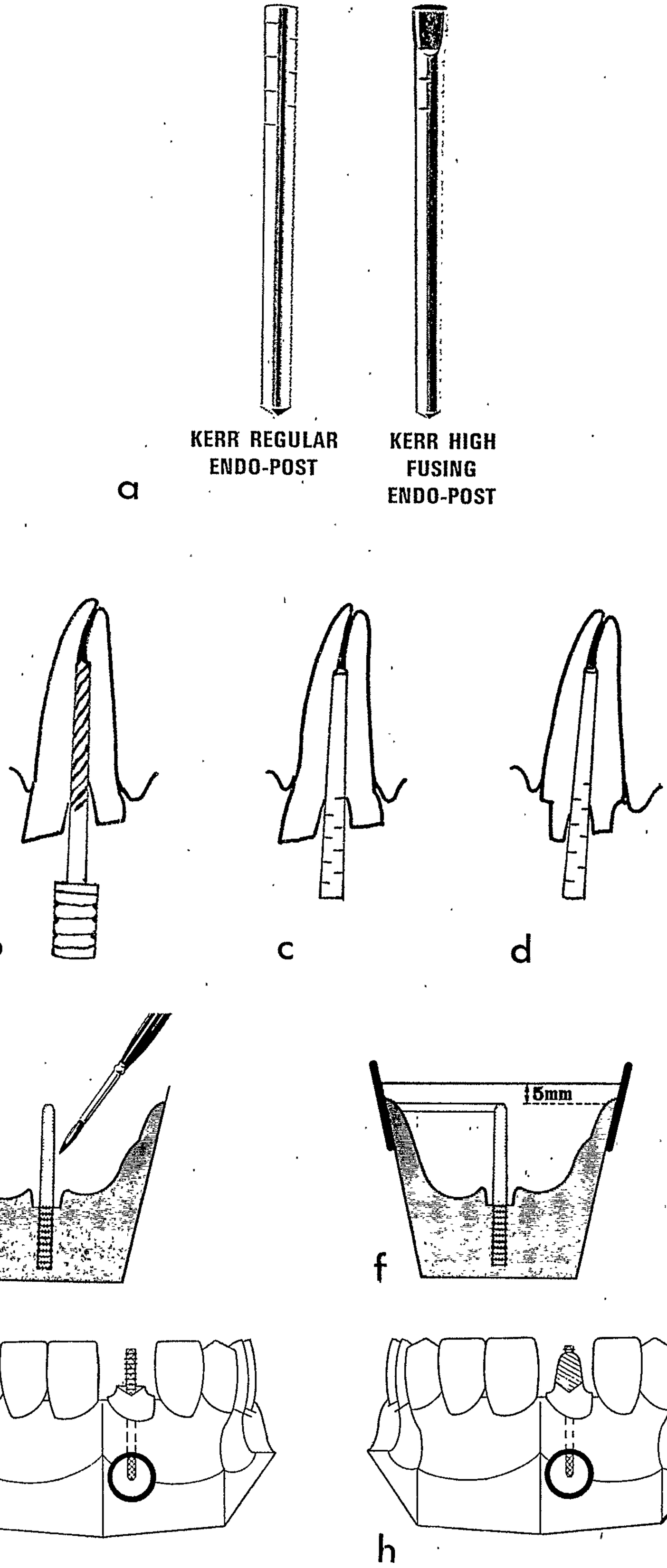

KERR REGULAR
ENDO-POST
KERR HIGH
FUSING
ENDO-POST
a
b
c
d
e
f
5mm
g
h

Fig. 11.2 a. Star Endowel System.

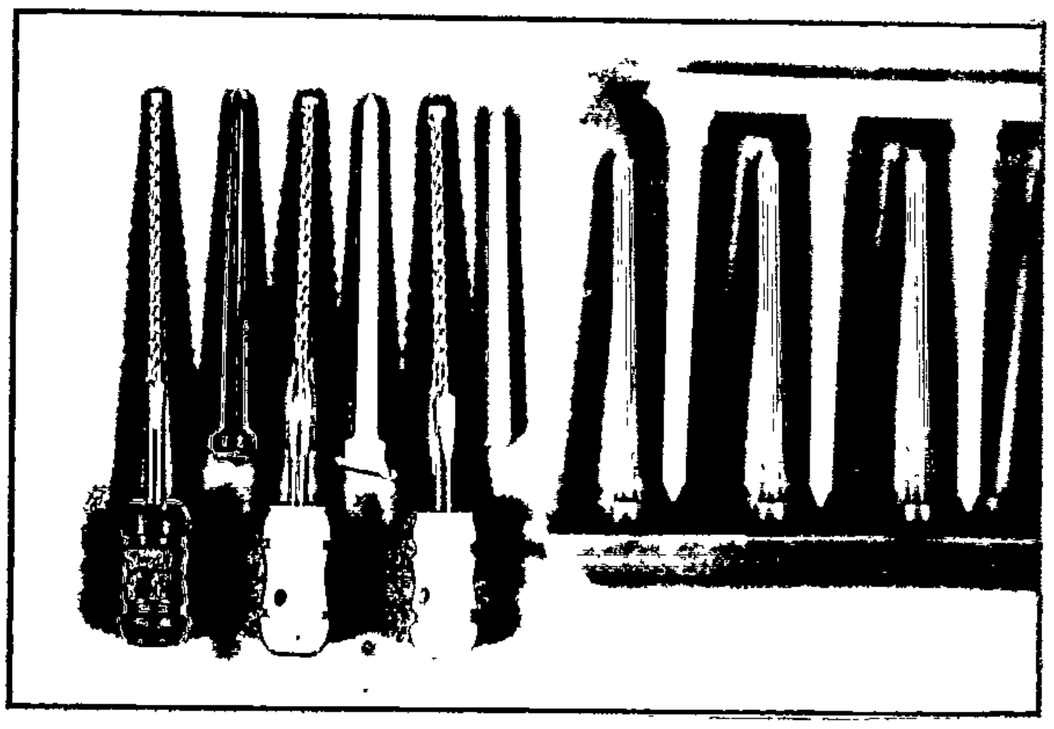
b. a burn-out acrylic resin core pattern with an Endowel post.

Fig. 11.3 a. L. to R. hand reamers, engine reamers, serrated stainless steel posts, sizes #1-6.

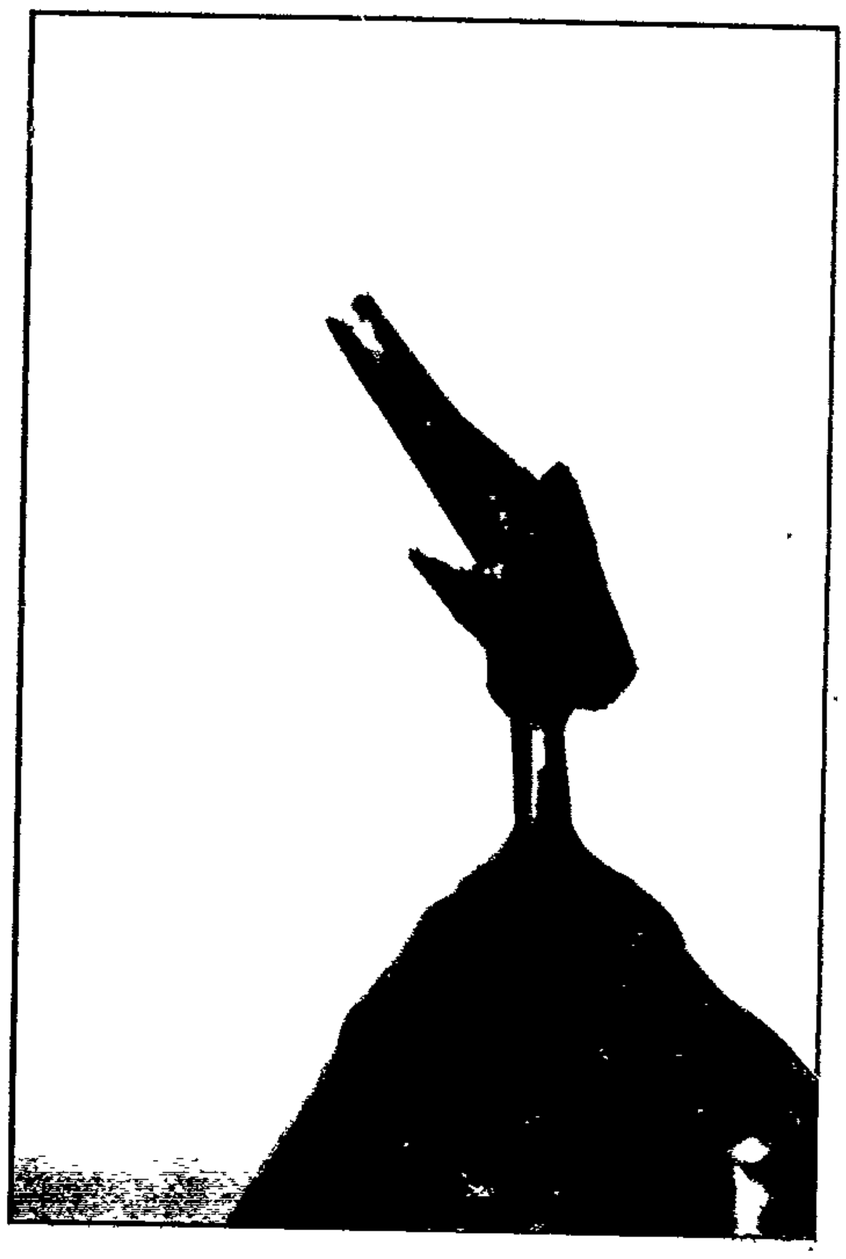
b. engine reamers and plastic burn-out posts.

c. calibrating a hand reamer to the proposed post length.

