SQUASH BITE TECHNIQUE.

This is perhaps the earliest form of recording centric relation. In the early days the patients were asked to close into a large moulding of beeswax, this served as the 'bite' and in some cases the impressions as well. The squash bite as we know it to-day has developed from this phase into a scientific technique. It consists of having the patient close into centric relation holding this position and fixing the base plates together by means of a suitable recording medium. It necessitates some patient training, or the use of a technique involving some means of retrusion, so that the patient will in actual fact close into centric relation. Inherent also in the technique is the ability of the operator to recognise when the patient is indeed in true centric relation.

This method is of three fold purpose: To record an approximate centric relation so that the base plates may be mounted for the purpose of attaching some form of tracing device; to record true centric relation; and to check previous records. For the first two approaches a similar technique is used. The last requires a variation due to the usual presence of articulating cusps.

(A). Direct Check Bite Method:

In this method the operator, by manipulation, repeated trial and observation and training, attempts to have the patient close in a position of centric relation. The inter-arch distance has been previously established by occlusion rims or teeth. When it is perceived by the operator that the desired position is obtained, the appliances attached to the jaws are fixed by a suitable recording medium. The method presents the possibilities of recording a position with equalised contact, at a pressure determined by the displacement quotient of the recording medium, if this medium is of consistent texture throughout and if the occluding surfaces are not permitted to penetrate through the recording medium.

It is stressed that the pressure at which the record is made and the degree of equalisation of contact between the occluding surfaces is

entirely dependant on the consistency and uniformity of the recording medium.

The technique demands the ability of the operator to recognise the position of centric relation and the role of the recording medium must be kept in mind.

Schuyler is representated as being the first to place the wax bite technique on a sound basis. He describes his system in 1932 as follows: The first requisite is a perfectly adapted base tray. After the bases have been formed to the cast, the desired occlusal plane and facial fullness is established with the maxillary occlusal rim of modelling compound. The occlusal surface is trimmed to approximately 3 m.m. in width anteriorly and 5 m.m. posteriorly. Compound is then added to the lower base, to approximately two-thirds of the desired height of the rim while the base is on the cast. This is placed in the mouth and the patient is requested to close in rest relation. At this point the maxillo-mandibular degree of o opening should be about two m.m. in excess of the normal, after which the occluding surfaces are conformed and reduced to the desired thickness. The surface of the lower rim is again warmed to an even depth, preferably about 3 m.m. and is then returned to the mouth. The patient is again instructed to close very lightly in the normal rest position. This closure must be less than the depth of the warm plastic material. The compound is then chilled and the bases are removed and trimmed.

We should now have a set of rims of even thickness and well related to each other with little possibility of uneven occlusal pressure and also possessing the proper maxillo-mandibular opening. Very small interlocking notches are now cut in the occlusal surfaces of the maxillary rim in approximately the area of the second bicuspid. The occlusal surface of the lower rim is warmed and pinched to a gable-like peak.

It is again warmed and returned to the mouth, at which time a special effort is made to have the patient close lightly in centric maxillo-mondibular relation. The compound is quickly chilled and the

bases are removed from the mouth and submerged in ice water. Excess compound is removed from the lower base. The rims are returned to the mouth and all possible checks are made to ensure that the registration was received with an even distribution of occlusal stress.

Schuyler (1932) points out that many prefer to leave the occluding surfaces of the rims smooth, recording the relation between them by placing of slots and compound keys on the buccal surfaces of the occluding rims. This method appears to me to be more hazardous, especially in the flat ridge cases, owing to a possible lateral displacement while placing the compound keys which serve to lock them.

Furnas (1935) has a variation on the direct closure technique. The patient inserts the occlusal rim and after a sufficient period of time during which the patient accustoms himself to the bite blocks, the vertical dimension and rest position is checked. It would appear this is entirely scientific procedure, that the patient does indeed require some time to adapt himself to the presence of these strange appliances in the mouth, and to be confident of them so that there is little or no interference in the normal neuro-muscular patterns. He continues: If these are satisfactory the patient is asked to stand up. The patient is relaxed or his attention distracted from the bite rims by speech or reading. At a suitable time he is asked to assume a position of perfect rest and relaxation and to gently bring the lips to a comfortable and unstrained contact. If there is slight evidence of tension remaining in the muscles of expression, the patient is asked to moisten his lips with the tongue. The operator is now standing three or four feet from the patient and quietly asks him to swallow, and, as he makes this request, steps toward the patient, arriving at his side just as the act of swallowing is consummated. He grasps the head and chin firmly and instructs the patient to hold the exact relation. The upper lip is now raised and on either side of the occlusion rims a vertical line is cut in the wax or compound in the region of the first bicuspid area and crossing the plane of occlusion. Now the patient is returned to the operating chair and

instructed to open and close repeatedly until asked to stop. At the first closure it will probably be noted that owing to protrusion of the mandible the vertical guide line will be broken at the occlusion plane. This relation will prevail for pharhaps several closings. Soon the muscles will begin to tire and the mandible will gradually start to drift backward until finally the two parts of the vertical guide line above and below the occlusal plane are again united. This is accepted as evidence that the mandible is in correct centric relation.

It would seem that the latter phases of this technique are to-day scientifically unacceptable. It is difficult to realise that the patient would be able to maintain the jaw in a position of centric relation as the dentist moves quickly to his side and grasps the jaw. It has been pointed out by the Shpuntoffs that the presence of an extra-oral indicator will interfere with the neuro-muscular pattern and may cause an incorrect recording of centric relation. What then are we to expect, if the patient's chin and head are suddenly firmly grasped? Apart from the element of surprise, and the natural antagonism which the jaw would have against any pressure exerted upon it, there is the interference of the neuro-muscular pathways and impulses which in the edentulous condition determine centric relation. This author also does not refer to his technique of recording relation once he has assumed that the patient has achieved the position.

Block in 1953 describes his method of using a wax bite technique as follows: Vertical dimension is established and the upper cast is mounted by means of the face bow. Three or four m.m. of wax are removed from the posterior areas of the lower occlusal rims corresponding to the positions where the bicuspids and molars would be. Soft base plate wax is now sealed and built up in excess of the lower posterior area to take the place of the wax removed. The bulk of this new and softer wax is softened almost pooled and the patient is instructed to close into this soft unresisting mass. This is done only after the patient has been rehearsed over and over until the proper centric closure is reasonably assured. Excess wax is removed after chilling and the registration is checked.

The mandible is not forciblyretruded manually because an unstrained retrusion is what we seek.

This approach is to be considered as a typical mode of application of the technique as it exists to-day.

Brill in 1957 advises the use of a gable peak lower occlusal rim. This is basically similar to the original technique outlined by Schuyler, but in this case the author advises a solid lower rim, which is designed to penetrate and register in a softened upper rim. When the registrations are made the wax occluding surfaces on both sides of the upper occlusion rims are heated approximately to liquefaction to a depth of approximately 3 m.m. The upper and lower occlusion rims are then placed in the mouth and the patient is directed to bring the occlusion rims into very light contact. The closing movement is to be performed as a pure hinge movement with the condyles in the most actively retruded position. Through this procedure the lower occlusion rim presses into the upper occlusion rim without any resistance from the wax. Care must be taken in the upper rim to have the wax equally as softened on both sides to avoid displacement. Furthermore, the procedure is to be undertaken in such a way that the patient opens his mouth immediately after contact between the occlusion rims has been established. The impression made in the upper rim should be approximately 1" x 1 m.m. so that a positive re-attachment can be made.

The preceding techniques have all employed the use of wax as a recording medium. It would seem that the acceptability of these techniques would depend on having wax of equal flow and consistency on either side. Although the authors have advised pooling the wax, and another technique of flaming the edge of a sheet of wax, it would seem that the most scientifically acceptable and desirable method would be to heat the wax in a water bath at a preordained temperature. It would appear to me that this is the only method of obtaining equal consistencies of the medium on either side.

Bertram in 1959 introduces another technique based on the squash bite system. A different recording medium is used and the patient's physiologic action of swallowing is employed to obtain the position of centric relation. His technique is as follows: The upper wax occlusal rim is established and the lower is cut down by hand with a warm knife until the vertical dimension has been overclosed about 2 m.m. Aluwax is heated in a flame and dripped onto the lower occlusion rim in small mounds about 4 m.m. high and 4 m.m. in circumference. Three such mounds are formed, one in the anterior region and one on each side of the posterior sides. The Aluwax holds the heat well and remains soft while the patient closes lightly into the mounds to a depth of about 2 m.m. Because the area of contact between the upper and lower occlusion rims is reduced to 3 small mounds of soft wax minimum closing effort is required. The lower occlusion rim is removed from the mouth. Zinc oxide and eugenol impression paste is applied to the surface of the rim and the rim is returned to the mouth. Since vertical dimension has already been established the patient closes lightly in centric relation making only minimum contact of the rims. The feeling of maintaining the rims lightly in contact must be conveyed to the patient or the mounds of wax may be further compressed.

A rapid set of the material is essential to avoid the muscular fatigue which accompanies the maintenance of a fixed closed position for a long period of time.

This technique it will be noted employs swallowing as an aid to retrusion and this idea of using swallowing as a means of obtaining centric relation is based upon the theory of continuation of neuro-muscular reflexes.

The technique was advocated by Shanahan in 1955, who says to establish the physiologic centric relation blocks of soft wax are placed on the same lower occlusion rim in the bicuspid and first molar regions, both occlusion rims are inserted in the mouth and the patient is requested again to swallow several times. As the mandible rises to its vertical dimension

terminal, the occlusion rims are evenly balanced by the musculature and the mandible is retruded by the tongue to a natural centric relation.

Each of the above techniques involves a considerable amount of training of the patient This has been emphasised by Shore (1959), Block (1953), Jamieson (1956), amongst many others.

The training involves education of the patient and a means of effecting retrusion of the mandible. These will be considered later.

The above techniques also employ active positioning of the mandible, that is the mandible assumes centric relation at the direction of the patient. It has been advocated by some authors that this can more accurately be done passively as the mandible may be placed in the desired position by the operator. It would seem that some operators definitely have the ability to manipulate the mandible into centric position. However, it appears to be an art acquired by few which may, in the average case, meet with some degree of disaster.

Wright in 1939 describes his technique which he terms a muscular relaxation method. The mandibular denture base isprepared for registration of centric relation as follows: Two pieces of pink occlusion rim wax, equal in length, are cut to fit the bicuspid molar regions of the base. Each piece is softened in warm water to 120° F and neatly adapted and sealed to its respective side of the base, after which it is moulded by finger pressure and trimmed to a wedge shape throughout its length. The crest of these pink wax wedges should be about 8 m.m. higher then the block wax record in the anterior region; this latter is the predetermined vertical dimension guide. Both dentures are inserted and then examined. The patient is instructed to slowly close into the soft wax, until the upper surface of the black wax inter-maxillary record is within about 4 m.m. of touching the maxillary wax rim, whereupon closing is discontinued and both denture bases and rims are removed and chilled.

