RHYTHMIC MOVEMENTS.

T. GRAHAM BROWN

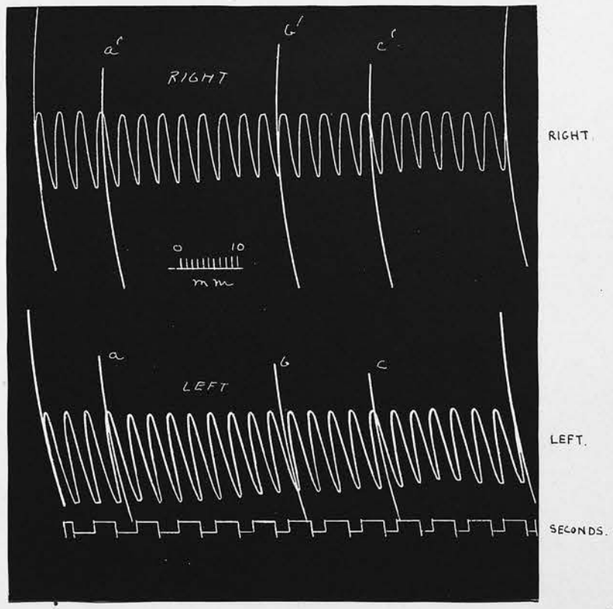
ILLUSTRATIONS FOR
THESIS ON
RHYTHMIC MOVEMENTS
By T.GRAHAM BROWN.

RHYTHMIC MOVEMENTS,
A CONTRIBUTION TO THE
PHYSIOLOGY OF THE
CENTRAL NERVOUS SYSTEM.

NOTE

The illustrations contained in this book are proofs of plates made directly from the original records. This method of presenting them was determined upon in part because of the great length of some of those which it was necessary to submit with the thesis. The plates have been especially pre=pared for this thesis with the exception of some of the rodent ones and a few plates which demon=strate rhythmic "rebound". These have already been published by the author and are not necessary to the arguement of the thesis but are here included as they add somewhat to it. The plates are arranged as far as possible in accordance with the arrange=ment of matter in the thesis — but this order has been broken where necessary in order to keep together all illustrations from the same experiment.

The rise of the curve denotes either flexion of a limb or contraction of a muscle. The beginning and end of stimul=ation are marked by ordinates lettered to correspond to the signal fettering. Time is marked in seconds, and a millimeter scale drawn upon each original has been re=produced in proportion with the tracing and thus serves as a scale for the measurement of its parts.



RIGHT.

LEFT.

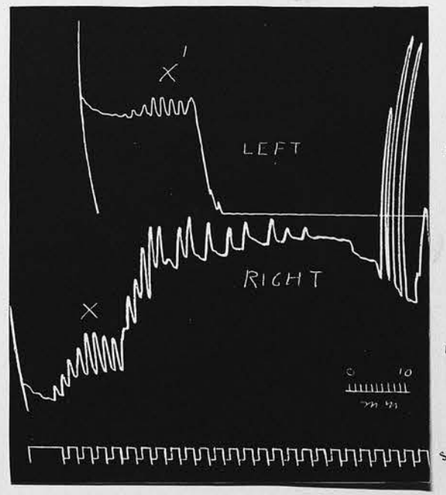
FIG. 1.

Rabbit, 10:2:10. Record of the movements of progression in the two hind limbs under narcosis. The ordinates a, b, c and a', b', c' mark corresponding points and demonstrate that the movements are synchronous in the two limbs.

QUADRICEPS.

FIG. 2.

Rabbit, 16:VI:10. Record of the movements of narcosis progression in isolated quadriceps extensor cruris. The form of the record corresponds closely with that obtained from the intact hind limb (Fig 1).



LEFT.

RIGHT.

FIG. 3.

Rabbit, 6:VII:10. Record of the movements of the two hind limbs during the transformation of these from progression to scratching in the right limb, during narcosis.