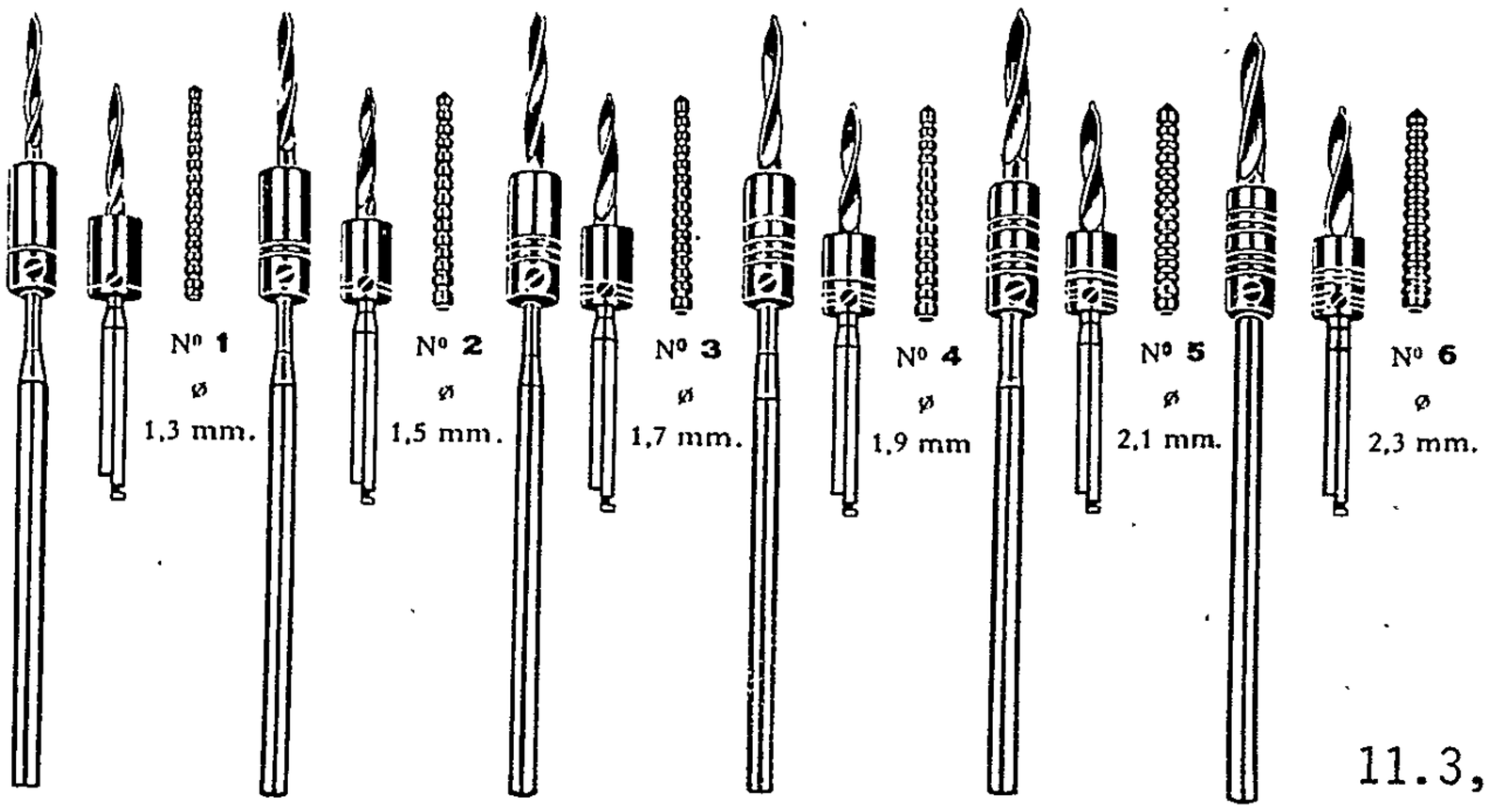
Fig. 11.2; 11.3



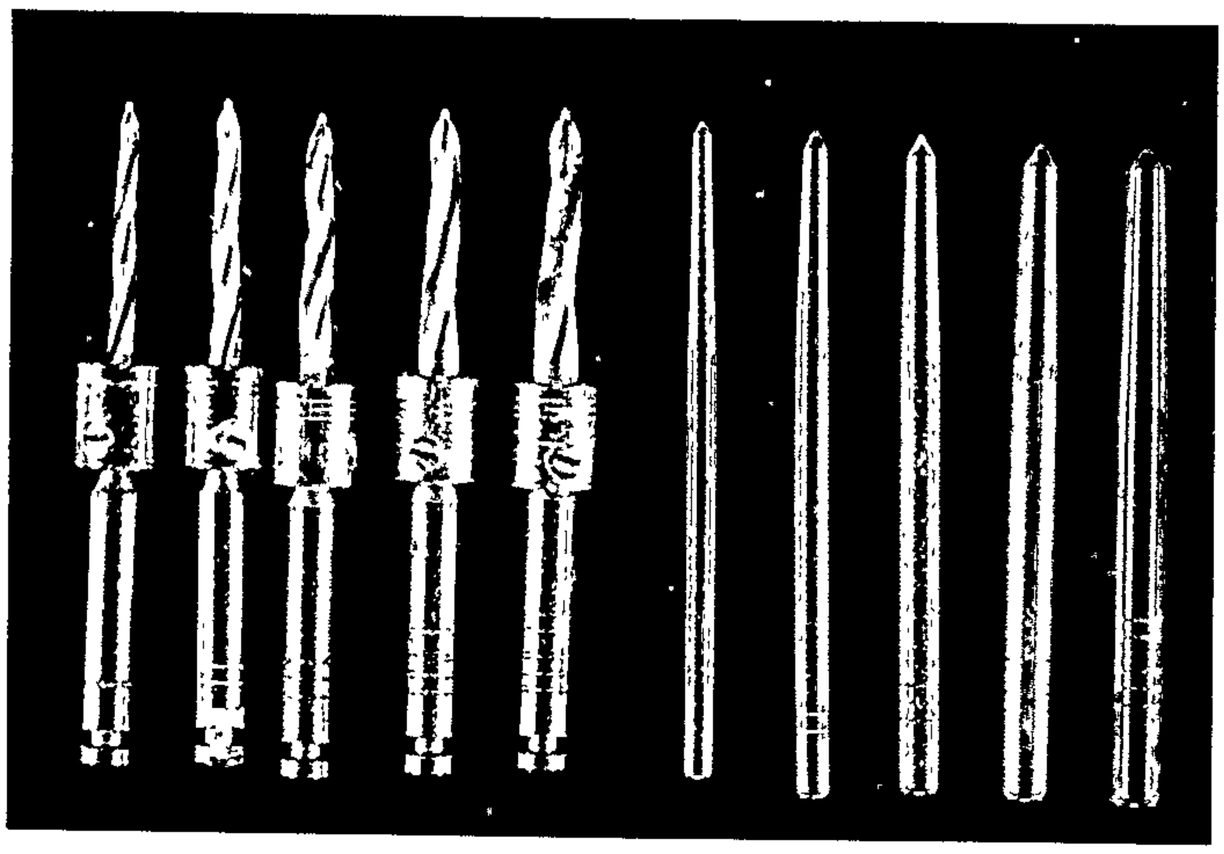
11.2,a



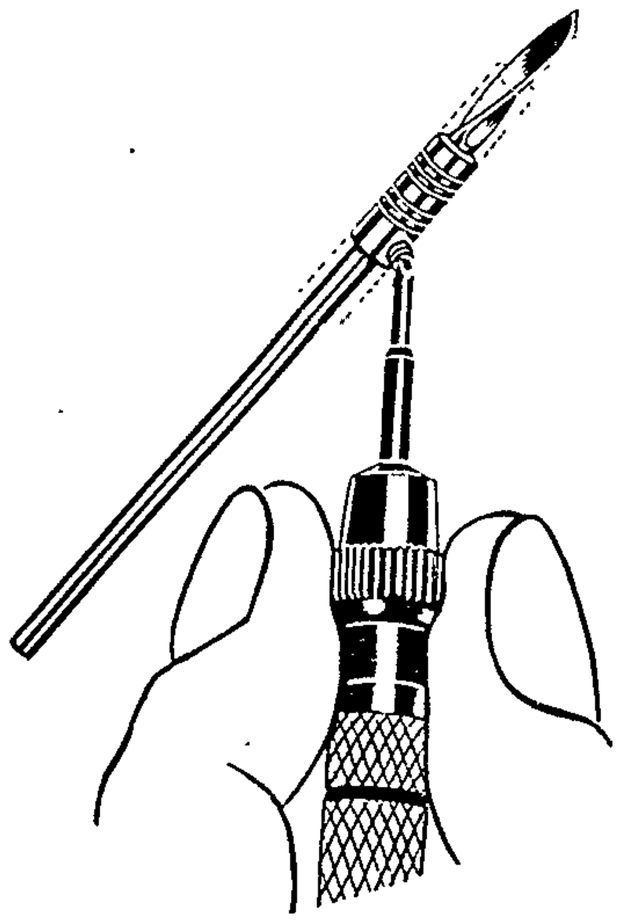
11.2,b



11.3,a



11.3,b



11.3,c

Fig. 11.4 a. Note the difference in the angle of convergence between the Endo-Post (L) and the Mooser post (R).

b. Mooser posts and matching engine reamers.

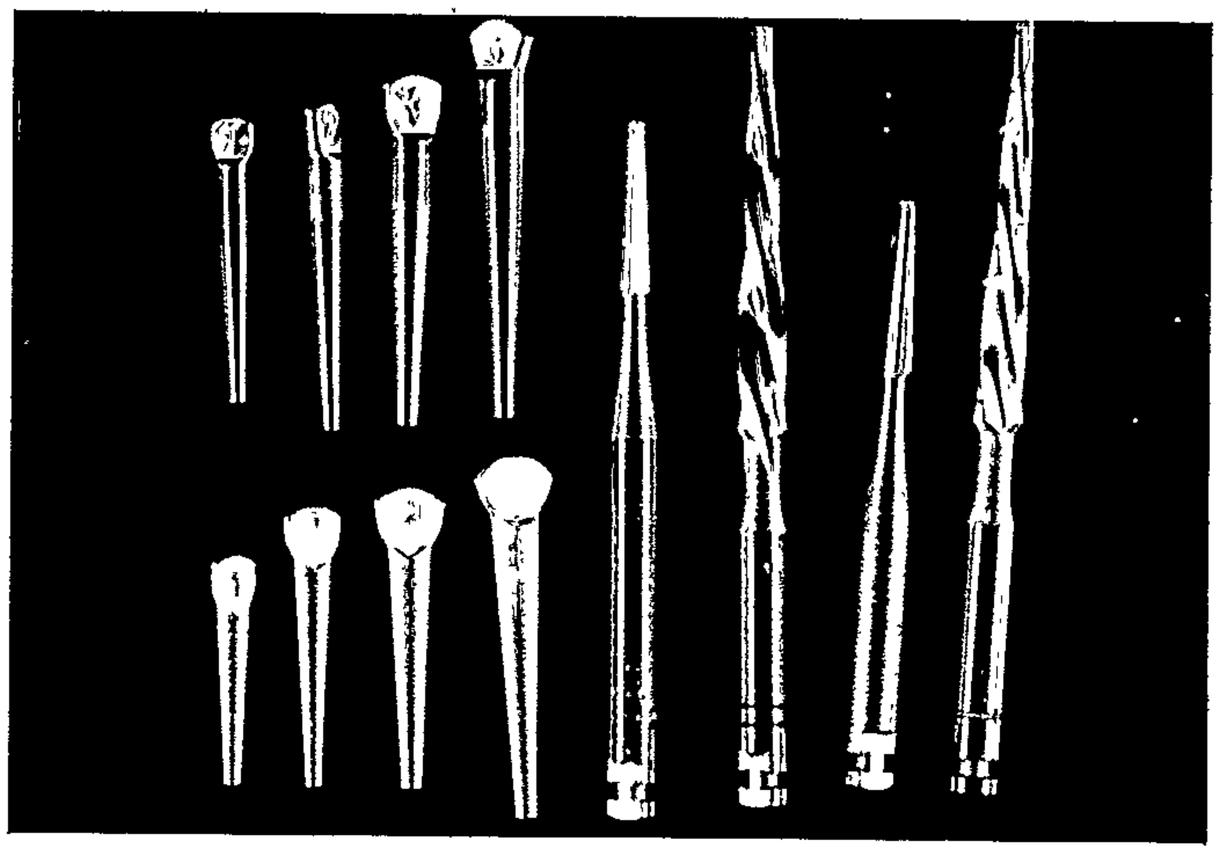
Fig. 11.5 Parkell C.I. System (refer to 11.6).

Fig. 11.6 a. Components of the Stutz Root Canal Shell-Post System (L. to R.) — silver shell, short (14.35 mm) post and long (18.35 mm) post, calibrated Stutz engine reamer and carrier tool for cementation of the silver shell.

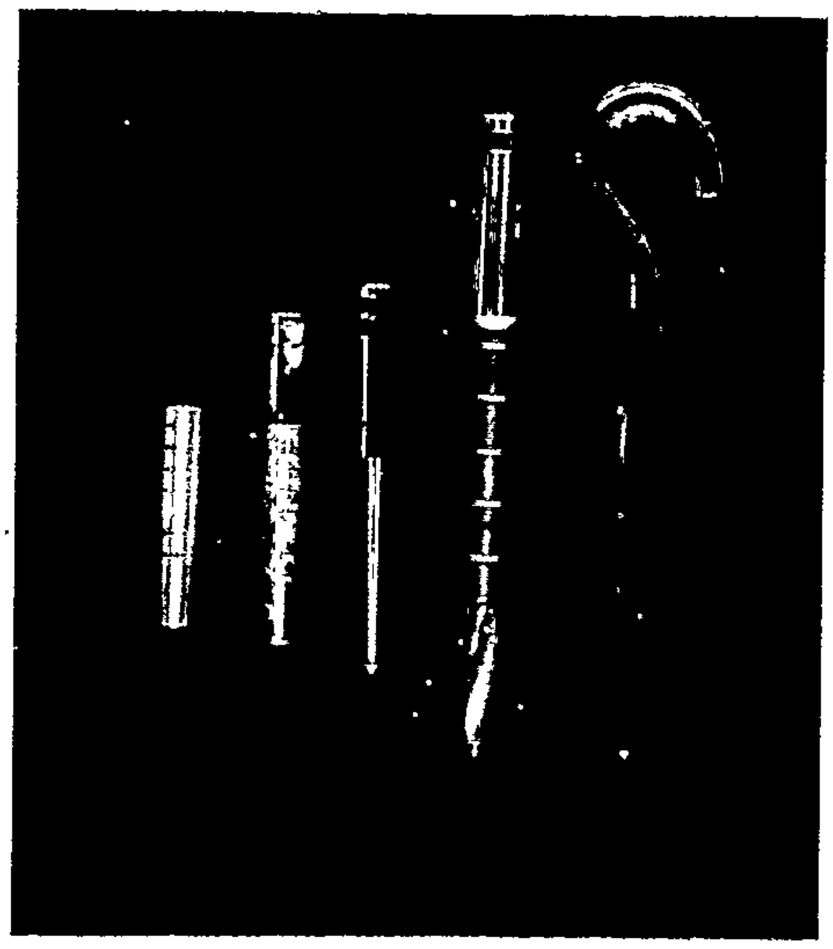
b. to e. For legend, refer to 11.7.2.