In this manner the softened wax wedges of the mandibular denture base are flattened against the maxillary wax rim and pressed into the grooves in the wax recording surface. The flattened wedges are now re-shaped by the trimming way, with a heated knife blade, of all the flattened portion except the crests which fit into the grooves on the maxillary wax recording surface. The reformed wax wedges on the mandibular base are submerged and heated in warm water to 130^{o} F. When these are softened the mandibular base is transferred to the mouth and the patient is instructed to relax the mandible so that the operator may freely move it. The operator stabilises the denture base on the lower ridge with the index finger while the thumbs rest under the lower jaw. The mandible is rapidly opened and closed while it is moved gently backwards into relaxed centric position. When the jaw is completely relaxed and in the most distal rest position the operator repeatedly opens and closes the jaws without biting pressure into the softened pink wax wedges until a space of approximately 1 m.m. remains between the maxillary wax rim and the black wax inter-maxillary record. Balanced centric jaw relation, together with the proper inter-maxillary denture space is thus recorded.

Squash Bite Used to Check Centric Relation:

This method may be used at the try-in stage to ensure accuracy of the previous recordings, or it may also be used after processing of the dentures to effect a remounting for elimination of processing errors. It is used in association with cusped teeth and for this purpose the record cannot be made at the predetermined vertical dimension of occlusion. Its use involves the belief in the presence of a hinge axis movement of the mandible and it must necessarily be made along this path if the record is to be serviceable.

Shore in 1959 has described the technique which he uses in edentulous cases and which I feel can be well applied to the check bite technique with full dentures. The dentist must be able to recognise immediately whether the patient is recording a correct centric relation bite. When a patient is asked to close usually he will go into his habitual occlusion

convenience bite. The dentist must be able to retrain the patient so that he will give a centric relation position. The following describes the procedure for training the patient and securing an accurate centric relation wax bite:

By tapping quickly and lightly on the bracket table with an instrument handle the dentist demonstrates the rate of speed at which he will want the patient to tap his teeth together into the wax. It is important to emphasise light and rapid mandibular movements because as the patient opens and closes very quickly usually he will close in a correct centric relation arc.

The patient is seated in a 45^{o} reclining position (his head is supported) and told to relax and permit his jaw to hang loose. In this position the forces of the anti-gravity muscles will be counter-acted and the mandible will tend to return to its proper position. Then the patient is trained to give a centric relation closure. He is instructed to open his mouth wide and move his jaw first to the right and then to the left. To relax all the muscles this cycle is repeated three times. Now the dentist places the ball of his thumb on the buccal surface of the upper right bicuspid and the ball of his forefinger on the upper left bicuspid.

The ball of the right thumb is placed on the incisal edge of the lower anterior incisors with the nail up. The patient is now directed to tap lightly and rapidly on the dentist's thumbnail. He is told to stop tapping, to hold his teeth lightly against the dentist's thumbnail and move his upper jaw forward. This seems to be the best technique for causing the patient to retrude the mandible. Then the dentist, having first removed his thumb, the patient is told to close his jaws lightly. After this training procedure has been completed the patient is told that the centric process will be repeated this time using the Aluwax index bite.

The $\frac{1}{2}$" marginal edge of the wax form is dipped into water at 118^{o} F and returned to the patient's mouth, care being taken that the teeth are

fitted into their original imprints. The rehearsed stops are now repeated with the wax form in the patient's mouth. This method of training the patient and taking the registration ensures a correct centric relation bite, because the forefinger and the thumb of the dentist's left hand preclude eccentric movements on closure and immediately indicate to the operator when the patient is making other than centric movements. The patient should be told to close lightly and repeatedly into the wax in a centric relation bite until a clear index is produced without perforating the bite.

It is important to note how the process of patient education is inherent in the technique of registration.

Schuyler in 1932 emphasises that with the check bite the new records must always be made in the mouth and checked on the articulator and never by taking a record from the instrument to be checked in the mouth as indicated by Schlosser (1941).

Swenson (1953) points out that in checking centric relation the mistake is sometimes made of taking a bite on the articulator and then observing the fit in the mouth. This procedure of going from the articulator to the mouth is almost worthless, because in case the mounting is incorrect the mandible can drift forward or laterally to assume the same eccentric position. The error thus goes undetected. On the other hand if the record is taken from the mouth and then tried on the articulator an error in the registration at either time will be made obvious on the articulator. If this is the case the test is repeated, because we still do not know whether the original mounting was correct or whether the second check bite was incorrect.

Schuyler (1950) points out that the theory motivating additional check records to prove accuracy of cast mountings, is that only an accurate unstrained maxillo-mandibular relationship can be exactly duplicated. A protrusive or lateral relation record or a movement of the denture base

while the record is being obtained cannot be exactly duplicated.

Schuyler's (1950) record technique is as follows:

One or two thicknesses of common base plate wax is laid over the occlusal surface of the lower teeth. The wax is carefully warmed to an even depth, the upper teeth being in the mouth, the lower denture is inserted into the mouth and the patient requested to close gently into the wax (the request is always made that the patient close upon the back teeth to induce them to close in the normal retruded relation). No opposing tooth cusps should be permitted to make contact through the wax, as such tooth contacts would induce uneven occlusal stresses or movement of the denture base. An even penetration of the cusps into the wax is necessary to assure an even distribution of occlusal force. This is seldom done in the first trial. By trimming the wax and rewarming the entire surface and re-inserting an even penetration of opposing teeth into the wax is obtained. Cusp penetration of approximately 1 m.m. is most desirable. The thickness of wax separating the teeth should not exceed 1 or 2 m.m.

The check record is thoroughly chilled and returned to the articulating instrument. Accuracy of mounting is proved only upon closing the instrument in centric every tooth cusp fits perfectly into the opposing wax record.

Swenson points out that in such a record none of the teeth in this biting pressure should penetrate the wax. Should they slip through and hit a tooth, there are three factors that will cause trouble, namely:

1. Over compression of the soft tissue opposite the porcelain contact.
2. A shifting of the bases due to inclined hitting.
3. A tendency for the incline to shift the mandible out of centric.

Regardless of the actual technique employed the essentials involve:

1. Even penetration of the articulating surfaces.
2. Lack of contact of opposing cusp.
3. Records must be made in the mouth and checked on the articulator.
4. The second must be reproducible.

The control of distribution of pressure, both inregard to the type of impression technique used and in the interest of avoiding excessive unilateral displacing pressure, is an important consideration in this type of registration technique. It has been claimed that it offers the closest approach to registration under minimum pressure and thus lends itself to use when flabby ridges and displaceable tissue is present. It is also recommended for use in conjunction with a mucostatic impression technique.

Recording Medium:

Stuart (1959) has found it advisable to use great care in making centric inter-occlusal records. Mostso-called check bites are snap taken as if it were easy to make such records. He has tried plaster, modelling compound, various kinds of wax in various plies, or wax plied about metallic foils and quick cold curing plastics. He claims it has been harder to find a suitable method and material for making such a record than anything else he has tried to do.

Swenson (1953) points out that many materials have been advocated for the squash technique, not only wax but also plaster and compound.

Bertram in 1959 does not feel that a wax record is sufficiently accurate. He claims that once it is made it is subject to being scraped, blunted, distorted and compressed. He points out that ideally the material used to obtain precise inter-occlusal records, should offer no resistance to closure, have true fluidity and permit the mastigatory mechanism to operate free from strain. Any attempt to make a record with anything more than unusual closing force generally leads to an incorrect centric relation.

The choice of materials narrows down to plaster, wax, modelling compound and zinc oxide and eugenol impression paste. Of these wax has received the widest acceptance.

Bertram points out that regardless of the wax used some force must be exerted by the patient to achieve the inter-occlusal record. Another variable is the masticatory muscular development and closing power of different individuals. When patient effort, variation in masticatory muscular capability and temporo-mandibular joint displacements are combined, it is little wonder that wax records are often clouded beyond recognition.

The material of choice for the inter-occlusal record is the zinc oxide and eugenol type of impression paste. The material mixes to a true fluid consistency, offers no resistance to closure and adheres to its carrier. It sets to a hard non-compressible consistency and is sharp and easily read.

Articulation of the casts may be accomplished accurately without fear of distortion or compressing the record unequally in the vertical dimension.

It would appear to me that wax and plaster have been used so consistently because at the time of the development of the wax bite technique they were the only materials available which could be used, thus these materials were adapted to the process of recording the centric relation with this technique, rather than a material being developed to suit the ideals of the material desired. I tend to agree with Bertram.

AIDS TO RETRUSION.

There are some wiles available to the operator in using the Schuyler check bite technique by which he attempts to have the patient close into centric relation.

Logan (1935) indicates that we ask the patient to close on his back teeth. This approach should prevent many patients from attempting to incise and so bringing the condyle forward in its path. It is obviously not sufficiently accurate for a final centric relation technique, and may be criticised on the grounds that it relies upon the patient's muscle tactile sense which is notoriously inadequate.

Again we ask the patient to swallow, believing the physiologist who tells us that deglutition is impossible unless the mandible be fixed in occlusion. But again we are baulked by the patient whose many dental operations have taught him to swallow with his mouth open.

Campbell in 1937 has pointed out that swallowing usually brings the mandible to a retruded position and is an aid in securing this relation. However, it must be remembered that a person can swallow when the mandible is not completely retruded.

Another technique is to invite the patient to place the tip of the tongue on the palatal edge of the denture and close; this often succeeds as the tongue is drawn back and carries the mandible with it. A piece of wax about one-fourth of an inch in thickness is sealed in the posterior border of the maxillary base tray to facilitate this retrusion of the tongue. As the patient is instructed to reach for it with the tip of his tongue, the mandible is retruded and if the operator is satisfied that he has the correct retruded position the patient is instructed to bite.

Campbell feels that thismethod is often useful in securing the tentative relation, but it is not felt that it is definite enough for a final relation.

Logan also points out that it is contra-indicated in the presence of a short lingual frenum which may render the placement of the tongue impossible and leads to a series of lingual contortions which will end in a complete expulsion of the bite plates.

One method that is almost universally condemned by the pundits as leading to almost certain failure; that is the application of firm pressure on the symphysis mental to force the mandible back.

This approach is used with the use of the Hickok bite strap. However, the idea of this harness is to put tension from the back of the head to the point of the chin, thus forcing the mandible to a retruded position. The device fatigues the protrusive muscles so that the mandible will assume the most retruded position. This technique has some validity. It is not to be compared with the application of direct pressure against the chin during the recording process which will be counter-acted by a muscular action tending to protrude the mandible.