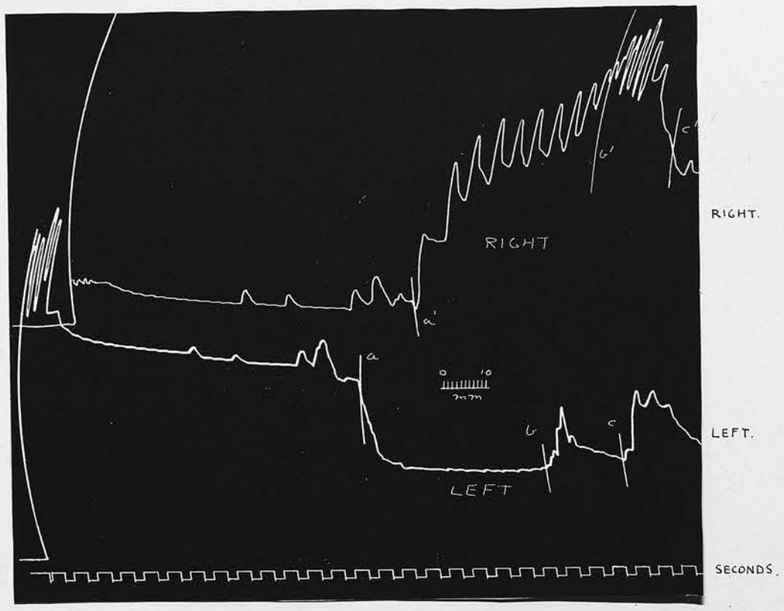


FIG. 5.

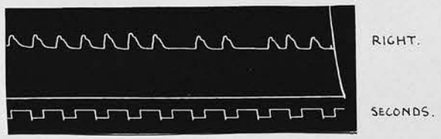


FIG. 4.

Rabbit, 24:11:10.

FIG. 4 :— Hopping movements of progression in the right hind limb in narcosis.

FIG. 5 :— Translation from "hopping" to "scratching". This takes place at or about ordinates a, a'. The 'beats' are at first of the same rhythm as those of progression but later — at ordinates b, b' — are twice as fast. These are the true movements of the scratch.

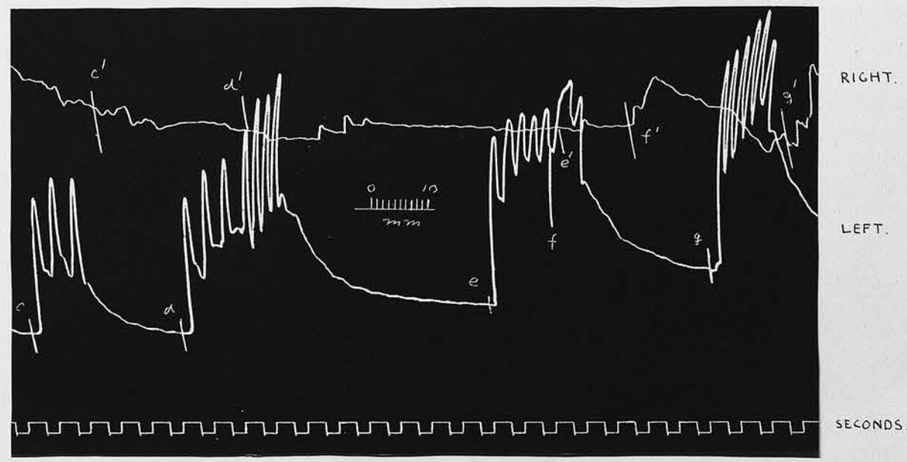


FIG. 6.

Rabbit 2:11:10. Four phases of the narcosis scratch in the left hind limb to show the change from the rhythm of progression to that of the scratch in the 'beats'. In the first phase the rhythm is in rate that of progression. In the last it is that of the scratch — exactly twice as fast. In the intermediate phases both rates obtain — the change from one to the other being sudden.