Fig. 11.4; 11.5; 11.6

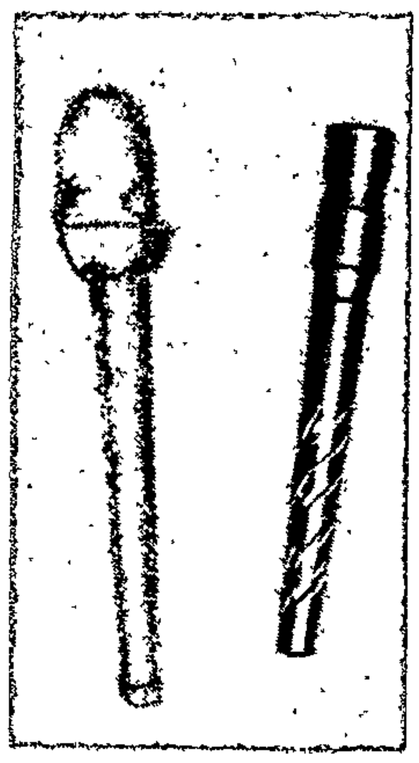
11.4,a



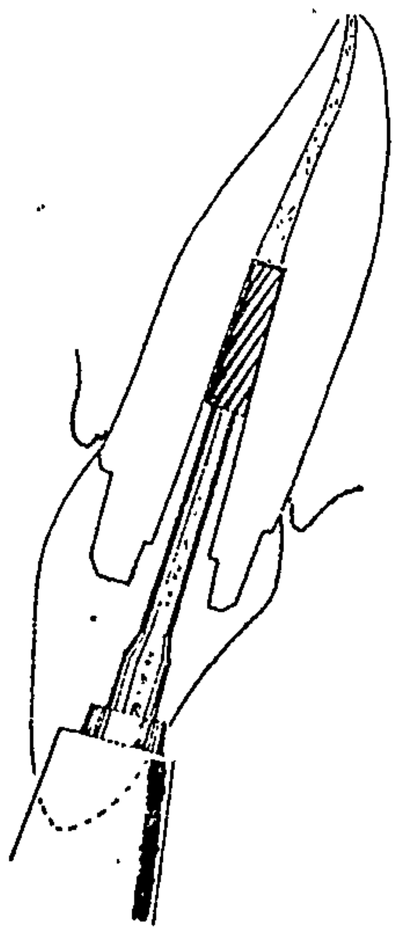
11.4,b



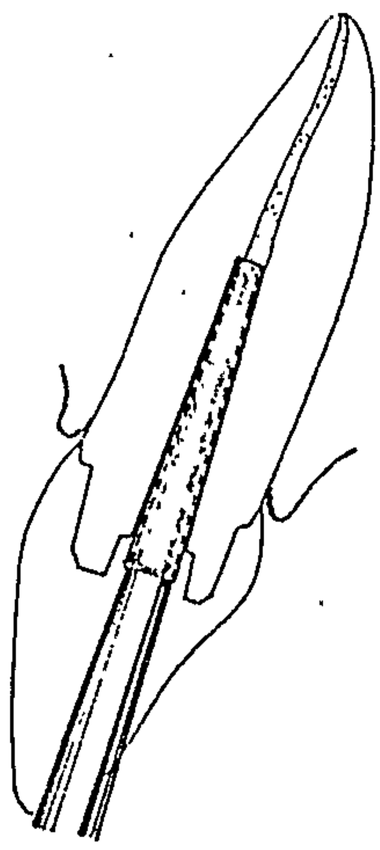
11.6,a



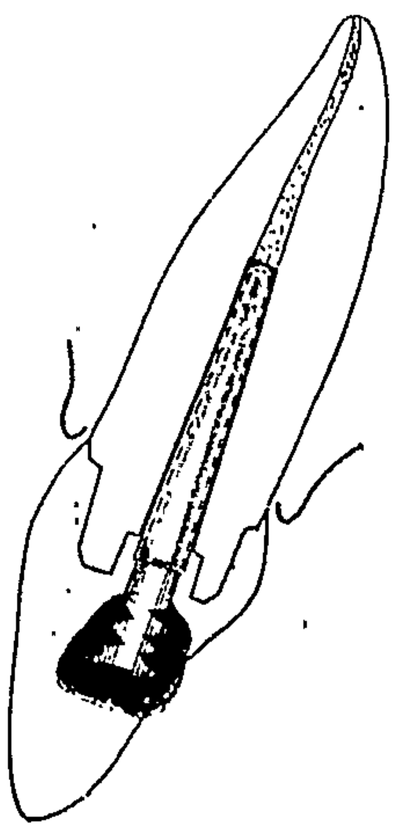
11.5



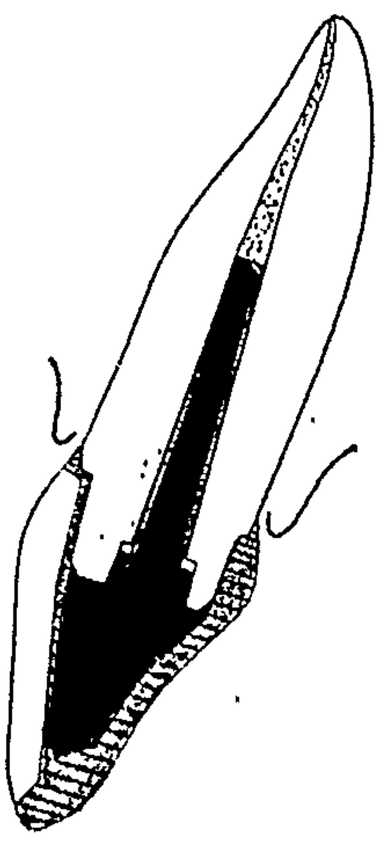
11.6,b



11.6,c

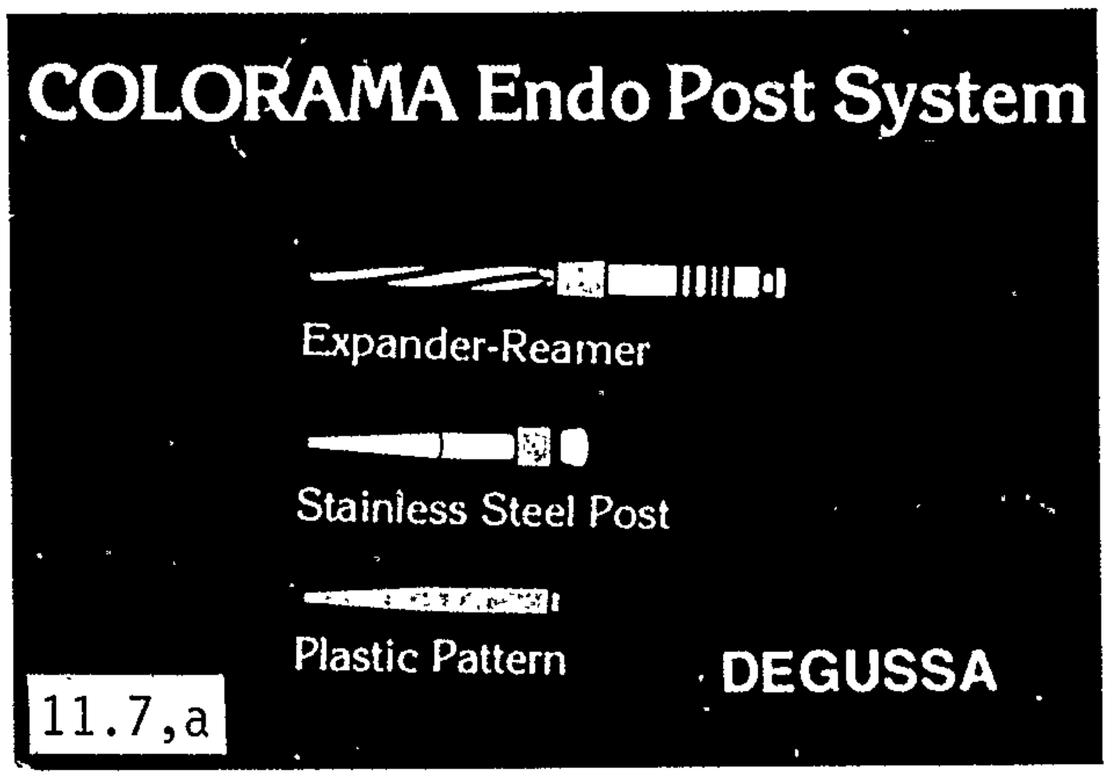


11.6,d

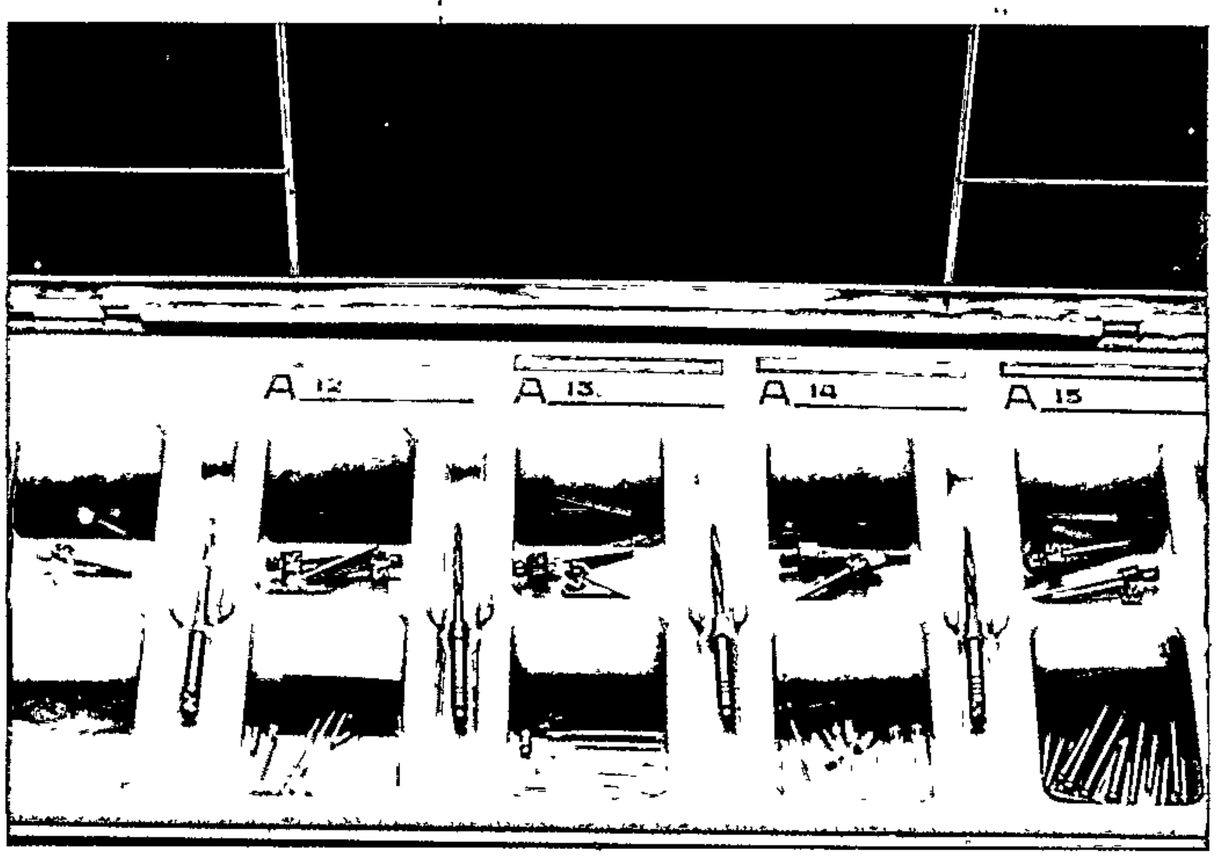


11.6,e

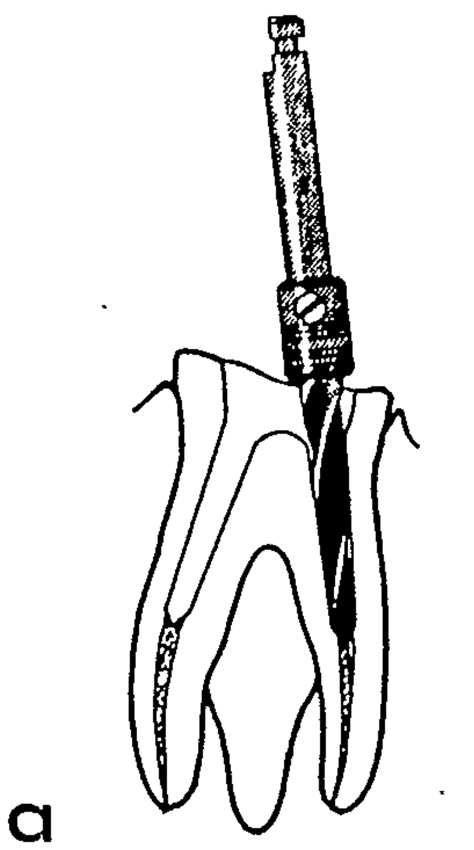
Fig. 11.7; 11.8



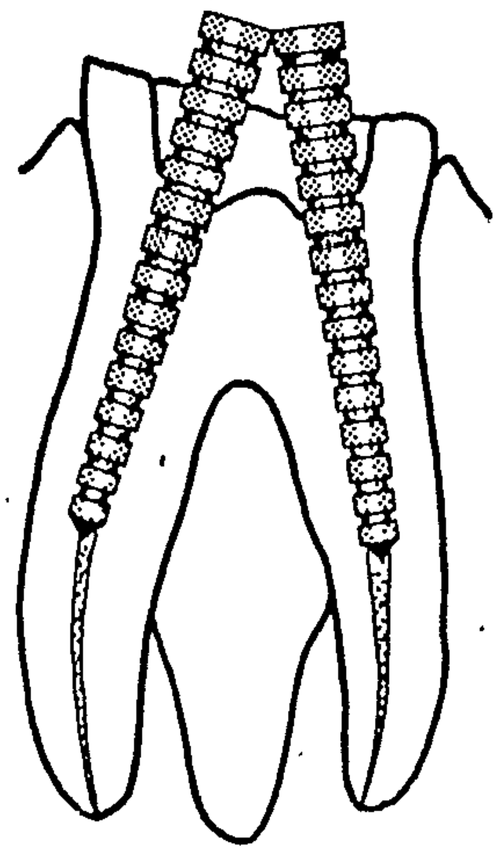
11.7,a



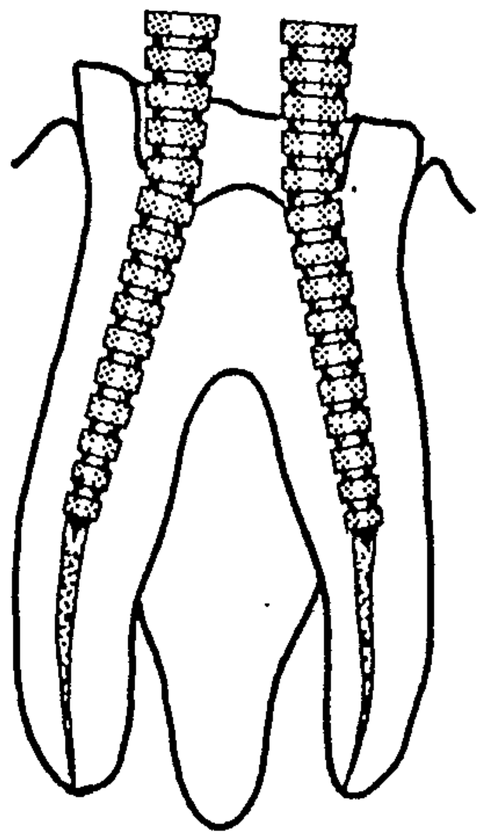
11.7,b



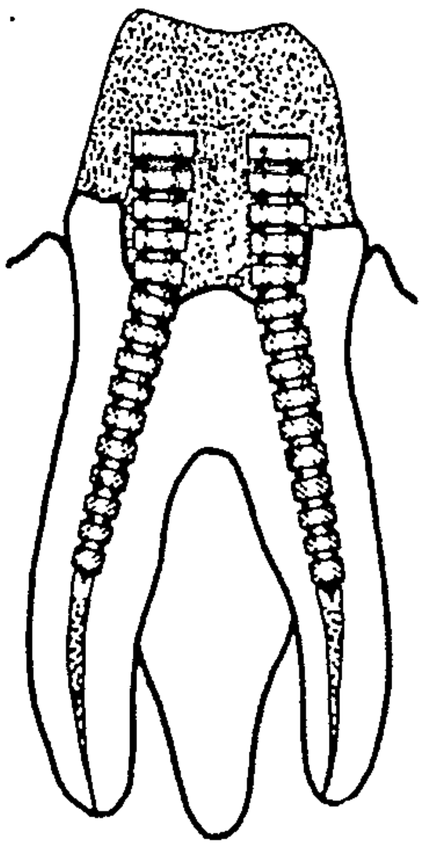
a



b



c



d

Fig. 11.8

CHAPTER 12

THREADED POST SYSTEMS

Parallel-sided post systems

12.1 Kurer Post Systems
- 12.1.1 Kurer Anchor System
- 12.1.2 Crown Saver Posts
- 12.1.3 Fin-Lock Posts
- 12.1.4 Kurer Press Stud System

12.2 Dentaurum Post System
12.3 Radix Anchor System

Tapered post systems

12.4 Dentatus Screw Post System
12.5 Schein Screw Post and Compo-Post System
12.6 Blue Island Post System
12.7 F.K.G. Screw Post System

12.8 Discussion

12.1 Kurer Post Systems*

The main aim of this fairly comprehensive prefabricated post and core system which was developed by Kurer (1967), was to achieve maximum retention of the post-core foundation in the root canal. In Kurer's opinion, failure of post crowns was most commonly due to lack of retention of the post in the root; by cutting a thread into the walls of a prepared root canal, increased mechanical retention could be achieved. This also effectively increased the surface area of the root canal walls for cementation. The various types of Kurer posts are shown in Fig. 12.1.

12.1.1 *The Kurer Anchor System*

12.1.11 Design principles

According to Kurer (1967), a 'crown post' should have a number of features which formed the basis for the design of the Kurer Anchor System.

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*Cottrell & Co., London, U.K.

1. A threaded parallel-sided shank made of a strong and hard material capable of withstanding the stresses and strains to which the tooth is likely to be subjected.
2. A "head" (core) made of a readily workable material which can be shaped by the use of normal grinding instruments to adapt to the anatomical requirements of adjacent and opposing teeth and strong enough to support the final coronal restoration.
3. A core with a flat base at right angles to the post so that, when fitted on to the specially-prepared central flat portion of the root face, an accurate fit can be obtained.
4. The union between the core and the post should be sufficiently strong to withstand all possible stresses and strains.
5. The core should have a screw slot or some other mechanical device so that the prefabricated post-core can be firmly inserted into the threaded root canal with a screw-driver or similar instrument.

12.1.12 Instrumentation

The Kurer Anchors are prefabricated metal post-core foundations for use in single-rooted, endodontically-treated teeth. The threaded post is constructed in stainless steel and the core is made of soft machining brass and these are united by a process known as "staking" — a method by which the female portion in the core is made smaller than the male portion of the post and the two parts are forced together. The strength of the union may be controlled by varying the depth to which the post is "staked".

The Kurer Anchors are currently available in four sizes. Auxiliary instruments are provided (Fig. 12.2,a).

1. Parallel-sided, engine reamers that are matched to the diameter of the corresponding Kurer Anchor. They have a blunt non-cutting tip similar to the Peeso reamers.

2. Root facer. An instrument designed for the preparation of a central cavity with a flat base in the root face, into which the core is firmly seated. The blunt, non-cutting shank of the root facer is matched to the diameter of the post and acts as a guide during the preparation of the root face; the cutting blades are at right angles to the prepared canal.
3. A tap, matched to the diameter of the engine reamer, is used to cut a thread in the root canal walls.
4. A wrench or miniature screw-driver is used to screw the anchors into the tapped root canal during cementation.

12.1.13 Clinical procedures

The clinical procedures for the Anchor system were described by Kurer (1967) and are illustrated in Fig. 12.2. The crown of the endodontically-treated tooth is removed to within 0.5 mm of the gingiva. The engine reamer is introduced into the root canal to the desired level and the canal is enlarged into a parallel-sided channel (Fig. 12.2,b). The root facer is then used to prepare the centre portion of the root face until a cavity with a flat floor approximately 1 mm deep is obtained (Fig. 12.2,c). Using gentle digital pressure only, a tap is used to cut a screw thread into the walls of the root canal (Fig. 12.2,d). It is rotated in a clockwise direction, partially reversed and again rotated clockwise. If resistance is felt, the tap is unscrewed, cleaned with a bur brush and re-inserted into the canal. This procedure is repeated until the length of the previously prepared canal is threaded. A corresponding Kurer Anchor is then screwed into the threaded canal with a screw-driver and the length of the post is adjusted as required (Fig. 12.2,e). When the full length of the post is supported by the root canal walls and the base of the brass core is firmly seated on the prepared root face, the Kurer Anchor is removed and the root canal is washed with hydrogen peroxide and dried before the final cementation. The post is