The Hickok bite strap is used for some time before the recording of centric relation merely to tire the protrusive muscles. It may also be used to reposition the tissues posterior to the condylar head.

palpitations

Campbell in 1937 indicated a technique advocated involving the of the ramification of the temporal muscles. He feels that this test is fallacious as when the jaw is padded with some slightly resilient material such as blotting paper. The temporal muscle does not function when the muscle is in protrusion. For this reason it can be felt in its contraction only by placing the fingertips on either side of the head when the mandible is in or near its retrusive position and the patient is asked to open and close.

Swenson points out in 1953 it can be used only as a slight indication of the proximity to a centric relation.

Sharp's technique of obtaining a rest aquash bite (1959) involves tapping of the lower jaw against the upper to a pace determined by the operator; a series of fast opening and closing movements of the jaw against

in relaxing the jaw according to Campbell. The method recommends itself because of the ease with which it is initiated by the patient. However, he queries the fact that merely placing the finger beneath the chin stops the movement in correct relation as is advocated by some authors.

Swenson also feels that this tapping may be used successfully to retrude the mandible, but it is difficult to register these positions and as a patient can easily tap in a slightly protrusive or lateral position.

Tilting of the head during the process of recording centric relation has also been advocated.

Logan in 1935 points out that centric occlusion records may be obtained by asking a patient to throw his head back before closing. Inasmuch as there is a tendency for the mandible to be pulled forward when a patient closes into soft compound or wax we must have some means of holding this movement in check.

Swenson also indicates that oftentimes the tilting of the head backward at the neck will place a tension on the muscles of the floor of the mouth, which tends to pull the mandible to a retruded position. However, it is extremely difficult to obtain a registration in that position because of the awkwardness of inserting and removing the base trays from the mouth when the head is so tilted.

It would seem, however, from the work of Posselt (1952) that the habitual occlusal position more nearly approximates the true centric position when the head is in a posteriorly tilted position. This may be some of the basis to the application of tilting the head. It will be seen that there are many techniques available to aid the patient in retruding to a normal centric relation. Some of these or all of these may be used as exercises in conjunction with the patient's co-operation. None of them, however, is infallible and the position of centric relation still has to be assessed by the operator.

CENTRIC RELATION.

Functional Recording Method:

The functional registration method, frequently called "chew in", is a procedure as the name implies of allowing the patient to indicate the position of centric relation by functional movements. This procedure is accomplished with abrasive material on the opposing occlusal rims; wax between the occlusal rims; or by the use of studs which cut Gothic arch patterns in the opposing occlusion rim. It has many good points, but is not infallible.

In spite of the fact that it is claimed that the patient makes his own recordings it would seem that the operator must possess a clear concept of that which he seeks to accomplish. The ability of the operator to determine when the record has been carried to a successful completion is extremely important. The record is dependant upon the accuracy of the bases upon which it is made. It necessitates patient co-operation, it is developed under some pressure hence in patients with displaceable supporting tissue the correctness of the method must be closely checked, and verified by the operator.

Meyer (1954) describes thetechnique in its pure form in his functional generation path technique after generating the primary occlusal path in soft wax then establishes the approximate centric relation. This is done by: (a) Removing the lower occlusion rim from the mouth and trimming enough wax from the labial surface so that the upper rim will protrude over the lower. The median line is remarked and the bite block returned to the mouth. (b). The patient now closes in the most retruded position. With a pointed instrument, make an indentation on the upper occlusion rim just above the median line marked on the lower rim. Have the patient make various jaw movements and if he comes to rest at this point each time this is the approximate centric relation. The wax rims are stapled together and a face bow transfer is made to an articulator that permits no lateral movement.

This relation is then checked during cusp and sulci analysis after processing of the upper denture, thus: Soften the modelling compound ridges slightly, and have the patient close into centric relation with the median line marking as a guide. The ridge on one side will probably register more than the other side. A slight amount of compound should be added to the side with the lesser registration and when the compound is still soft have the patient close into centri c relation a second time. When all of the cusp and sulci registration are sharply defined the pressure is even on both sides.

There are variations on this technique such as that of Jaffe (1954) as follows: The upper anterior teeth are selected and tenbatively secured to the baseplate. This is tried in and a satisfactory aesthetic arrangement made. Compound occlusal rims are added in the posterior region. The lower baseplate with 6 anterior teeth secured is then inserted in the mouth. When the patient closes it is imperative that the lower teeth do not contact the lingual or incisal surfaces of the upper incisors, as they may effect some type of jaw guidance. Posterior occlusion rims are provided for the lower base plate and a tentative centric is recorded by any means which the operator chooses. The occlusion rims are now mounted on a phane line articulator, and the set up is now completed. The occlusal curve being determined by a template for the type of posterior teeth used. The upper denture is now processed and completed. A new lower base plate is constructed and a compound occluding block with an oversize occluding surface is built on this new base plate. The occluding surface should extend at least 3/16" buccal and lingual to the posterior teeth and about ¼" lingual to the incisor teeth. This is made to the same vertical dimension as the original set up.

The upper denture is inserted into the patient's mouth. The lower occlusion rim is built up with hot compound and carried to the mouth. The patient is instructed to tap closed quickly, in various excursive positions. The result eventually will be a composite generated cuspal clearance path. It is in reality a series of Gothic arch tracings when the anterior compound is added. The patient is left alone for an hour in which he chews for five minutes and rests for five minutes, etc.

The problem is simply to apply an indirect technique which will incorporate the wax lower set up that was laid aside while the occluding block was made.

Another variation is presented by Essig and Paterson as follows: After the bite plates have been trimmed and contoured to meet the aesthetic and occlusal requirements of the case in hand a shallow furrow is cast in theocclusal surface of each rim leaving a narrow margin around the periphery. This furrow is then filled with a mixture of equal parts of sand and plaster or carborundum powder and plaster and levelled off to a height of about 1 m.m. above the original surface. When the plaster has hardened, the bite planes are returned to the patient's mouth and he is requested to carry out the movement of mastication, sliding the bite rims one upon the other. The abrasive incorporated with the plaster causes those bite rims to gradually assume a curvature which permits an uninterrupted sliding contact between the plates in all of these jaw movements.

The upper case may now be mounted on the articulator, after which the bite plate is removed and preparations are made to secure the Gysi Gothic Arch.

It will be seen that this technique is designed as a means to record centric relation, together with the occlusal plane and curve and also the lateral or buccal roll (Monson's curve).

It employs muscular exercises, as in the grinding in procedure and the advocates of this technique assume that during the time taken to achieve the occlusal curves sufficient muscular balance is obtained to return the jaw to centric relation.

The obvious faults in the technique are that it invites horizontal dislocating forces with the risk of tissue displacement and base plate dislodgement, together with the development of tissue "sore spots" during the recording procedure. In this latter case electro-myographic data indicates that the patient will automatically close "away" from this

hyperaemic area and an lateral registration would be achieved.

In the case presenting with uneven tissue thickness on the bearing areas of the ridges, unequal impression will occur, as the paths are generated under some considerable vertical force.

It is apparent that in cases of class one ridge relationship with perfectly normal mucosa overlying the ridges, an accurate centric relation can be recorded. It would seem, however, that when this condition exists a simpler and more precise technique is available

COMPARISON OF TECHNIQUES.

Kingery (1959) feels that it is possible to record centric relation correctly by any one of the many methods -- the method is only a means to an end. The correctness of any individual registration is never assured until it is checked and verified by observation of the operator. There are certain techniques, however, he feels, which have a higher percentage of accuracy rating.

Swaggard (1957) also indicates that the important factor is not the method, but rather the ability to obtain multiple identical records. He points out that the method is to be varied according to the conditions encountered.

An indication of the many techniques used by dentists to-day is afforded by Willie (1958) in his survey, he found that centric relation was determined by:

1.	Wax closure with the patient's pressure evaluation			35
2.	Needle point tracing devices not used.			13
3.	Needle point tracing device used.			74
4. a.	A type of appliance	1.	Intra-oral	33
		2.	Extra-oral	40
b.	Record pattern used	1.	Diamond	5
		2.	Gothic Arch	60
		3.	Arrow head or Sea Gull	9
5.	Hikock bite check			1
6.	Bite plate record with tongue placed at the level of hard and soft palate.			18
7.	Pressure on long buccal nerve			0
8.	Jaw relaxation aided by manual jiggle by dentist			34
9.	Use of acquired centric			4
10.	Arbitrary methods			1
11.	Pre-extraction plaster casts			10

Other techniques mentioned in his survey include the use of tactile sense of the patient, flexation of bi-lateral temporalis, establishment of rotational centres of condyles, Coble Balancer, and Needles and House chewing techniques.

He indicates Young's (1949) finding that incorrect centric relation is a fault of about 90% complete dentures. Despite the difficulties encountered, I feel that this estimate is a little high.

Errors Involved:

Kingery (1952) has indicated that the errors may be made in either one of two requirements: The positional and the technical. The positional errors may be caused by:

1. Failure of the operator in his registration of the correct horizontal relationship.
2. Failure of the operator to record equalised vertical contact.
3. Application of excessive closure pressure by the patient at the time of recording.
4. Changes in the supporting area.

Technical errors may be caused by ill fitting occlusion rims and indiscriminate opening or closing of the occluding device or articulator and the movement of the teeth during processing. But these errors are common to all techniques. He also points out that errors involving displaceable supporting tissue, a too resistant recording medium and displacement of the recording bases by the dentist in attempting to force the mandible into its terminal position, are also common to the many systems.

Hight in 1936 feels that the majority of dentists are able to recognise gross errors in the registration of centric jaw relation. By far the majority of such errors, he feels, are of a protrusive nature. These protrusive inaccuracies, however slight, cause considerable annoyance to the patient because the sliding contacts of the cusps that result cause the constant tendency to pull the mandible forward while the muscles and proper position of the condyles have the tendency to carry the mandible

backward to true centric. The same slight errors may exist in lateral position.

Schuyler in 1950 has indicated that intra-oral visual checks of occlusion are deceptive, as tissue compression movement of denture base upon the tissue or changing maxillo-mandibular relation, or all of them, may occur as the opposing teeth are brought into contact, without being detected by the eye.

Trapozzano (1949) indicates that a preponderance of yielding tissue would indicate the use of the squash bite, because it was less likely to suffer form the effects of unequal tissue displacement. In patients with off-ridge relationship and varying degrees of tissue resiliency, it was found that the antero-posterior positioning was identical for the arch tracing and squash bite techniques, but the central bearing device incurred a vertical error due to lack of equalisation of pressure.