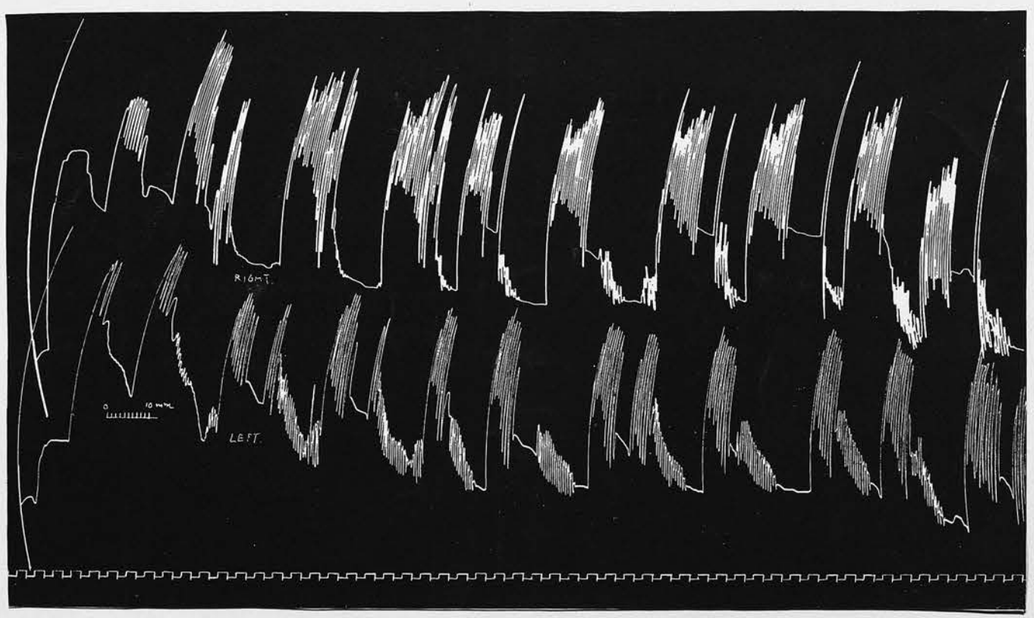


FIG. 7.

Guinea-pig, 14:vi:09. Record of the movements of the "narcosis scratch". The scratching phases here recorded in the intact hind limbs are alternate. The rate of the individual 'beats' is here about 8 per second.

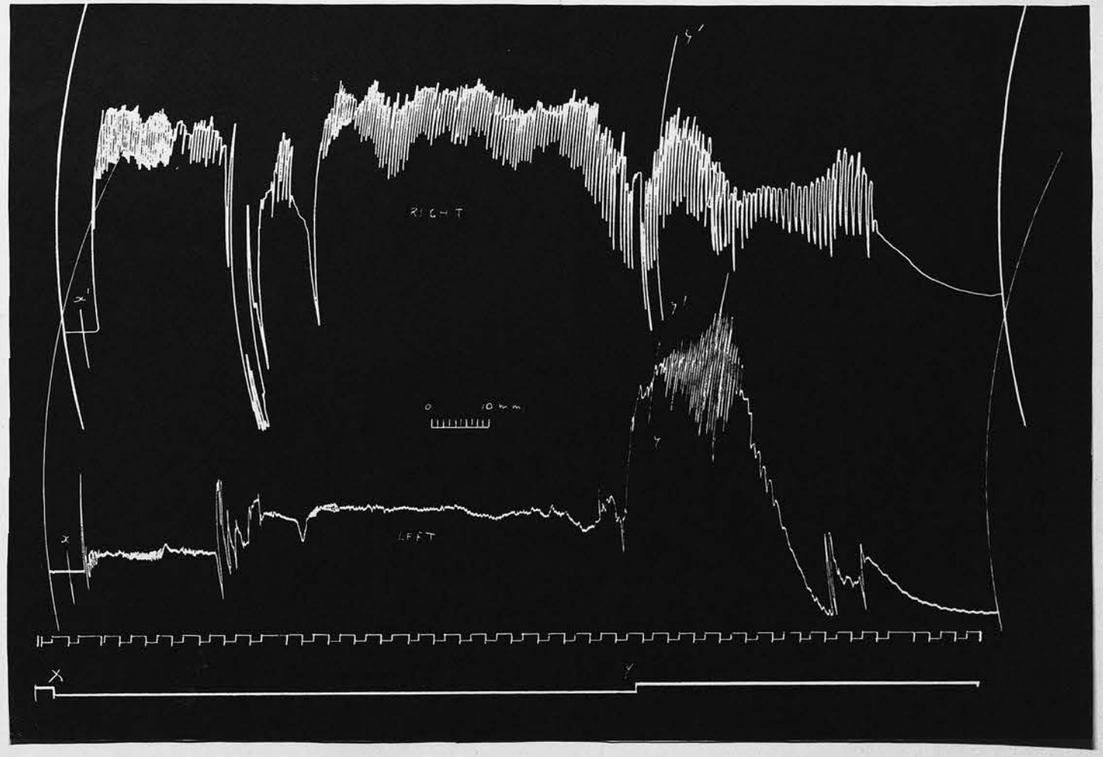
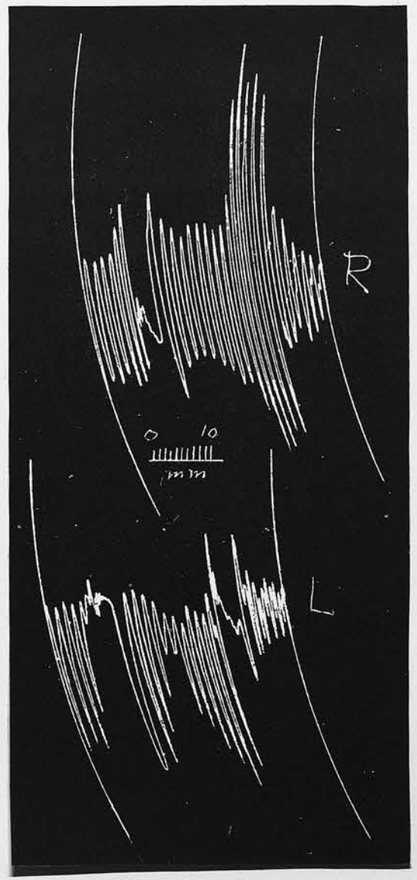