coated with cement, screwed into position, and allowed to set (Fig. 12.2,f). In order to avoid the build-up of hydraulic pressure when the Kurer Anchor is being cemented, Kurer suggested "leaving a space between the base of the threads and the tooth substance".

There is no provision for resistance to rotational forces in this technique; the uneven height of the shoulder of the jacket crown preparation must be relied on to resist any such forces (Fig. 12.2,g). Should it become evident during the crown preparation that the plane of the shoulder tends to be flat, Kurer suggested the extension of the palatal shoulder in a gingival direction.

12.1.2 *Crown Saver Posts*

These threaded, parallel-sided stainless steel posts are available in four sizes. They were designed for the restoration of multi-rooted pulpless teeth and the re-inforcement of existing crowns and bridges where endodontic treatment became necessary after placement (Fig. 12.3).

The clinical application of these threaded posts is relatively simple. Initial preparation of the root canal is carried out with the parallel-sided engine reamer. A screw thread is then cut into the root canal walls with the tap provided in the kit. The post is tried in and the length is adjusted as required. The post is removed and the canal is cleared of debris before final cementation. The post is coated with cement and screwed into position with the wrench provided. After the excess cement is removed, a core foundation may be constructed in amalgam or composite resin in the usual manner.

12.1.3 *Fin-Lock Posts*

The Fin-Lock Posts are threaded, parallel-sided stainless steel posts with two fine stainless steel fins threaded along the post shank for the retention of the composite resin core material. According to the manufacturer, the root face fin has two functions. First, it distributes stresses placed on the Fin-Lock post to the root face. Second, it has a

locking and anti-rotation action. The incisal fin is purely a convenient aid for retaining the composite resin core material. In some cases, for example, teeth with short clinical crowns, it may not be necessary to use the incisal fin at all.

The Fin-Lock Posts are supplied in three sizes. The root canal and root face preparation, and the tapping procedures are identical to those for the Kurer Anchor system (Fig. 12.4,a to c). After the post is trial-seated and adjusted for length, it is cemented into the prepared canal with the wrench provided. Excess cement around the post is removed and the root face fin is locked into position in the central cavity of the root face with the fin-driver provided (Fig. 12.4,d). The incisal fin is placed in an appropriate location for additional retention of the core material. Composite resin is applied and the core prepared for the final restoration in the usual manner (Fig. 12.4, e to g).

12.1.4 *Kurer Press Stud System*

These are threaded, stainless steel posts which are basically identical to the Crown Saver posts except for the press stud attachment incorporated on the coronal end to assist in the retention of removable prosthetic appliances (Fig. 12.5). They are available in three diameters and the procedures for reaming and tapping of the root canal are identical to those for the Crown Saver Posts. Details of impression and laboratory procedures are available from the manufacturer.

12.2 Dentaurum Post System*

This post system consists of threaded, parallel-sided, stainless steel posts of three different sizes — 1.10, 1.30 and 1.50 mm. Like the Dentatus Screw Post System (12,4), the Dentaurum posts are self-threading — that is, the post itself cuts the threads in the dentine as it is inserted

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*Dentaurum, Pforzheim, West Germany

into the root canal. Engine reamers with diameters corresponding to the appropriate posts are provided for canal enlargement. The posts can be used alone or with the aid of a luting cement for added retention.

12.3 Radix Anchor System*

12.3.1 *Instrumentation*

Developed by Spang, the Radix Anchor System is a relatively new post system designed to provide retention for composite resin core foundations. It utilizes a vented, parallel-sided post with retentive threads which engage into the root dentine. In fact, there are four venting channels along the length of each post. Multiple coronal "flanges" are attached to the post to facilitate core formation with composite resin materials.

The Radix Anchor posts are constructed in stainless steel and are supplied in three sizes, with diameters 1.20 mm, 1.40 mm and 1.65 mm. Components of this system and their size specification are illustrated in Fig. 12.6.

12.3.2 *Clinical procedures* (Fig. 12.7)

Remove all carious and undermined tooth structure and the tooth is reduced only as much as clearance requires. Root canal preparation may be carried out with either one of two sets of drills — sizes 1, 2 and 3 of the Elargisseur[@] root canal drills have diameters slightly greater than the corresponding Radix Anchor posts and are similar in design to the Peeso[@] reamers (Fig. 12.7,a). Alternatively, self-limiting twist drills calibrated to the length and diameter of the three different sizes of the Radix Anchor posts may be used. A gauge is used to control the length and diameter of the root canal (Fig. 12.7,b). The last ring on the gauge corresponds to the length of the post portion of the anchor.

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*Star Dental Mfg. Co., Inc., Conshohocken, PA., U.S.A.