Kingery (1952) points out some symptoms of this unequalised vertical contact:

1. Loss of retention which depends upon uniform contact between the denture and the supporting tissue.
2. Irritation on the crest of the lower ridge in the area of premature contact, this may be a localised ulcer with or without a generalised hyperaemic area.
3. One or several teeth on one side may seem long to the patient or seem to strike early.
4. The patient may complain of clicking if the teeth are of porcelain.
5. Premature contact anteriorly or posteriorly.

Symptoms of an error in horizontal relationship are frequently found in those instances where the centric occlusion has been established, does not coincide with the centric relation of the patient. The errors may be either anterior or posterior to centric relation.

1. If the centric occlusion established is anterior to the centric relation of the patient, the patient must protrude the mandible to have the teeth contact correctly in centric occlusion. The patient may

experience the following symptoms:

a. Looseness especially of the mandibular denture.
b. Denture consciousness.
c. Irritation under the anterior lingual flange of the mandibular denture.

2. The second type of horizontal error exists when the centric occlusion is posterior to the centric relation of the patient. It is extremely rare for such an error to occur as a result of faulty registration; it may occur as excessive arbitrary closure of the articulator, however, its most common cause is a loss of tissue support under the dentures. The symptoms are:

a. Looseness especially in the maxillary denture. The upper denture is driven forward on closure and frequently is dislodged.
b. Irritation under the anterior labial flange of the mandibular denture — this type of error is directly proportional to the permanency of the ridge support.

COMPARISON:

Although Trapozzano (1949) points out that it was found that with patients who have normal jaw relationships and normal stable ridges and healthy mucosa, that similar results were obtained with both techniques, some authors will prefer one technique to another.

Swenson (1953) indicates that if one side of the mouth may have a deeper layer of soft tissue than the other side, then the registration of this tissue at complete rest would not give the best results.

Schuyler in 1959 feels that the final record must be made after the dentures are completed at which time the use of the Gothic arch is impracticable.

The Gothic arch, however, has many supporters. Pleasure (1957) says the Gothic arch tracing is the only method of centric relation registration

that guarantees conformity to the terms of the accepted definition of centric relation. Trapozzano feels that the squash bite technique has the advantage that the material soft enough to secure records under zero pressure can be used, another advantage is that the record is made directly over the areas to be used for support. In comparison the central bearing point was located at the centre of the bearing area of the mandibular ridges.

Gysi in 1929 demonstrated his faith in the arch tracing. He performed a check on dentures constructed with various biting techniques. He made for each patient one set of full dentures by the check bite method with wax or compound, and one set by the extra-oral method. He gave the sets by turn to the patients to wear. At the end of 3 months every patient had returned the set made by the plastic check bite method and retained the set made by the extra-oral method. The cause of the error was traced to the inability to evenly warm the compound registration medium.

The best comparative work on techniques that is available has been done by Kapir and Yurkstas (1957) who classify their techniques as:

> Direct recordings, graphic recordings, functional recordings and cephalometric determinations.

These authors undertook a study to compare the duplicability of records utilising various techniques. The methods compared with the intra-oral tracing procedures after Hardy, the wax registration procedure after Hanau, and the extra-oral tracing procedure after Stansbury. A total of 31 patients were studied and these were grouped into age and ridge types. The ridge types were classified into well developed, flat, and flabby ridges. In this classification the following characteristics were considered:

a. Height of the ridges.
b. Muscle attachments.
c. Amount of mobility of the tissue covering the residual ridges and palate form.

In 17 cases the impression procedure used to obtain the final impressions followed the method described by Hardy. In 9 patients that were recalled an alginate impression of the residual ridge was made. The evaluating instrument consisted of an upper tripod and a lower calibrated base. The variation observed during the procedures were recorded on a millimeter graph paper. Each millimeter of deviation on the instrument was recorded as a 5 m.m. deviation on the recording graph paper to facilitate interpretation.

The initial mounting was accomplished using the intra-oral tracing method. Centric registrations were then made with the other techniques. The lower base plates were carefully fitted on to the casts and the upper cast was seated in the proper position, the position of the three-pointed legs of the tripod in relation to their central pits were plotted on the recording data sheets.

The recording of all 31 patients were accomplished by one operator. Ten of these patients were further evaluated using ten different operators; the first five used all 3 methods of recording procedures in triplicate and the last five only two methods in triplicate.

The mean central deviation for each patient was calculated for each method. In the experiment it was noted that the wax registration had three to four times the deviation of the intra-oral method, but that the deviation amounted to a fraction of a millimetre and for the most part would be hardly discernible clinically. A statistical evaluation was accomplished to determine if these differences were significant. The critical ratio found between wax and intra-oral techniques was 4.77 (1% significance) against the extra-oral technique 4.34 (1% significance), intra-oral versus extra-oral 0.84, which is not considered significant. In order to determine whether the results were consistent when handled by a series of operators the standard deviation between intra-operators and inter-operators were computed for each method on the same five cases. Five other operators used only the intra-oral and graphic and wax registrations. Slight differences were apparent in all three methods. Critical ratios

were found to be:

Wax method 0.46 (not significant)
Intra-oral method 0.20 (not significant)
Extra-oral method 0.59 (not significant)

It was also found that the pattern of deviation for intra and inter-operators consistent for the three methods studied were similar in that the wax registration method showed the largest variation.

Types of Ridges:

It was found that the wax method showed the least amount of scatter in patients with flabby ridges and the widest scatter in the patients with flat ridges. The intra and extra-oral tracing procedures showed maximum variability in patients with flabby ridges and minimum variability in patients with good ridges. The general pattern of scatter in the three different methods remained the same in three groups with different types of ridges. The wax pattern showed the maximum variability and the intra-oral tracing procedure minimum variability. An evaluation of these findings indicated that the difference of scatter in the extra-oral method with different types of ridges was not statistically significant. The wax method had a significant variation in patients with flat and good ridges, as compared to those with flabby ridges. No significant difference in scatter was indicated for this method in patients with flat and good ridges. There was a significant difference in the scatter using the intra-oral method in patients with flabby ridges as compared with patients with flat and good ridges. It was also noted that in patients with good ridges the wax method showed significant variation from the other two methods. No significant difference in scatter has been shown between the intra-oral and extra-oral tracing procedures. The same results were true for patients with flat ridges. In patients with flabby ridges the three methods showed no significant variation between each other.

Discussion:

No significant statistical difference could be shown between the

intra-oral and extra-oral tracing procedures. The magnitude of difference in consistancy between the graphic tracing procedures and the wax method was demonstrated to be statistically significant.

The extra-oral procedure seemed a little more difficult for senile type patients in that it was difficult for them to hold steady for the two to three minutes required for the plaster keys to set.

It must be noted that the mean deviation in millimetres of all three methods approached one-fifth to two-fifths millimetres. The amount in the case of an edentulous patient is barely perceptable.

TABLE SUMMARISING EFFECTS AS REPORTED BY PATIENTS OF CONSTRUCTION OF FULL DENTURES AT VARIOUS MAXILLO-MANDIBULAR RELATIONSHIPS. SEE TEXT.

LATTIE, G.A., PERET, H.T., CRUZE, B.D.

JPD, 8:793:1958.

Refer Page 108.

TABLE II.

DENTURE	PAIN	MASTICATORY EXPERIENCE	OTHER OBSERVATIONS
M. (muscular)	Very slight pain over ridge of left side after one week; prematurities were found to be causal, and after their elimination the dentures "felt fine"	Easy and effective; masticated well from the time of insertion; enjoyed steak 2 hours after insertion	Felt little difficulty or strangeness on insertion
Open I (opened to rest vertical dimension)	Some pain over ridge after first week, but not severe enough to necessitate removal of dentures	Easy and effective; period of adaptation very short	Not aware of opening; noted loss of retentive quality of upper; patient complained of not being able to bite hard
A.R. (artificially retruded)	Nothing unusual at time of placing; pain developed in third week; telephone conversation with patient, "This hurts me near the right ear"	"Have to chew forward to hit the teeth right"; (forward here probably relates to the maxillae and the statement thus indicates mandibular retrusive effort)	Pressure in front of right ear on biting hard at the time of placing denture
P. (protruded)	Pain started 3 days after insertion becoming very intense; two types of pain were noted— (1) dull pain over the joint area, and (2) much more severe pain over the right mandibular ridge; most severe over mylohyoid ridge where inflammation was marked; pain extended back from here into the throat	Pain necessitated removal of dentures at meals on many occasions	On insertion was aware that "jaw seems forward, but feels okay in a certain place"; noted decrease in retentive quality of upper denture after wearing this lower; pain in right mylohyoid area on biting hard
Open II (opened beyond rest vertical dimension)	Constant pain developing shortly after insertion of the dentures and localized on the right and left side of the ridge under the lower denture; pain increased in intensity when eating	Lack of masticatory power noted; pain after 4 days necessitated removal of dentures; this pain was in the medial pterygoid area; "It seems like a pressure relief when dentures are taken out—to explain this pressure would be difficult"	Now aware of the propped open position of the mandible; son had told him that his face looked funny with this denture in place
R. (retruded)	No pain	No problem in chewing	After 3 weeks of wearing the O_2 denture, the R denture was placed; "jaws feel more natural, big difference from that one"; there the patient was referring to O_2 denture