FIG. 8.

Guinea-pig, 5:vii:09. The scratching movements of the scratch-reflex of the 'Brown-Séquard phenomenon'. This was present on the right side – that great sciatic nerve having been previously cut – and was evoked by a mechanical stimulation of the skin over the angle of the lower jaw on the right side. The stimulus was applied between the ordinates x,x' and 4,4' and evoked the above scratching reaction the rate of the 'beats' of which is about 12 per second at the beginning of the record and about 4·5 per second at the end.

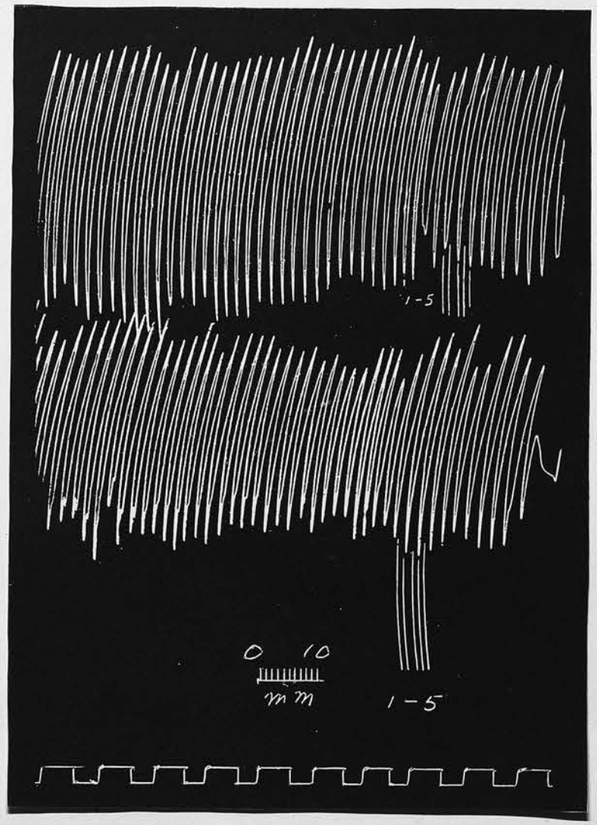


RIGHT.

LEFT.

FIG. 9.

Guinea-pig, 23:XI:10. Movements of progression in the intact hind limbs under ether narcosis and novocain. During this record the right femoral fold was pinched and there was then an immediate augmentation of the 'beats' of progression in that hind limb and a diminution in the left hind limb.



RIGHT.

LEFT.

2" BEATS.

FIG. 10.

Guinea-pig, 30:XI:10. Movements of progression in the intact hind limbs under ether narcosis and novocain. The corresponding oscillations marked "1-5" demonstrate that these movements are bilaterally alternate.

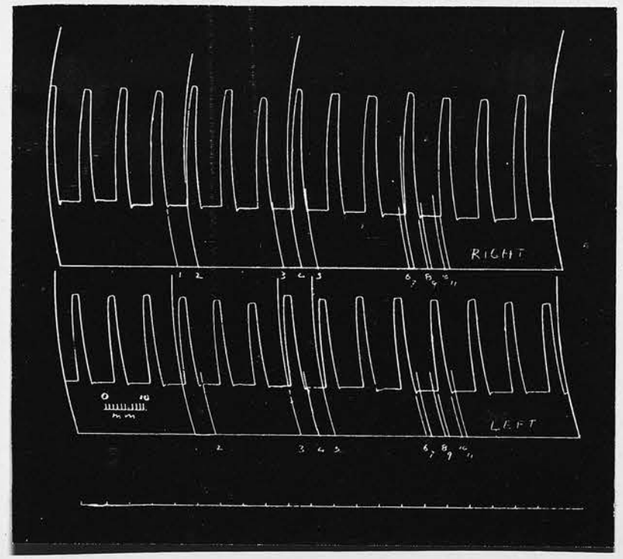


FIG. 11.