[@]Maillefer S.A., Ballaigues, Switzerland

The root canal wall is threaded by screwing the selected Radix Anchor into the prepared canal with the wrench (Fig. 12.7,c). When resistance is felt the end of the post is in contact with the base of the post hole. There is no need for the base flange of the head segment of the anchor to contact the occlusal surface of the tooth preparation. The composite resin core material will later occupy this remaining space. If the post is inserted to its full length but the head portion still extrudes too much occlusally, then either the canal preparation is extended and the post lengthened, or by removal of one or more sets of retentive flanges in order to give adequate occlusal clearance (Fig. 12.7,d).

A thin mix of cement is first introduced into the dried canal with a Lentulo spiral; the Radix Anchor is then screwed into the root canal to the established length using the wrench (Fig. 12.7,e). Any excess cement in the space between the base of the head portion and the occlusal surface of the root preparation is removed. A suitable matrix or crown former is adapted and filled with composite resin and pressed into position over the anchor head (Fig. 12.7,f). This is held under pressure until the composite resin sets. Preparation for the final restoration may then be carried out (Fig. 12.7,g).

12.4 Dentatus Screw Post System*

12.4.1 *Design principles*

Over the last two decades, these threaded, tapered brass posts have been used extensively for the retention of amalgam and, more recently, composite resin core foundations in endodontically-treated posterior teeth. The Dentatus posts are gold-plated for better corrosion and tarnish resistance. It is claimed by the manufacturer that "the silver alloy filling that is built around the post forms an amalgam with the surface of the post and the two are welded together to form a perfect anchorage".

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*Dentatus, Hägersten, Sweden

Because brass of this composition (Cu 60%, Zn 39%, Au and Ag 1%) has a low resistance to corrosion (Dérand, 1971), a large selection of post diameters and lengths are available so that the screw post can be inserted without length adjustment and the electrolytically precipitated gold coating remains intact for protection against corrosion.

12.4.2 *Instrumentation*

The Dentatus Post System consists of screw posts of four lengths — 7.8 mm, 9.3 mm, 11.8 mm and 14.2 mm. The extra long 14.2 mm posts are supplied in two diameters only — 1.50 and 1.80 mm. For the other three post lengths, six sizes are available — 1.05, 1.20, 1.35, 1.50, 1.65 and 1.80 mm. Engine reamers of corresponding diameters are supplied in the kit and are either 28.0 mm or 33.0 mm long. Serrations on the shank of the reamer identify the diameter of the post to be used. Two types of keys are supplied for use during post insertion — a square hollow key where there is no problem with access, and a cross key for narrow cavities (Fig. 12.8, a and b).

12.4.3 *Clinical procedures*

Following the removal of the root canal filling to the desired level, the root canal may be reamed to the size of the appropriate screw post with a corresponding Dentatus reamer. Depending on the amount of retention required, the post may be screwed into the root canal by itself or a luting cement may be used to supplement the mechanical retention of the post. Generally, the threads of the post will provide adequate retention for narrow roots. For large roots, the manufacturer suggested using a larger reamer than the desired screw post, so that a luting cement may be used. Comparison of the actual screw post with a radiograph of the root-filled tooth was suggested as an aid to the selection of the correct size post.

12.5 Schein Screw Post and Compo-Post System*

In almost every respect, the Schein Screw Post System is identical to the Dentatus Screw Post System. However, the Schein Compo-Posts have a modified head design which is supposed to improve the retention of the composite resin core material. Apart from this subtle difference, the instruments and clinical procedures described for the Dentatus system may be applied in the same manner.

12.6 Blue Island Post System@

The Blue Island posts are self-threading, tapered screw-posts. They are available in four sizes — 14 to 17 gauge — and in three lengths — short, medium and long. A wrench is provided for the insertion of the screw posts. Clinical application of these posts is similar to that of the Dentatus Screw Post System described in 12.4.

12.7 F.K.G. Screw Post System#

This screw post system is very similar to the Dentatus system with only two basic differences:

1. F.K.G. posts are made of stainless steel and, therefore, are much harder and possess greater tensile and shear strength than the brass Dentatus posts.
2. F.K.G. posts are supplied in ten different lengths (6.5 to 15.0 mm) but only in one diameter which corresponds to the diameter of a No. 3 Peeso# reamer.

Two keys are provided for the insertion of the posts — a cross screw-driver and a wrench.

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*Henry Schein Inc., Port Washington, N.Y., U.S.A.

@Blue Island Specialty Co., Blue Island, Ill., U.S.A.

#Union Broach Co., Long Island City, N.Y., U.S.A.

12.8 Discussion

Because of their nature (threaded), these posts are intended for use with composite resin or amalgam cores. As discussed in Chapter 5, laboratory research (Kurer, 1977; Standlee et al, 1978; Ruemping et al, 1979) has shown that threaded posts are considerably more retentive than passively-cemented posts of equal lengths. This superior retention may be achieved in one of two ways. The threaded post may be screwed into a post hole whose walls have previously been threaded with a special tap. Alternatively, the post may have self-threading action and the threads are cut into the root canal walls as it is screwed into the canal during cementation.

Threaded, parallel-sided posts

Several recent laboratory studies (Standlee et al, 1978; Ruemping et al, 1979; Standlee et al, 1980) have shown, beyond doubt that, in an axial direction, the screw-in, threaded parallel posts are the most retentive. The Kurer Anchor was found to be more retentive than the Radix Anchor presumably due to the larger number of retentive threads available for engagement with the dentinal walls of the root canal (Standlee et al, 1980). However, "retention in itself is not the sole criterion of a post system" (Henry and Bower, 1977,a). Photoelastic analysis of stress distribution by the threaded parallel-sided posts (Standlee et al, 1972; Henry, 1977; Standlee et al, 1980) demonstrated high stress concentration in the simulated pulpless tooth. Because high levels of stress were generated when the "core" or the "coronal flanges" of the Kurer Anchor and the Radix Anchor is allowed to impinge on the shoulder region of the post-core preparation, it has been suggested (Standlee et al, 1980) that the post should be shortened sufficiently to enable it to be installed until light resistance is felt and it should then be "backed off" one half turn.

Durney and Rosen (1977) emphasized that the tapping procedure for the Kurer system must be performed with utmost care in order to avoid root fractures. They suggested removing the tap for cleaning as soon as resistance to further tapping is encountered. In the study by Zmener (1980,a), microfractures occurred in the dentine adjacent to the threads of the Kurer tap as well as the Dentaurum posts.

Reported failures associated with the Kurer Anchor System included fracture of the stainless steel posts (Messing and Wills, 1973) and separation of the brass core from the stainless steel post (Bryant, 1982). As in the case of the Charlton, the Hannah and the K.D. post systems, the Kurer Anchor system requires the removal of most or all of the clinical crown, and the uneven shoulder of the crown preparation is relied upon to provide resistance to rotational forces.

Threaded, tapered posts

The use of tapered screw posts such as the Dentatus posts, places the pulpless tooth in considerable risk of root fracture (Henry, 1977). As the tapered post is driven apically, it forces the tooth to expand (Durney and Rosen, 1977). The amount of expansion that is caused depends on several factors:

1. the shape and length of the post
2. the shape of the thread
3. the difference between the diameter of the prepared canal and the maximum and minimum diameters of the threads
4. the amount of torque applied, and
5. the physical condition of the dentine.

Although Durney and Rosen (1977) concluded that these screw posts are "simple and relatively safe" to use, they did emphasize the added risk of root and post fractures due to overmanipulation. They suggested that, perhaps, the manufacturer of the screw posts should provide a suitable

self-limiting torque wrench with a maximum torque of 5 ozf in for the insertion of the post. While the problem of thread stripping in the relatively soft, brass Dentatus posts may be solved by using a stronger material such as stainless steel, this type of failure may actually result in a decrease in the incidence of root fracture. Photoelastic studies by Henry (1977) have shown that when this type of screw posts is used, the pulpless tooth is subjected to high stress concentration, even in the unloaded state. Evidence of root fractures caused by the Dentatus posts in Zmener's investigation(1980,a)appeared to support Henry's (1977) findings. Fracture lines were found to radiate from where the threads of the posts cut into the dentine.

Investigation of the corrosion resistance of the brass screw posts by Dérand (1971) found that sometimes screw posts do corrode *in vitro* and that the corrosion products can penetrate dentine. Examination of biopsies from discoloured gingiva, adjacent to extracted teeth which had screw posts placed in them 3 to 10 years earlier (Arvidson and Wróblewski, 1978), showed the presence of copper, silver, zinc and iron in relatively high concentrations. Visual inspection of the sectioned teeth showed varying degrees of tarnish of the cemented screw posts. It was thought that the metallic content of the gingiva most probably originated from the dental materials used. In view of this, screw posts which are discoloured or show a defective surface should not be used; grinding or cutting of the screw post should be avoided (Dérand, 1971) and care taken to prevent damage to the thin gold coating.

Although threaded posts have undoubtedly functioned satisfactorily in very many cases for many years now, it is the dentist, ultimately, who must determine for each case whether the additional retention obtained justifies the risk incurred in their use.

TABLE 12.1

THREADED POST SYSTEMS

	PARALLEL-SIDED POST SYSTEMS			TAPERED POST SYSTEMS			
	Kurer Post System	Dentaurum Post System	Radix Anchor System	Dentatus Post System	Schein Post System	Blue Island Post System	F.K.G. Post System
Surface finish	threaded	self-threading	self-threading	self-threading	self-threading	self-threading	self-threading
Venting	no	no	yes	no	no	no	no
Sizes (diameter)	4	3	3	6	6	4	1
Materials	Anchor System - stainless steel post and brass core Crown Saver, Fin-Lock and Press Stud - stainless steel	stainless steel	stainless steel	brass (gold-plated)	brass (gold-plated)	stainless steel	stainless steel

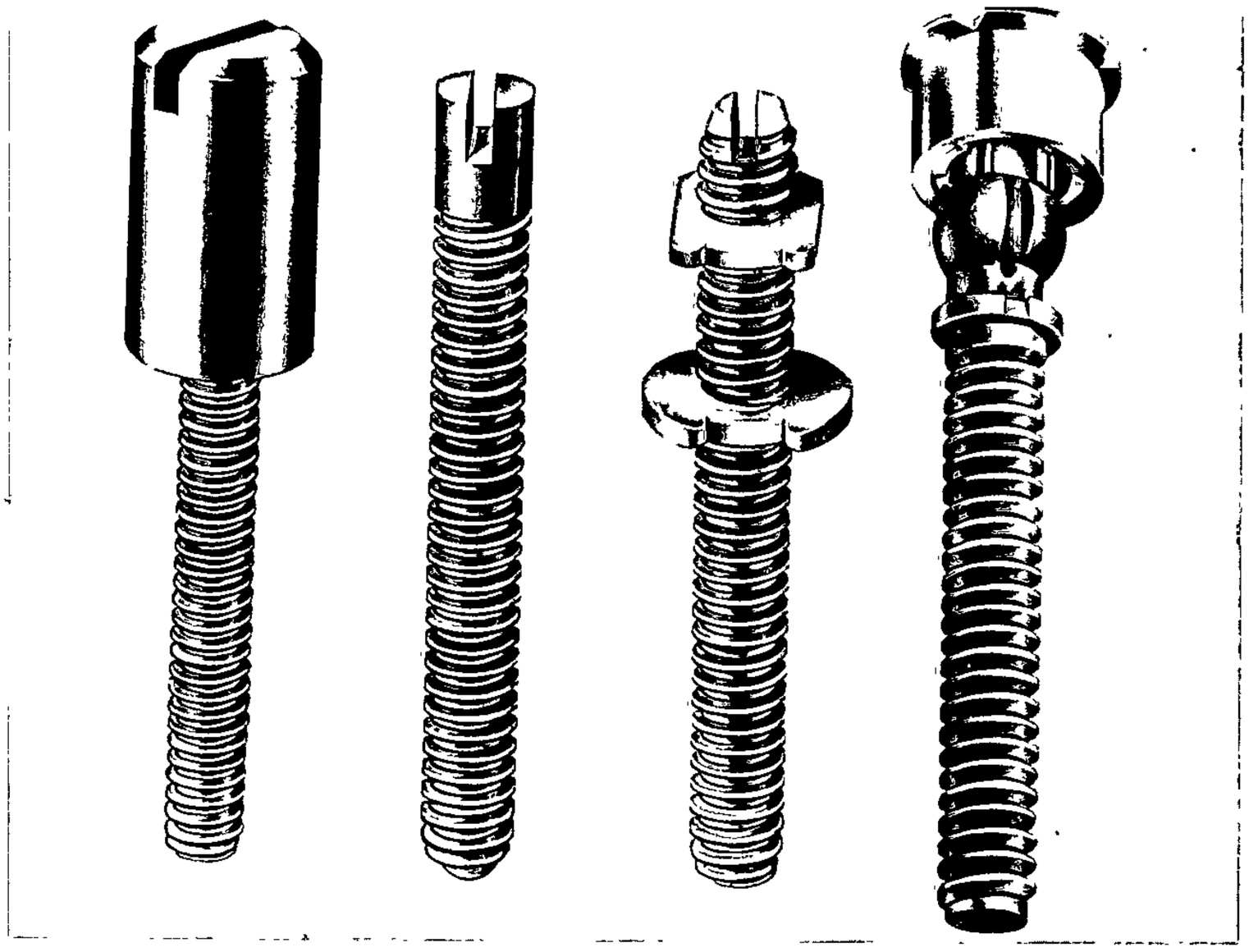
Fig. 12.1 Kurer Post Systems.