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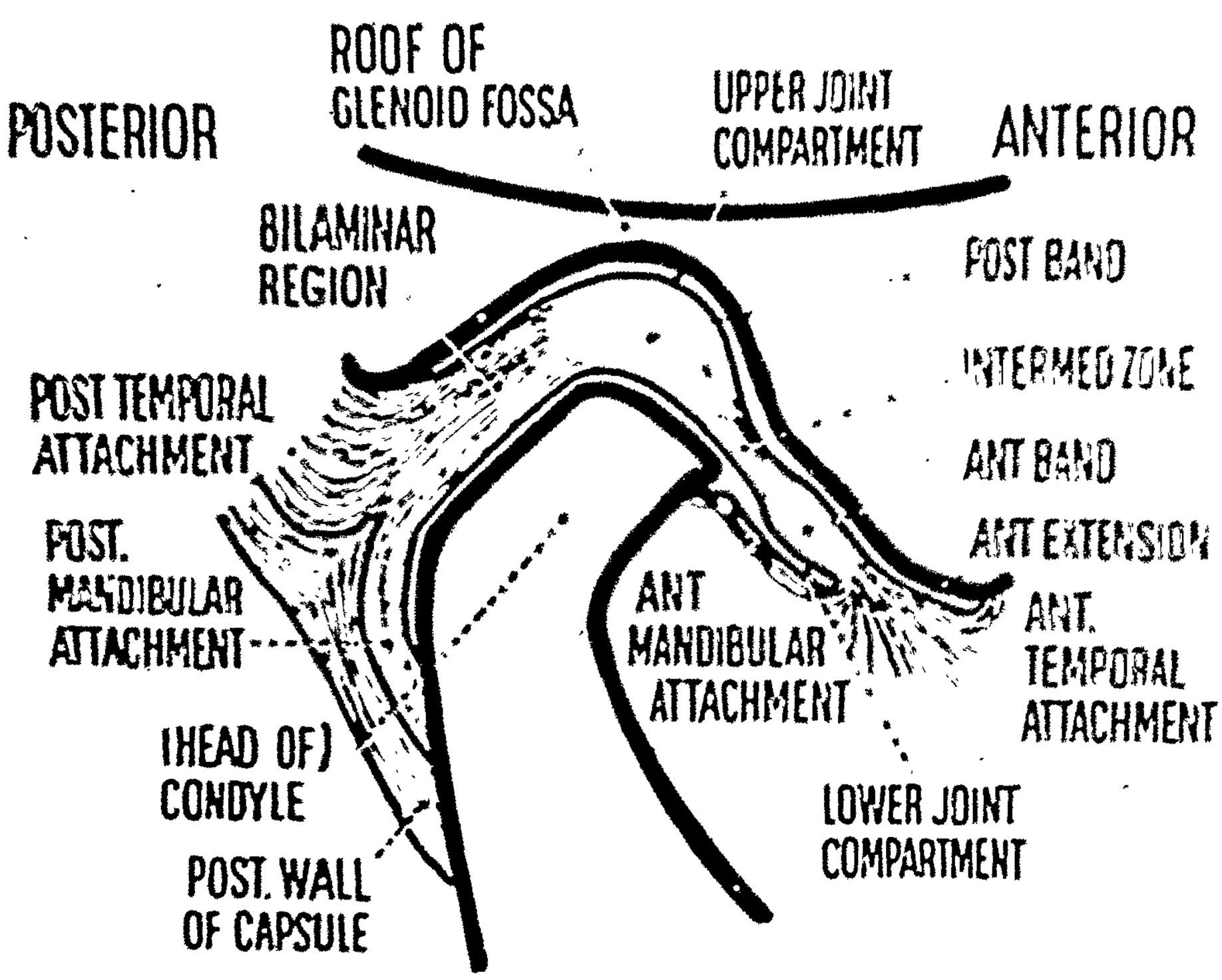
2.

SEMI DIAGRAMATIC FIGURE OF
TEMPORO-MANDIBULAR JOINT
AND RELATED STRUCTURES.

G. Lindblom 1960

See Page 7



—Section of the meniscus, glenoid fossa and the head of the condyle.

Fig. 1

LIST OF CONSONANTAL GROUPS WITH EXAMPLES AND PHONETIC SPELLING

FROM

ROTH, G.J., Am.J.Ortho 26:1.1940.

Refer to page 33

CONSONANTAL GROUPS	SYMBOL	WORD		PHONETIC SPELLING	
I. Linguo-dentals	T	Tooth	Toot	'tu :θ	'tu :t
	D	Dent	Drop	'dent	'drŏp
	N	Net	Noon	'net	'nu :n
II. Bi-labials	P	Pulp	Pop	'pʌlp	'pŏp
	B	Bone	Beam	'boun	'bi :m
	M	Mold	Men	'mould	'men
	W	Wear	Way	'wɛ :ə	'weɪ
	Wh	Which	White	'ʌɪtʃ	'ʌaɪt
III. Labio-dentals	F	Food	Fine	'fu :d	'faɪn
	V	Verse	Vocal	'vɜ :s	'voukəl
IV. Post-, Inter-dentals	S	Sit	Seal	'sɪt	'si :l
	Z	Zinc	Zone	'zɪnk	'zoun
	Th (θ)	Youth	Thin	'ju :θ	'θɪn
	Th (ð)	Thus	Breathe	ðʌs	bri :ð
V. Front-Palatals	Sh (ʃ)	Shade	Shine	'ʃeɪd	'ʃaɪn
	J	Jaw	Rage	'ɜɔ :	'reɪʒ
	Ch	Chew	Chin	'tʃju :	'tʃɪn
	j	New	Yes	'nju :	'jes
VI. Back-Palatals	K	Kite	Kind	'kaɪt	'kaɪnd
	G	Gold	Gland	'gould	'gləɪnd
	Ng (ŋ)	Sing	Ring	'sɪŋ	'rɪŋ
VII. Linguals	L	Lip	Light	'lɪp	'laɪt
	R	Root	Room	'ru :t	'ru :m
VIII. Aspirate	H	Heat	Habit	'hi :t	hə'bɪt

FIG. 38. Words which embody Consonantal Sounds, of Consonantal Groups.

LIST OF VOWEL SOUNDS IN RELATION TO POSITION OF MOUTH AND TONGUE.

BOTH. G.J. fm.J.Ortho
26.1.1940.

Refer to Page 33

ng diphthongs.*

POSITIONS OF MOUTH AND TONGUE	PHONETIC SYMBOL	WORD	PHONETIC SPELLING	WEBSTER'S DIACRITICAL MARK
Front-High	i:	read	'ɪi :d	ē rēd
	◦	machine	mə'ʃi :n	
	ɪ	six	'sɪks	ĭ sĭks
		city	'sɪtɪ	
Half High	e	head	'hed	ĕ hĕd
		men	'men	
Half low	ɛ:	chair	'tʃɛ :ə	â chârr
		fair	'fɛ :ə	
	æ	man	'mæn	ă măn
		cat	'kæt	
Low	a	aft	'aft	å åft
		ask	'ask	
Middle or Mixed	ɜ:	girl	'gɜ :l	ûr gûrl
		bird	'bɜ :d	
	ə	baker	'beikə	ẽr bāk'ẽr
		alone	a'loun	å ålōne'
	ʌ	upper	'ʌpə	ŭ ŭp'ẽr
		cut	'kʌt	
Back-High	u:	root	'ru :t	o͞o ro͞ot
		tool	'tu :l	
	ʊ	book	'bʊk	o͝o bo͝ok
		foot	'fʊt	
Half High	o	omit	o'mɪt	ŏ ŏmĭt'
		obey	o'beɪ	
Half Low	ɔ:	mortar	'mɔ :tə	ô môr'tẽr
		born	'bɔ :n	
	ɒ	dog	'dɒg	ŏ dŏg
		cot	kɒt	
Low	ɑ:	father	fa :ðə	ä fä'thẽr
		artist	'a :tɪst	

* Key to Webster's diacritical vowel sounds, their phonetic spelling, location of production and diacritical marking (after Ronsseau & Cramer).

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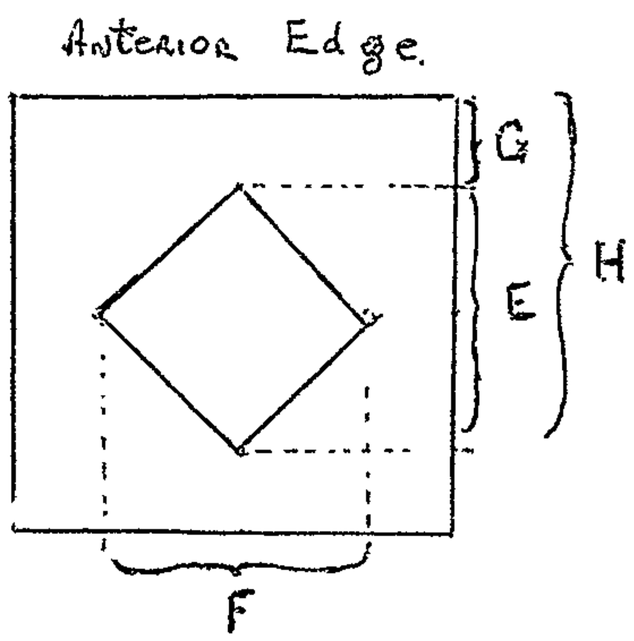
5.

REPRESENTATION OF TONGUE POSITION FOR THE PRONUNCIATION OF VARIOUS SOUNDS.

ROTH, G.J., Am.J.Orthc.26:1:1940.

6.



Horizontal Border Movements

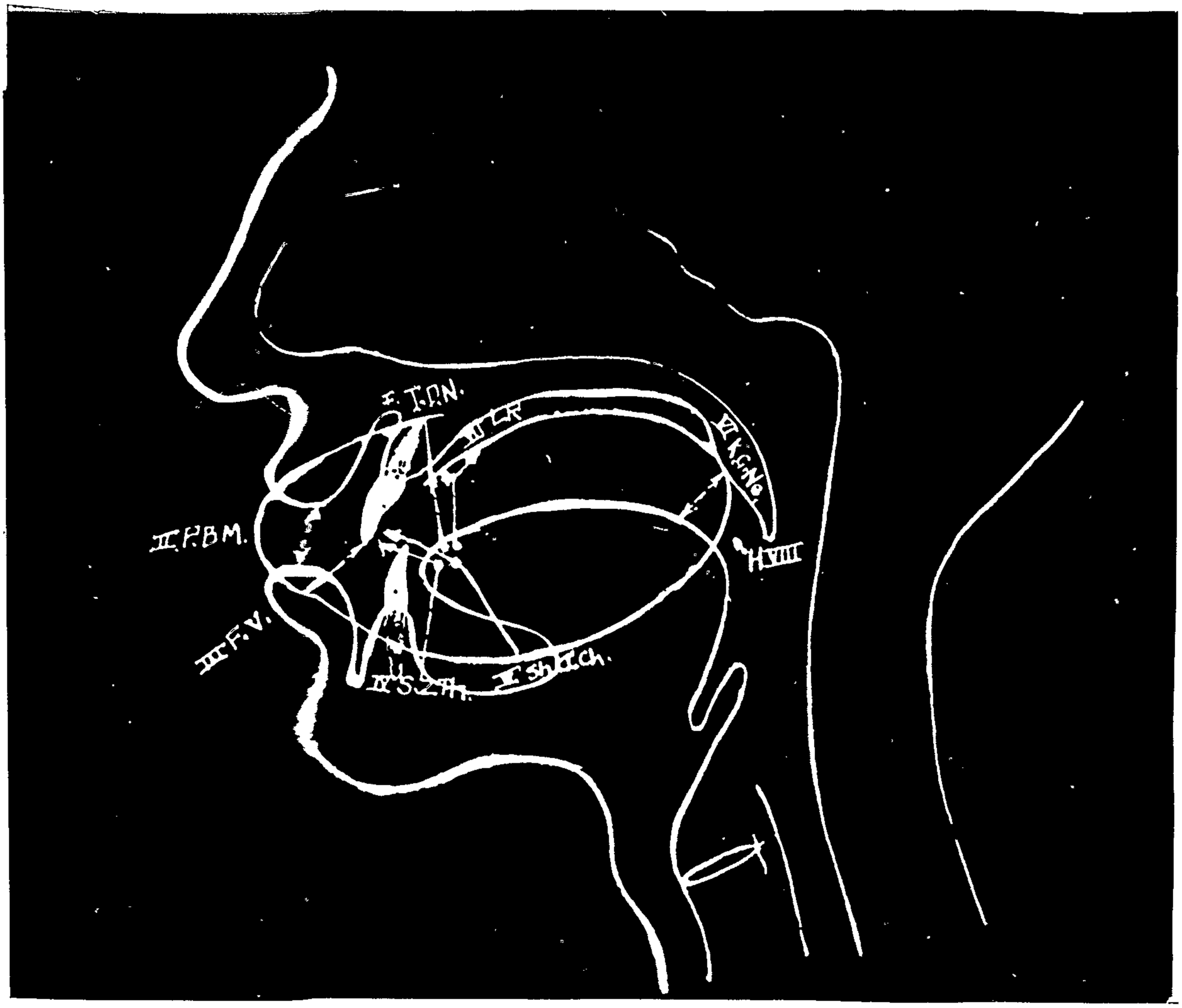
Posselt U. Acta. Odont. Scand. 10. 1952

Refer to page 157.

7.

ILLUSTRATION OF POSSELT'S CONCEPT OF MANDIBULAR MOVEMENT IN A HORIZONTAL PLANE.

POSSELT, U. Acta.Odont.Scand.10: 1952.



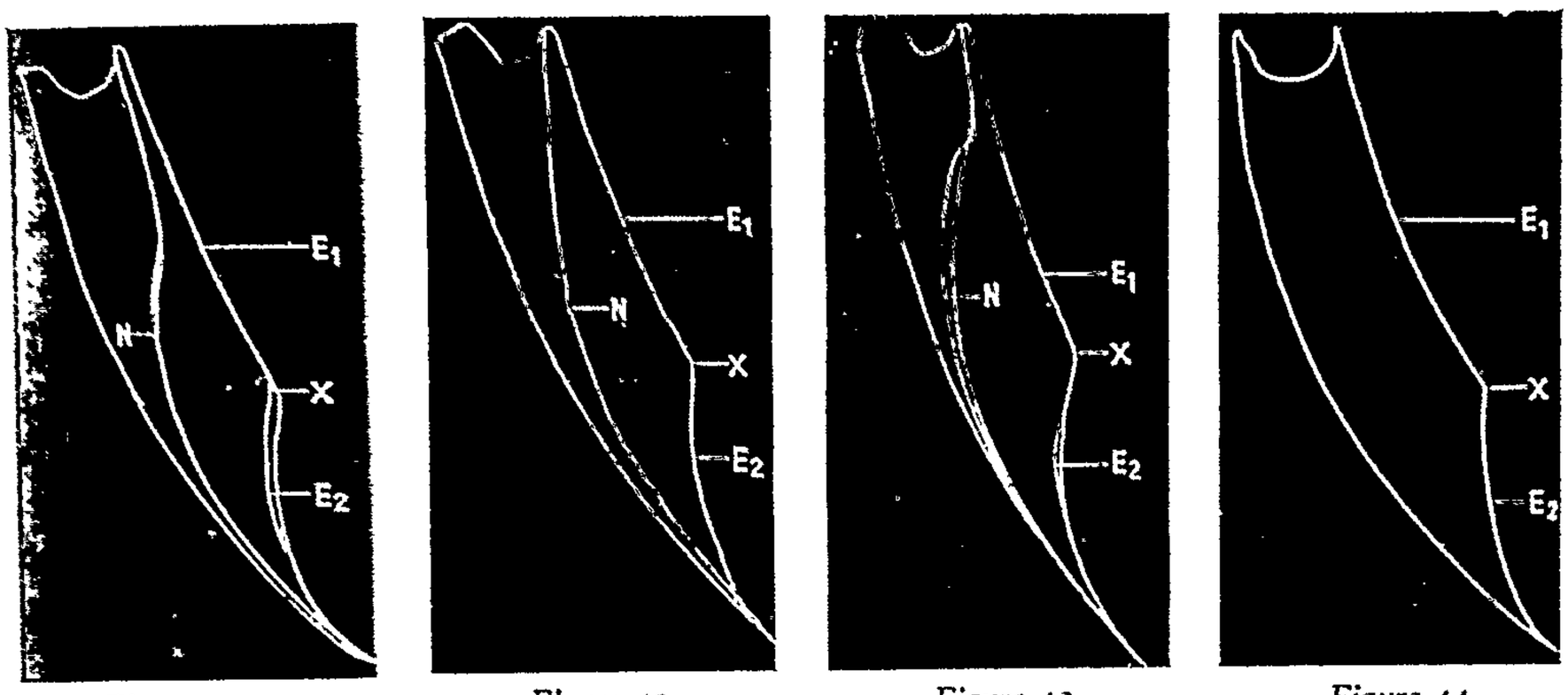


Figure 41 *Figure 42* *Figure 43* *Figure 44*

Figures 41, 42, 43, and *44*. Movement areas in the median plane traced by the subject *C*. *Figure 41* shows the tracing passively recorded, *Figure 42* the actively recorded one, both with the individual in the sitting position. The movement area in *Figure 43* was recorded with the individual lying on his back and conscious, whilst the area shown in *Figure 44* was traced with the subject lying in the same position but during anaesthesia and simultaneous muscle relaxation by curare.

ILLUSTRATION OF DEVELOPMENT OF CONCEPTS OF MANDIBULAR MOVEMENTS IN A HORIZONTAL PLANE.

POSSELT, U.: Acta Odont. Scand. 10: 1952

Refer to Page 151

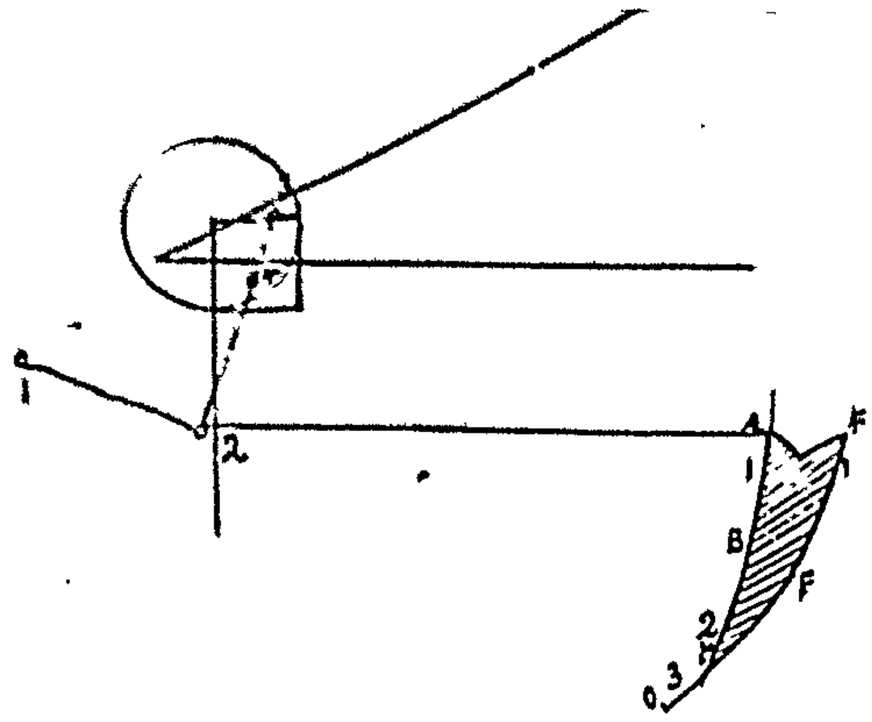


Figure 6. After THOURÉN (1914). An example of the movement areas of the infradentale found in five out of six cases. Axes for the different minor sections of the movement paths have been constructed.

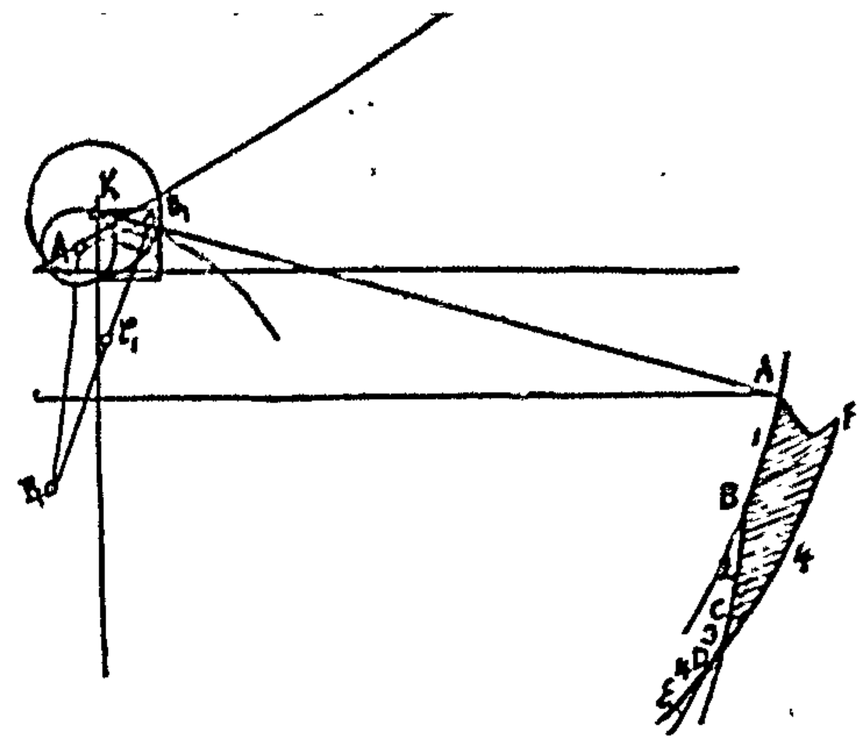


Figure 7. After THOURÉN (1914). The shape of the movement area found in one out of six cases.

Figure 8. After NEEDLES (1927). To the right the movement area traced by the infradentale. The small loop inside this area is traced during habitual opening and closing movements. To the left the paths of the two condyle points.