L. to R. Kurer Anchor System, Crown Saver Posts, Fin-Lock Posts, Press Stud System.

Fig. 12.2 a. L. to R. engine reamers, root facer, wrench, anchor post, root tap.

b. to g. For legend, refer to 12.1.13.

Fig. 12.1; 12.2



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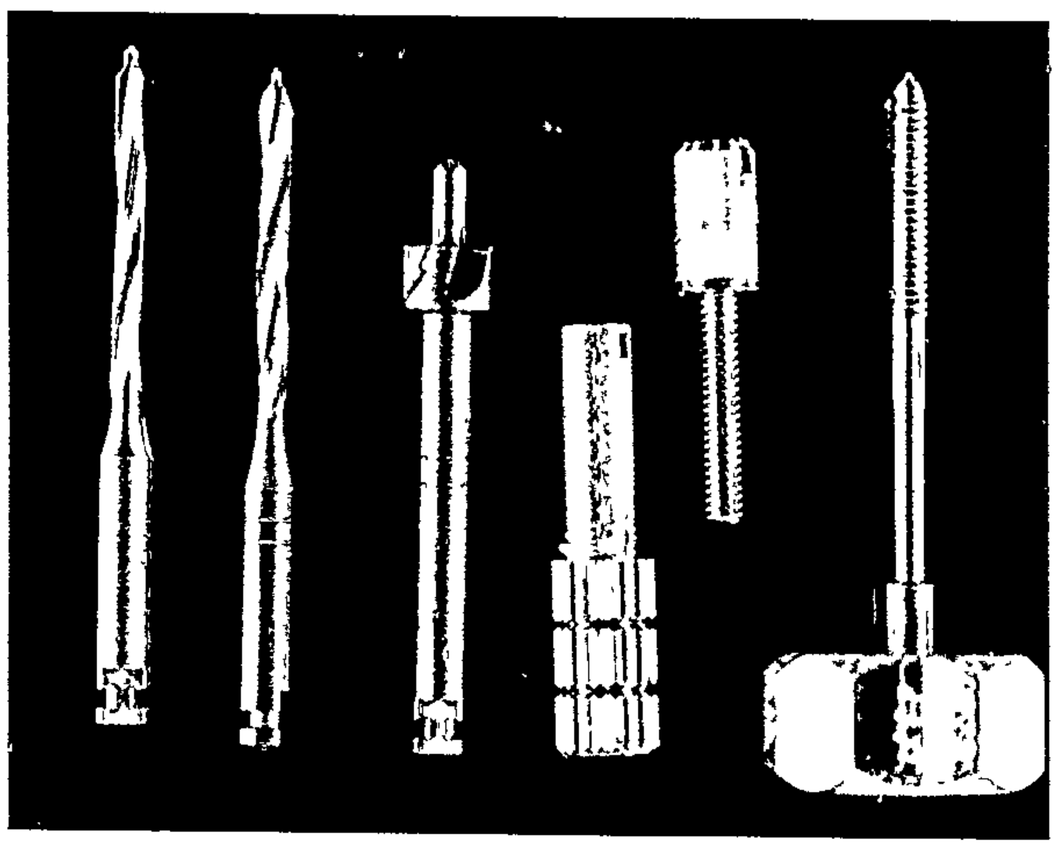

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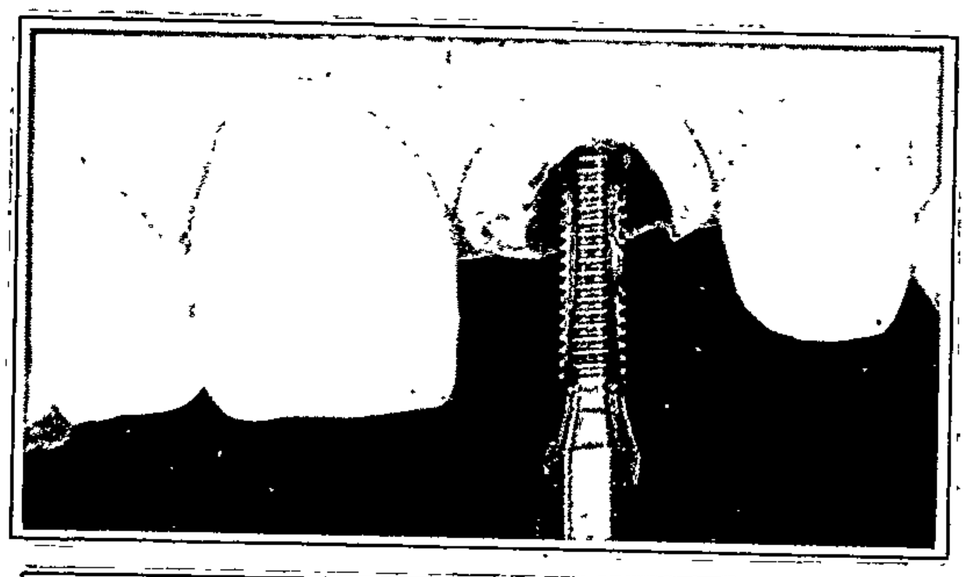

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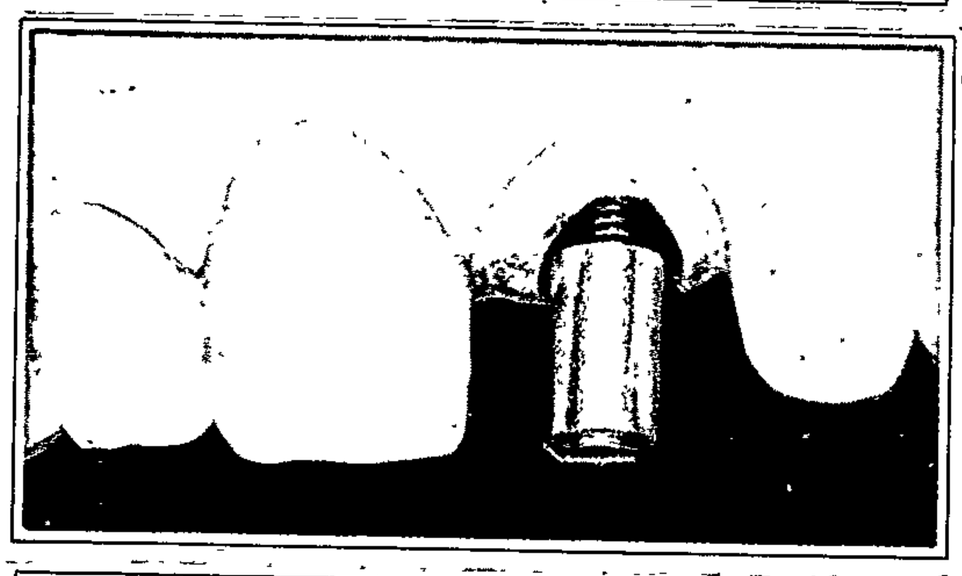

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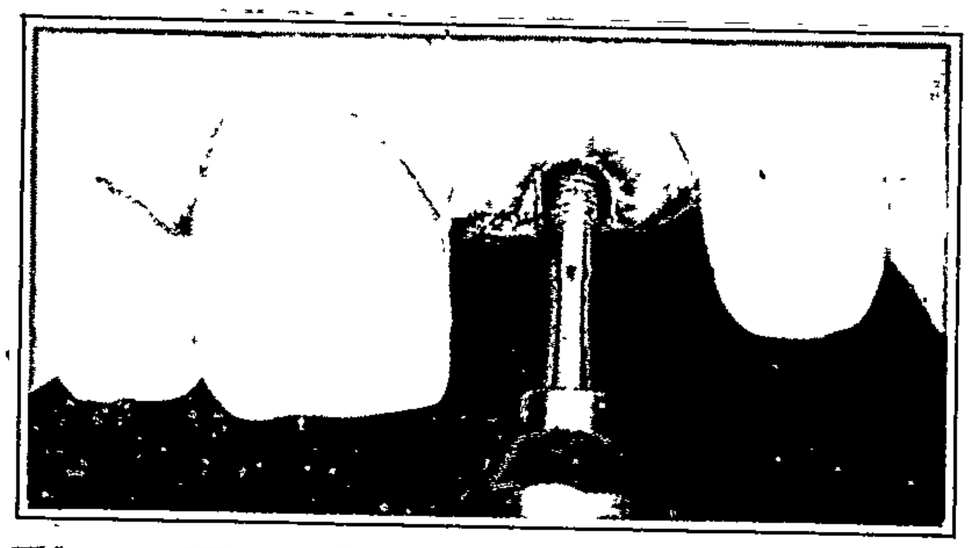

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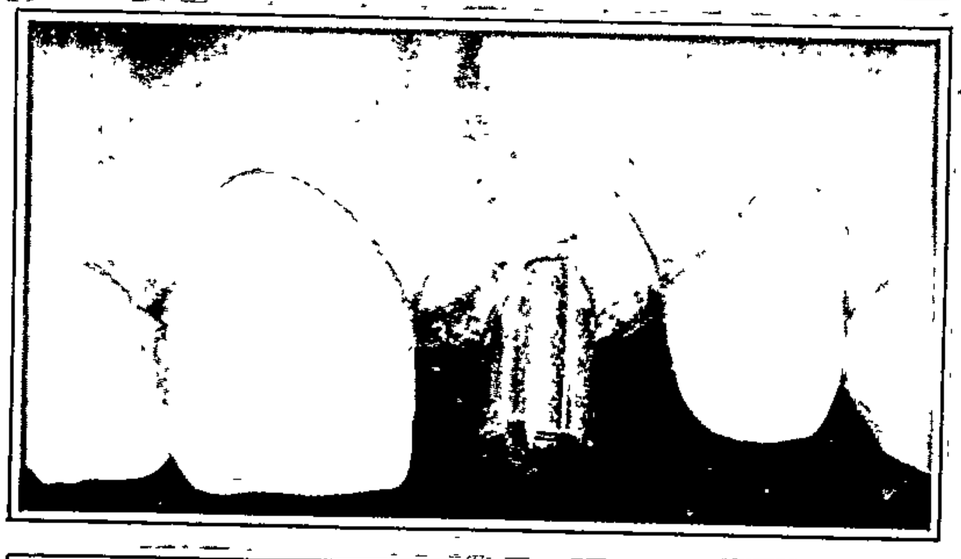

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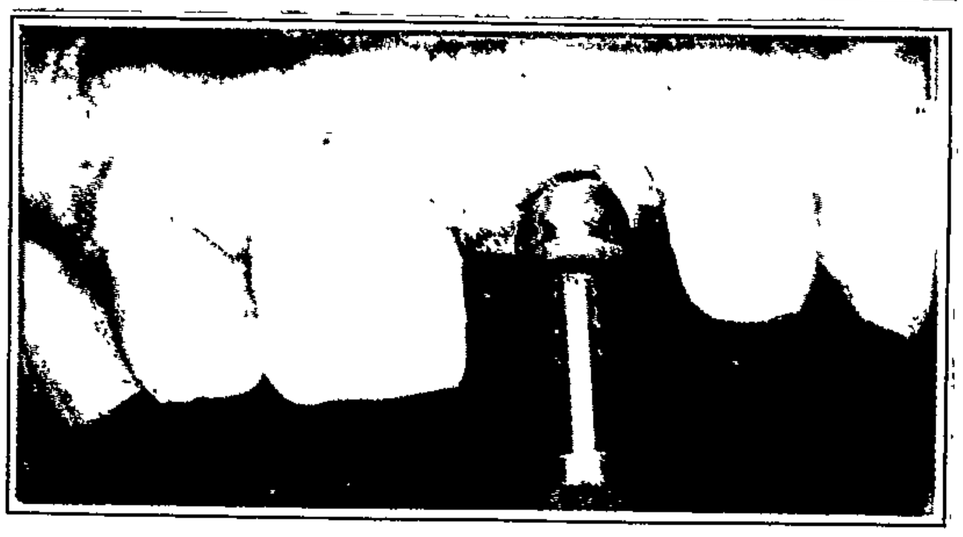


c

g

Fig. 12.3 Crown Saver Post.