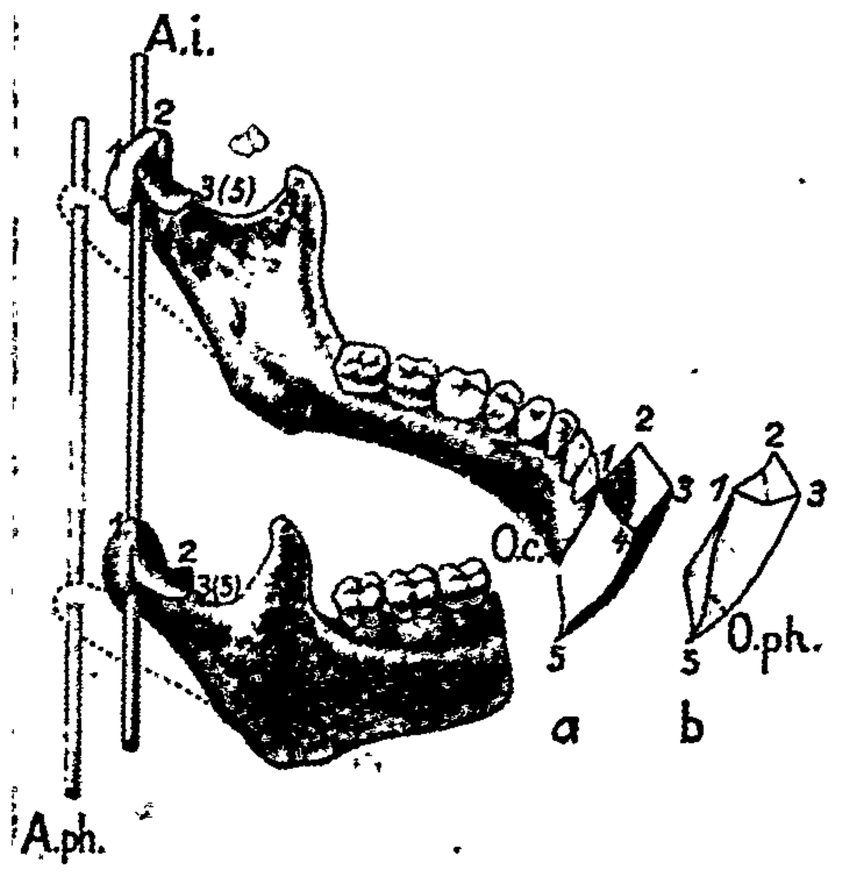


Figure 9. After FISCHER (1935). At *b* is seen the movement area of the incision inferius marked 1-3-5, which is a median section of the movement space seen at *a*. O.ph. designates the path of the habitual opening movement.

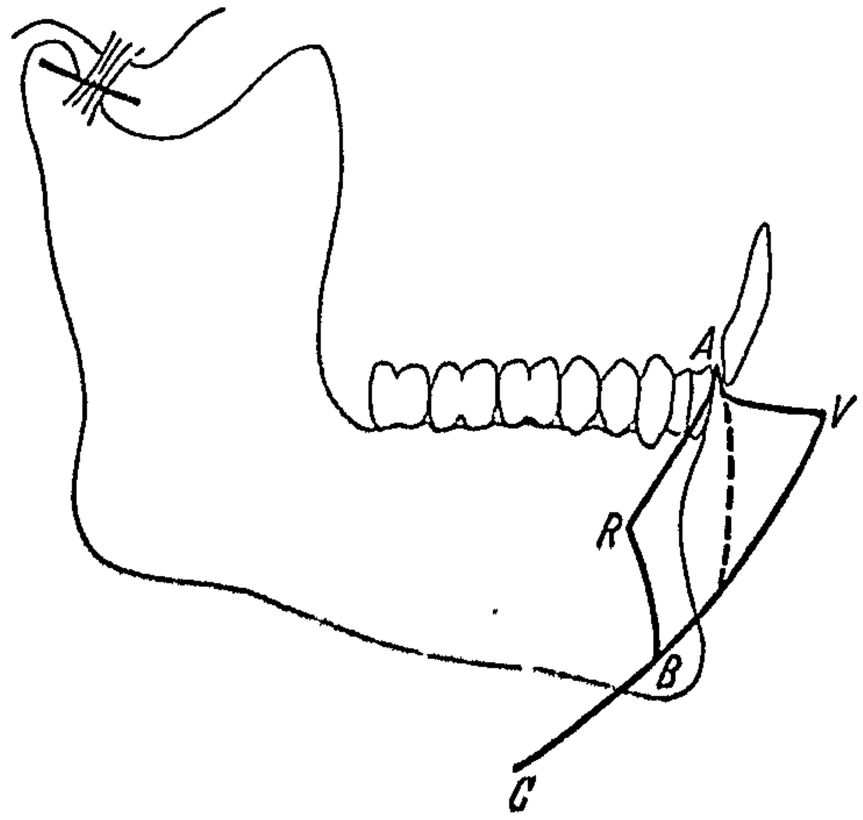


Figure 10. After V. HAYEK (1937). The shape of the movement area of the incision inferius. B-C, according to the author, is the only possible movement from a degree of opening of about 30 to about 60 mm.

9. 245

DIAGRAMATIC REPRESENTATION OF
STRUCTURE OF SKELETAL MUSCLE.

KELL. S.H., DAVIDSON. J.N.,
SCARBOROUGH. N., 1959.

Refer to Page 123

10.

ILLUSTRATION OF MUSCLE SUPPORT
OF SKULL IN RELATION TO REST
POSITION.

Eberle W.R. J.A.D.A. 42:15:1951

Refer to Page 48

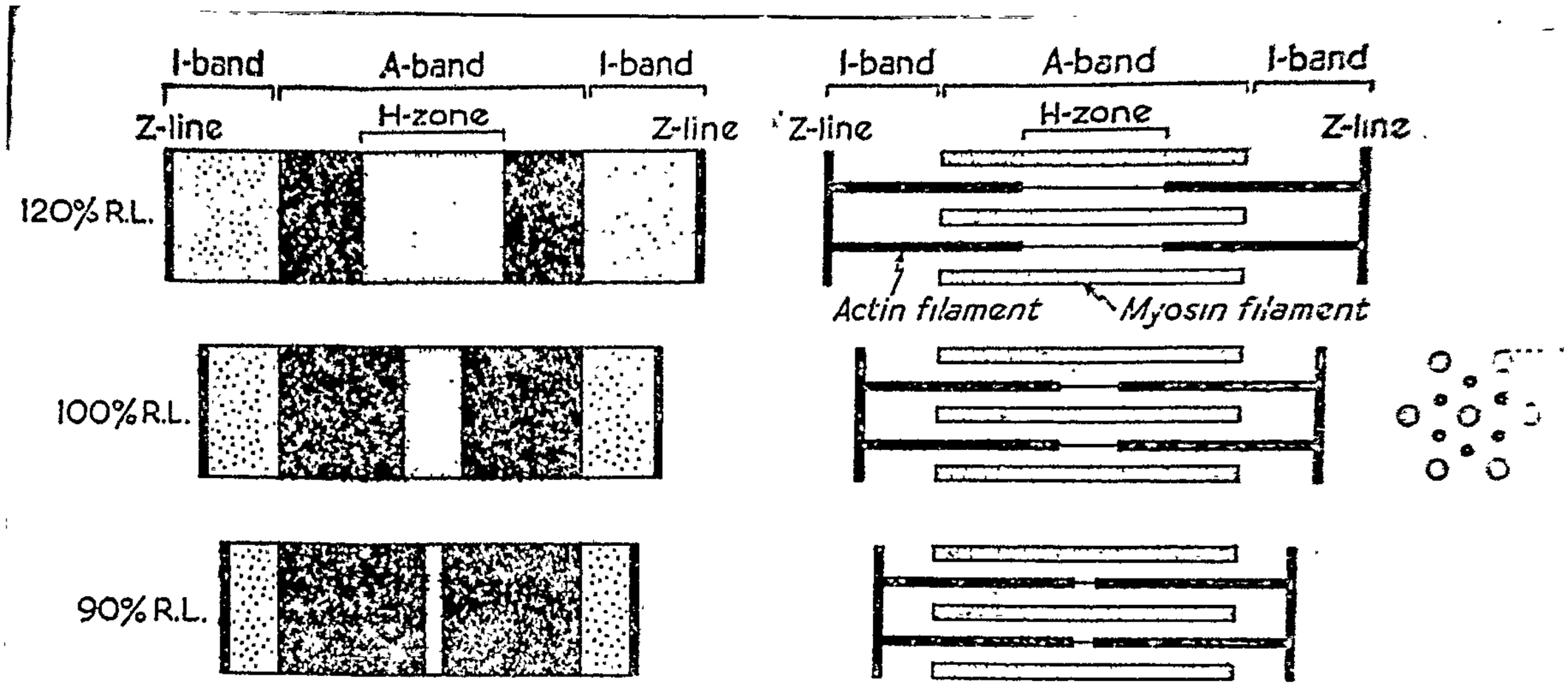


FIG. 42, 1

Diagrammatic representation of the structure of skeletal muscle. The thr[illegible] on the left show the appearances as seen with the phase contrast or interf[illegible] scope (see p. 763) at various percentages of the resting length, R.L. N[illegible] A band remains constant in length, about 1·5 μ in the rabbit psoas. Fi[illegible] on the right show the arrangement of the filaments in muscle in both lo[illegible] and transverse section; the latter should be compared with the middl[illegible] Fig. 42, 2A. (*After* H. E. Huxley (1956). *Endeavour*, **15**, 177 [illegible]

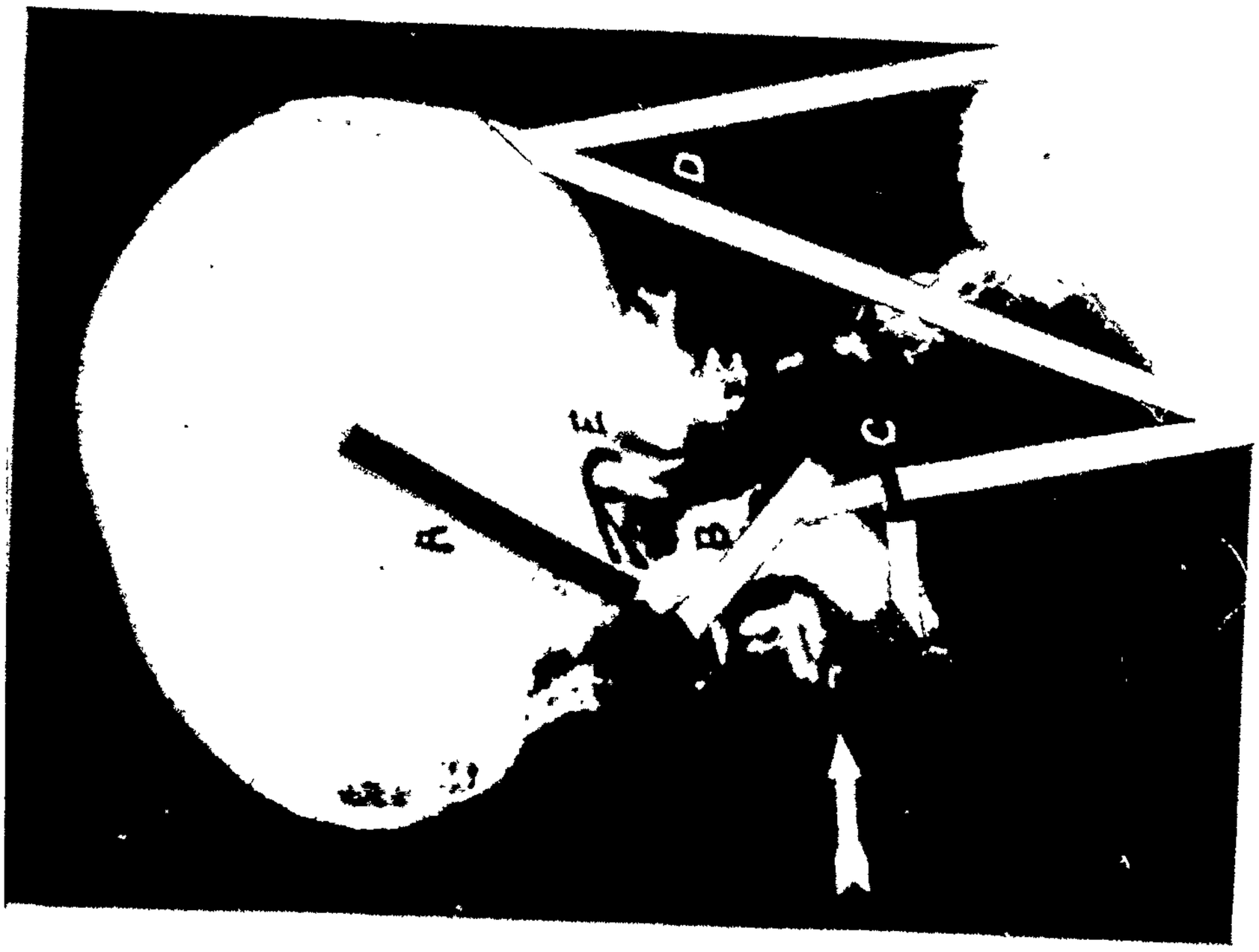


Fig. 1 • Roentgenogram of head with mandible at rest position. Muscle support of the head is shown by diagram. A: Temporal muscle. B: Masseter muscle. C: Hyoid bone and supra- and infrahyoid muscles. D: Sternocleidomastoid and other muscles attached to back of head. E: External pterygoid muscle and menis-

ELECTROKYMOGRAPHIC RECORDING OF
MANDIBULAR CLOSURE. (see Text)

GREENFIELD, B.Sc., and
UNG, B.D.S.

B.D.J. 100;129:1956.

Refer to Page 139

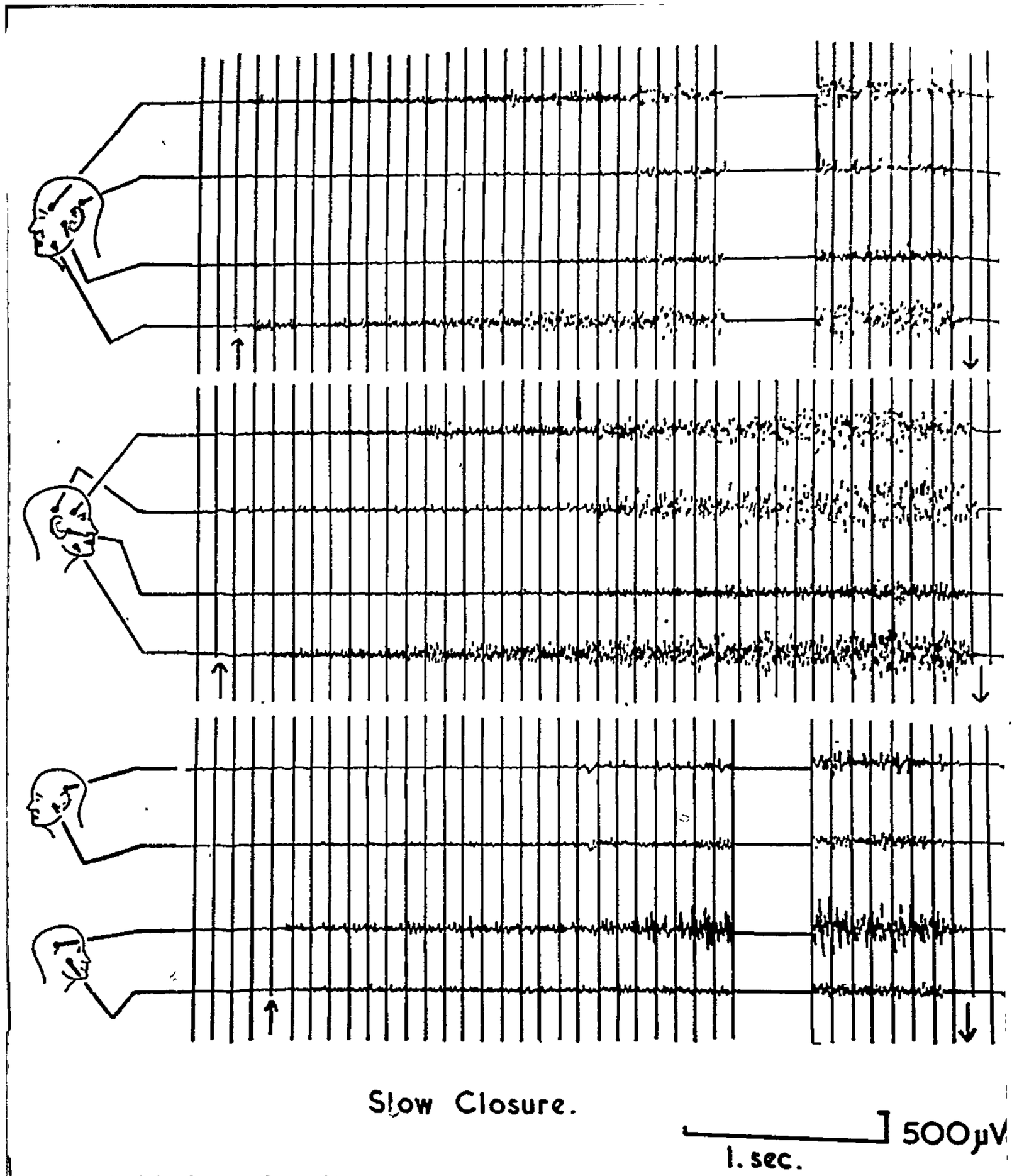
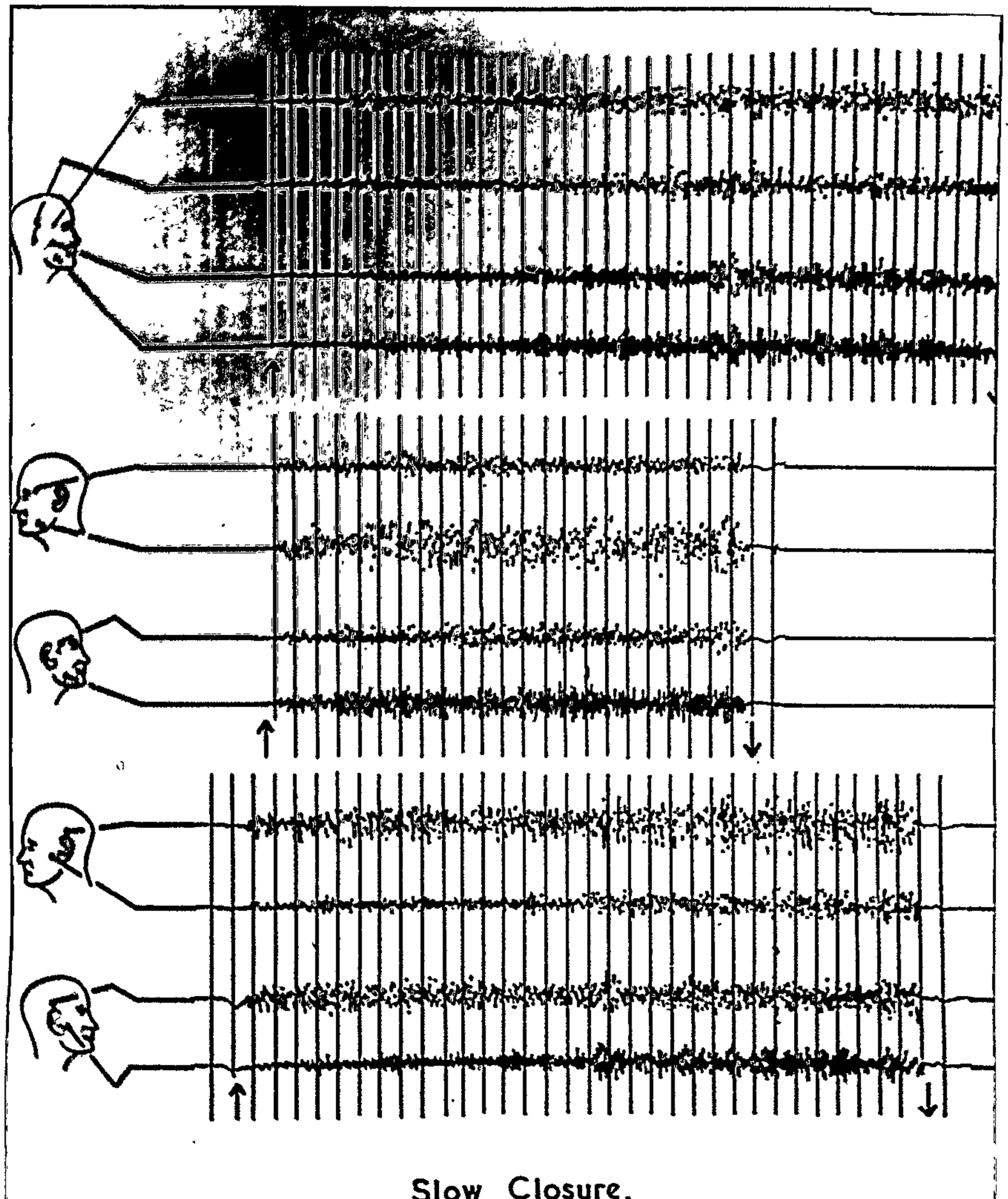


FIG. 16.—Activity in a patient with a slight mandibular deviation to the right, during progressive slow c
m the rest position. Unilateral and bilateral recordings for comparison with fig. 15. Note increased rec
ed.

asseter, which continues to discharge, on the region of the electrodes during deviati
eation of the movement, for some time the mandible to the left



15.—Activity in a normal individual during progressive slow closure of the mouth from the rest
Note increased recording speed