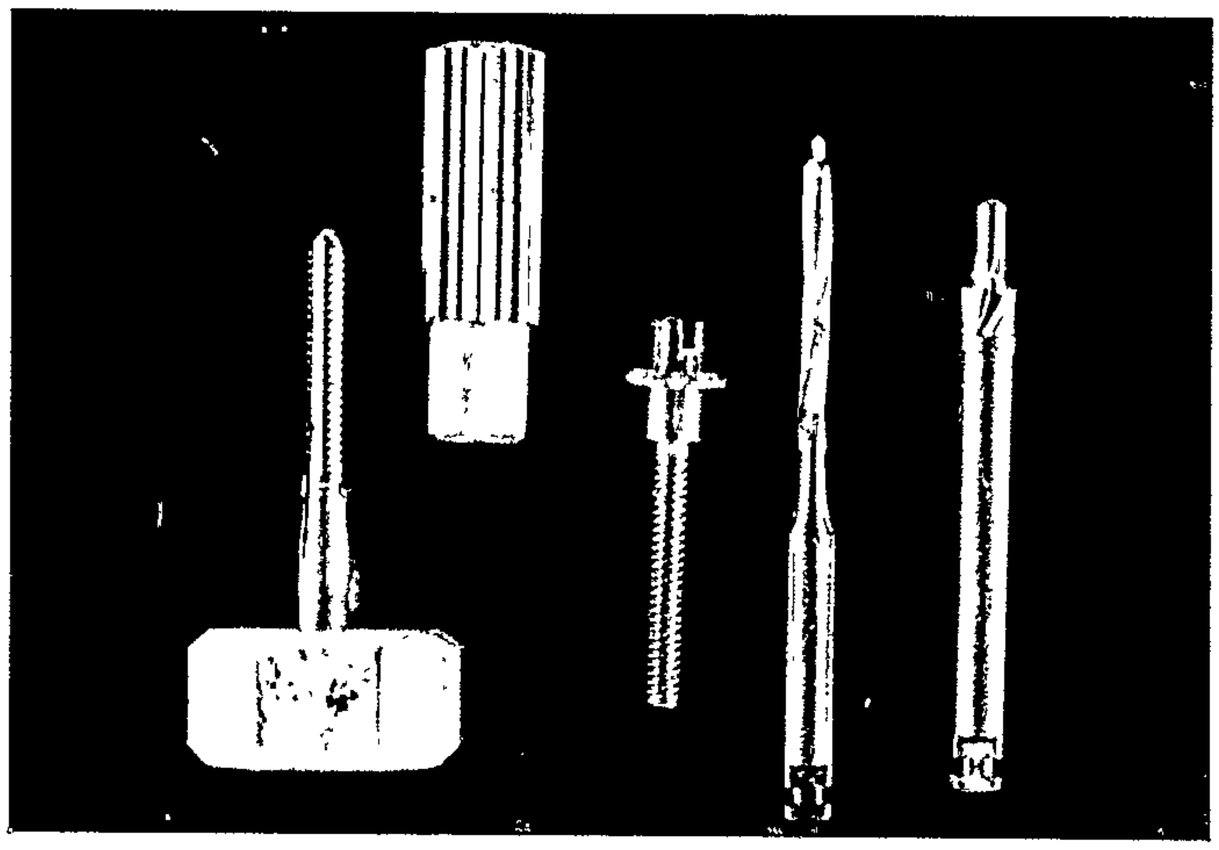
L. to R. root canal tap, wrench, Crown Saver Post, engine reamer, root facer.

Fig. 12.4 For legend, refer to 12.1.3.

Fig. 12.5 The Kurer Press Stud System.

(refer to 12.1.4 for detail).

Fig. 12.3; 12.4; 12.5



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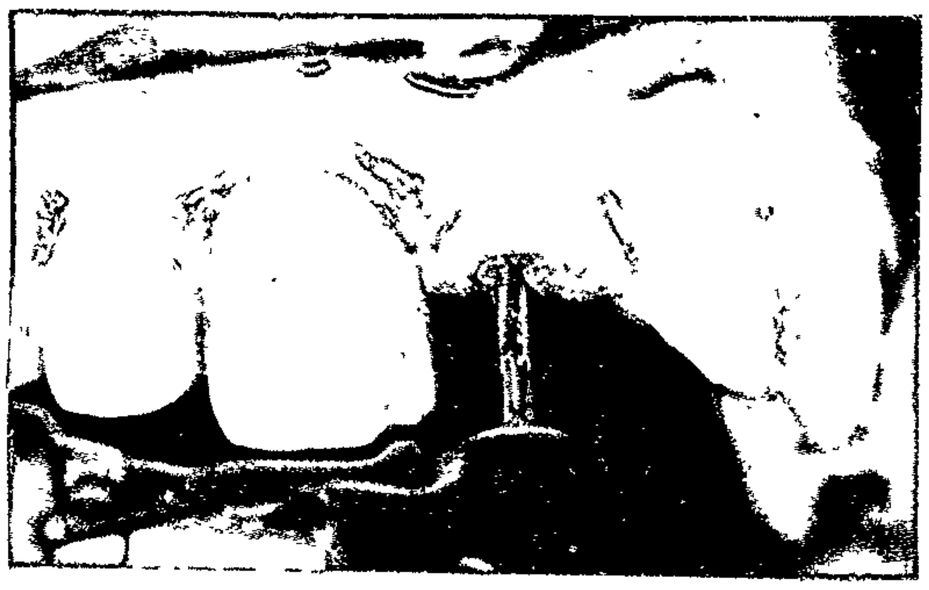

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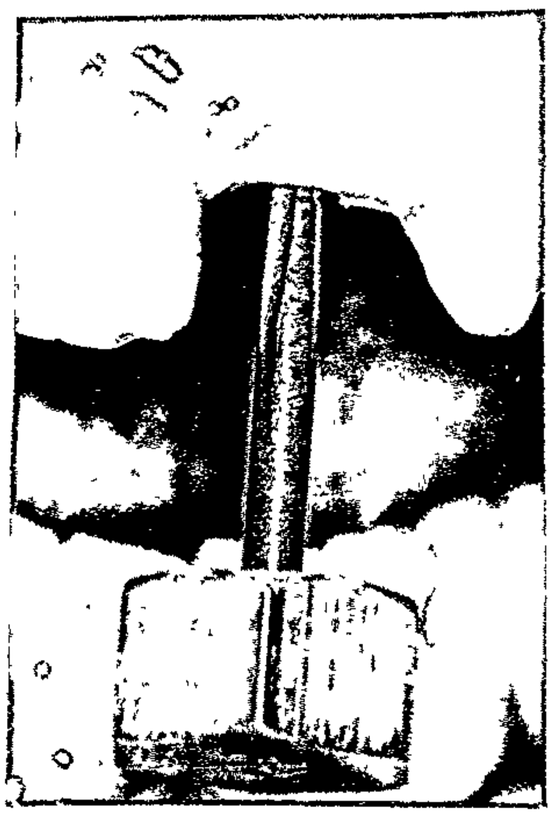

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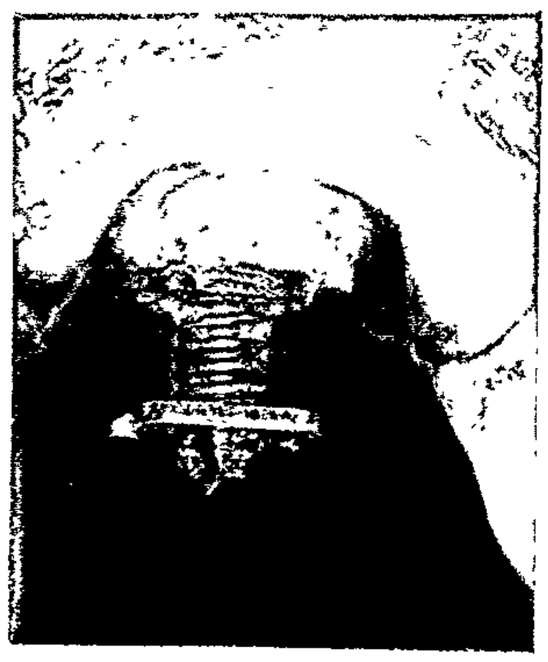

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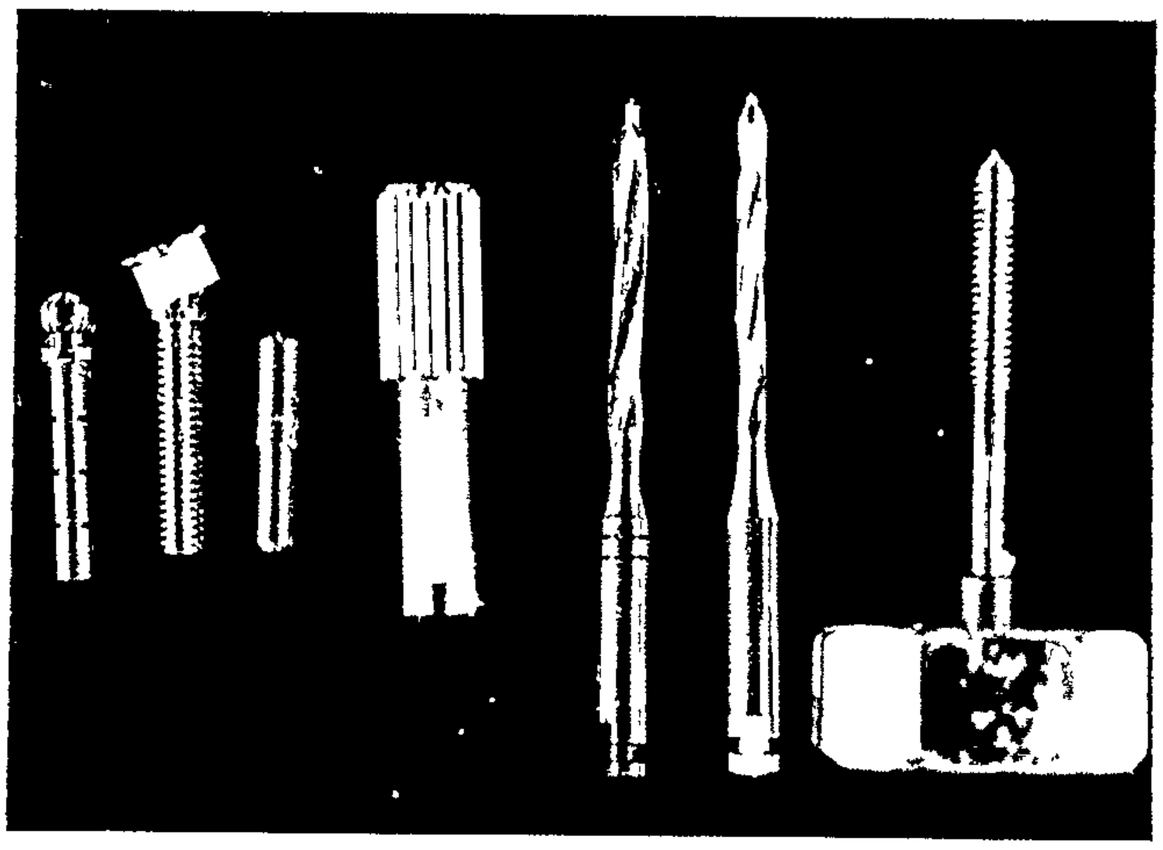


12.5

Fig. 12.6 Radix Anchor System.

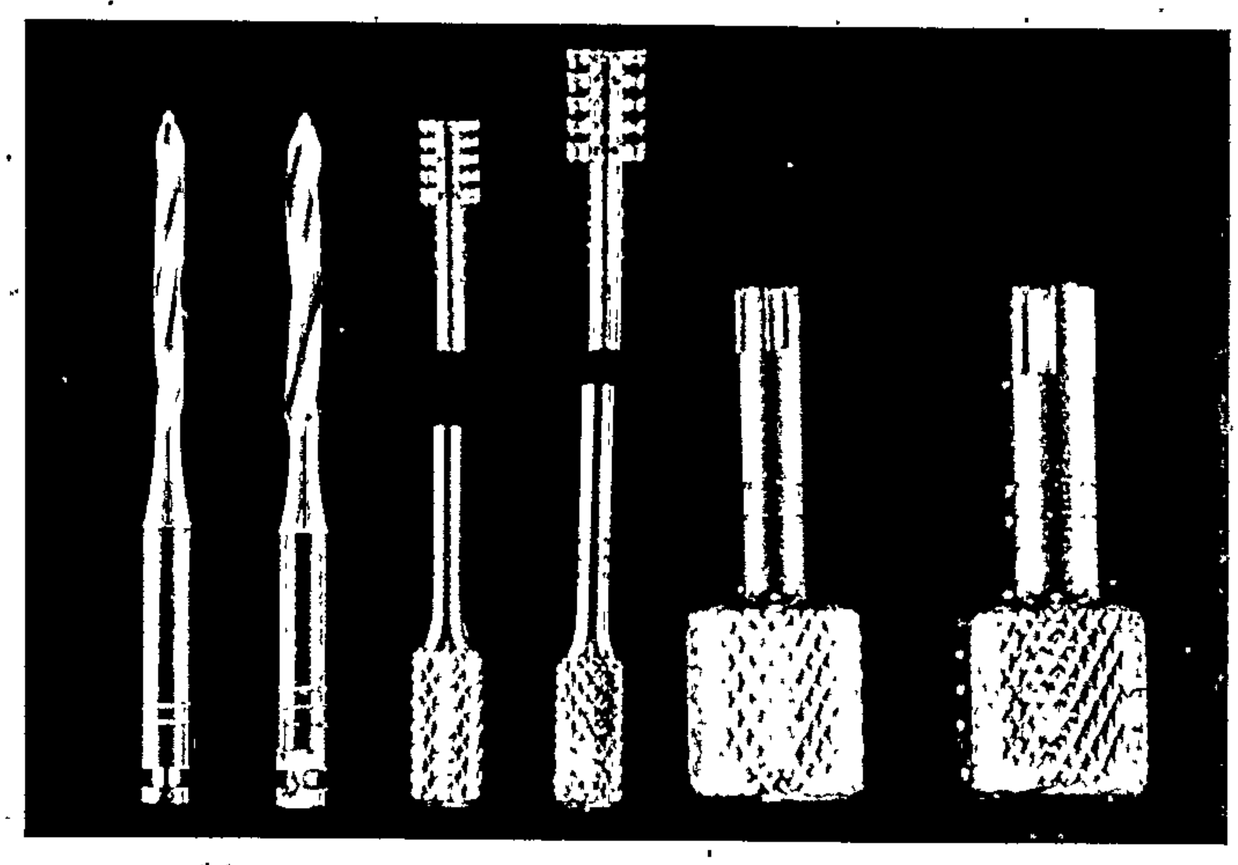
L. to R. Elargisseur root canal drills, Radix anchors, calibrated gauges, wrenches for Sizes #2 and 3.

Fig. 12.7 For legend, refer to 12.3.2.

Fig. 12.8 a. A selection of Dentatus posts and wrenches.

b. Dentatus reamers.

Fig. 12.6; 12.7; 12.8



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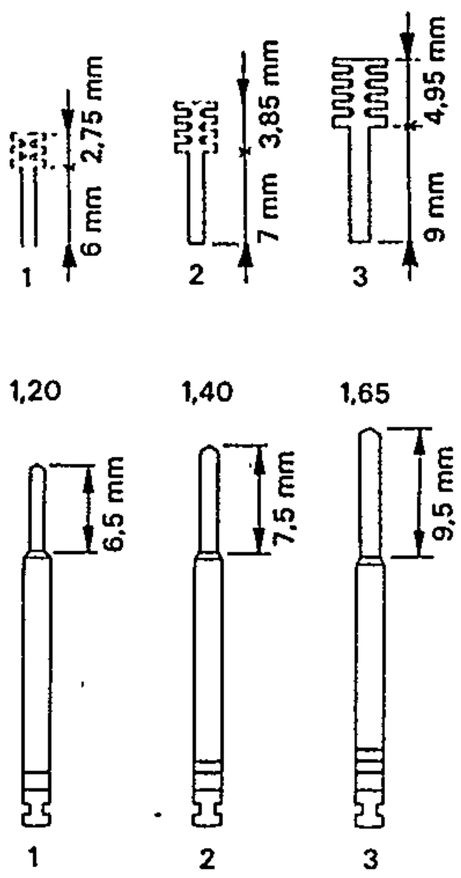


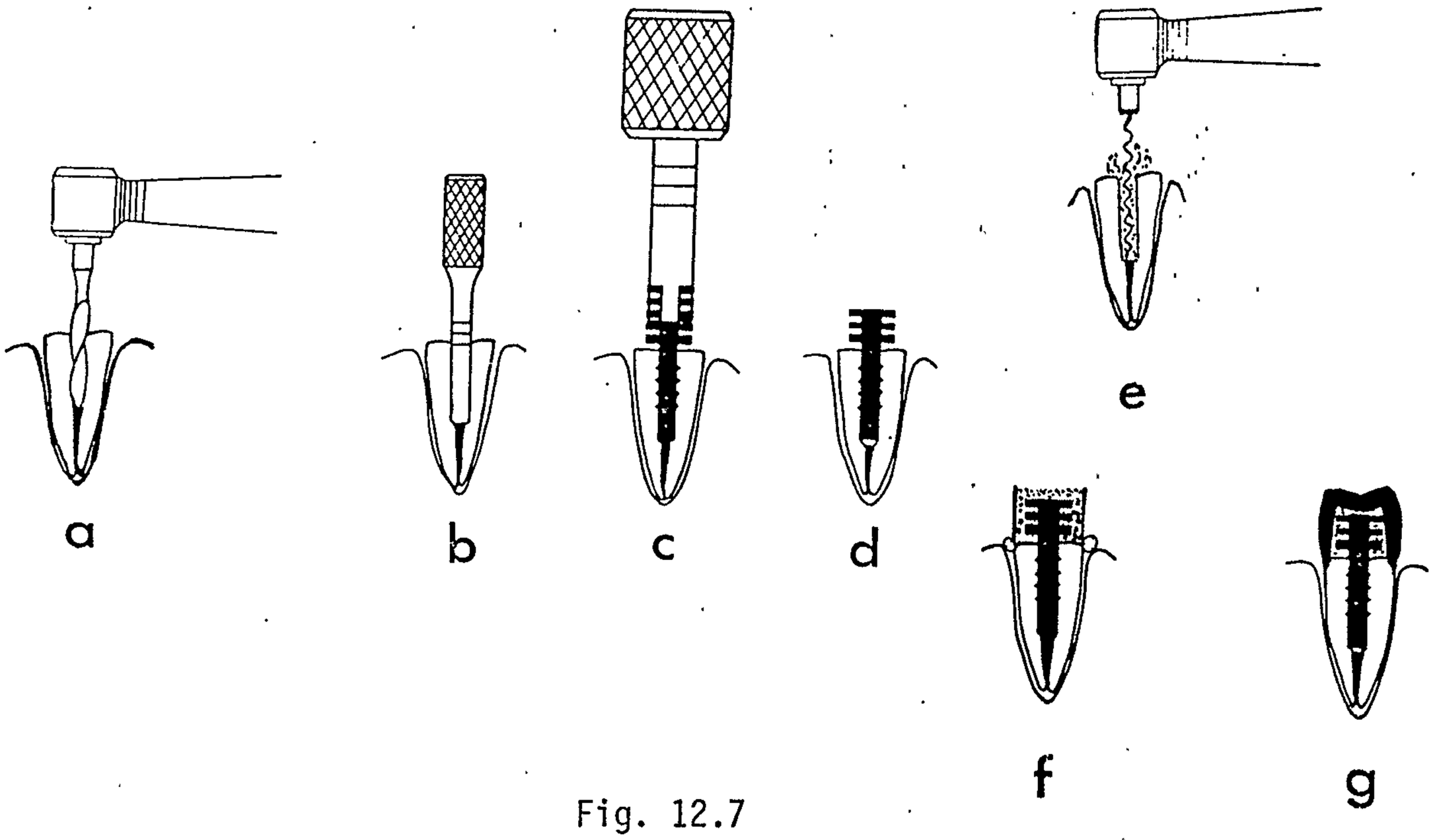
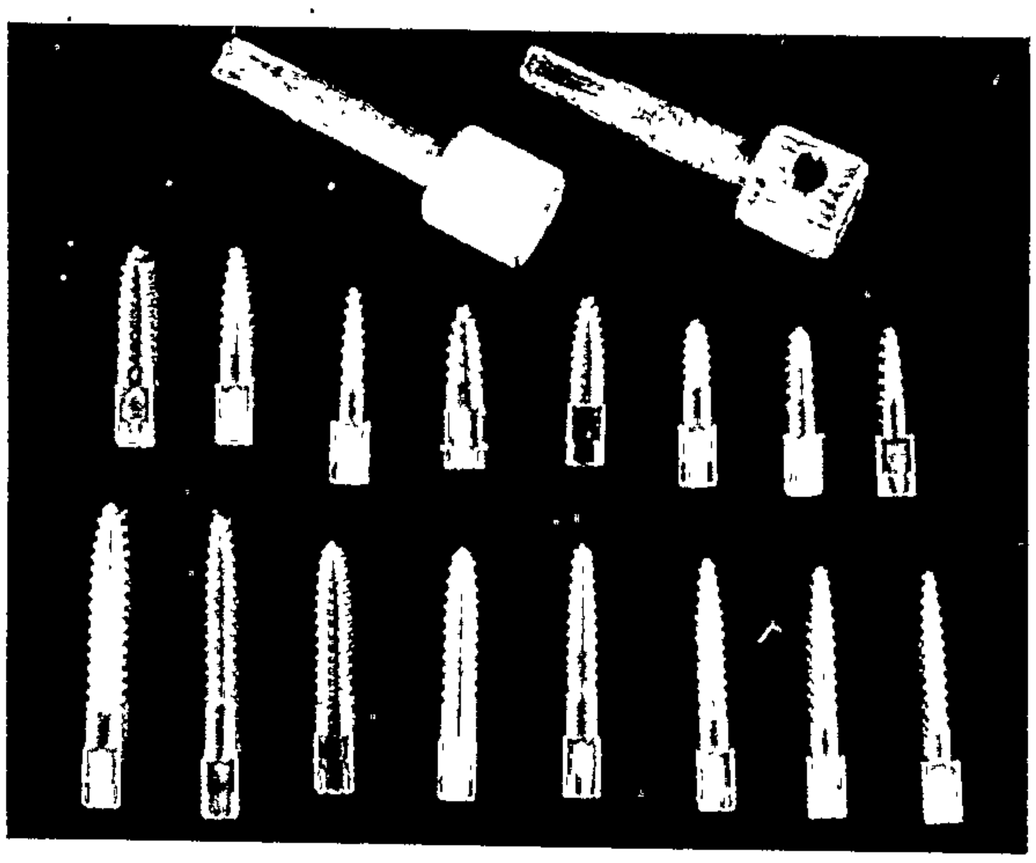


Fig. 12.7



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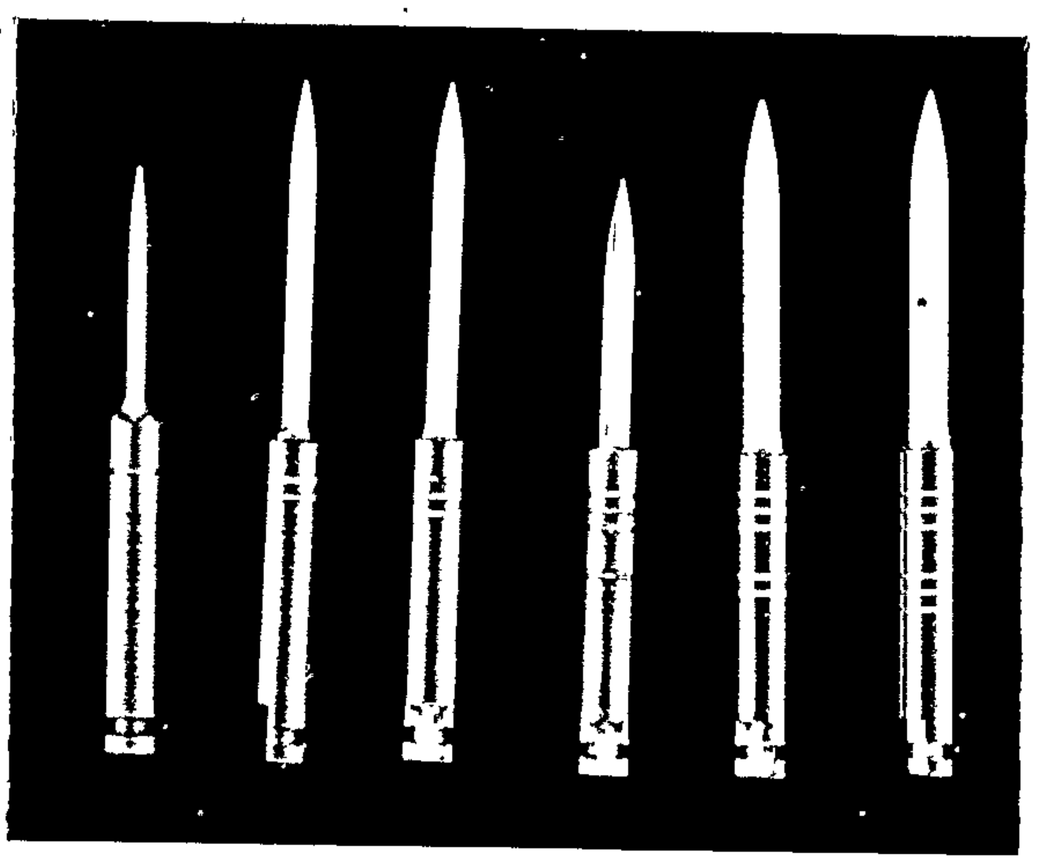

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