Cat, record 1638, 11:iv.11. Movements of progression under narcosis in the intact hind limbs. The corresponding ordinates marked 1 – 11 demonstrate their bilateral alternation and also that here there are periods (i.e. 6-7, 8-9) in which both limbs are in the posture of rest.

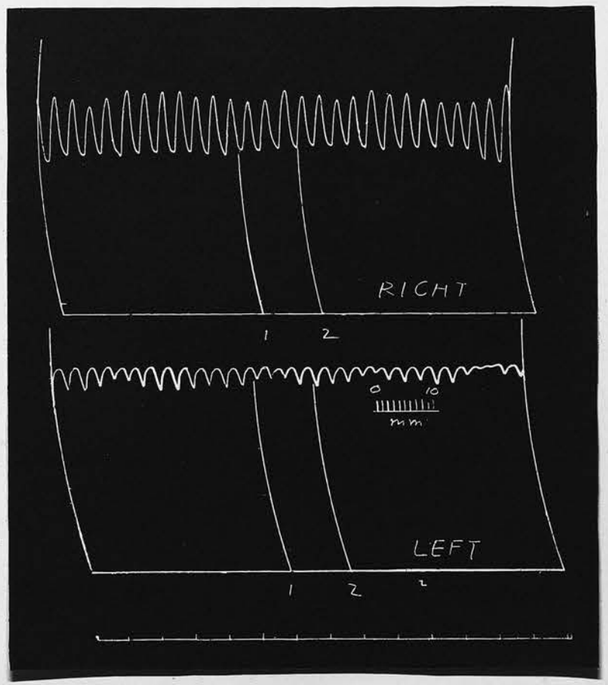


FIG. 12.

Cat, record 1640, 12:iv:11. Progression movements in narcosis – intact hind limbs. In this case the movements are of bilateral synchronism. This is shewn by the corresponding ordinates.

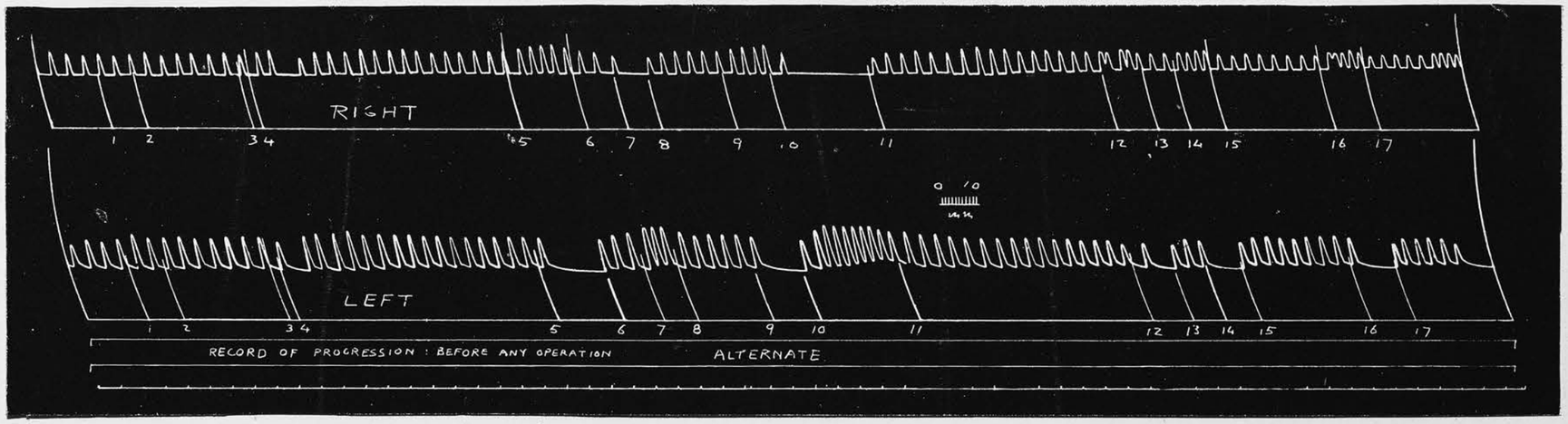


FIG. 13.

Cat, record 2817. Movements of progression under narcosis in the intact hind limbs. These are discontinuous and it will be seen that when confined to one limb the beats are of increased rate and extent :- e.g. between ordinates 10 and 11.

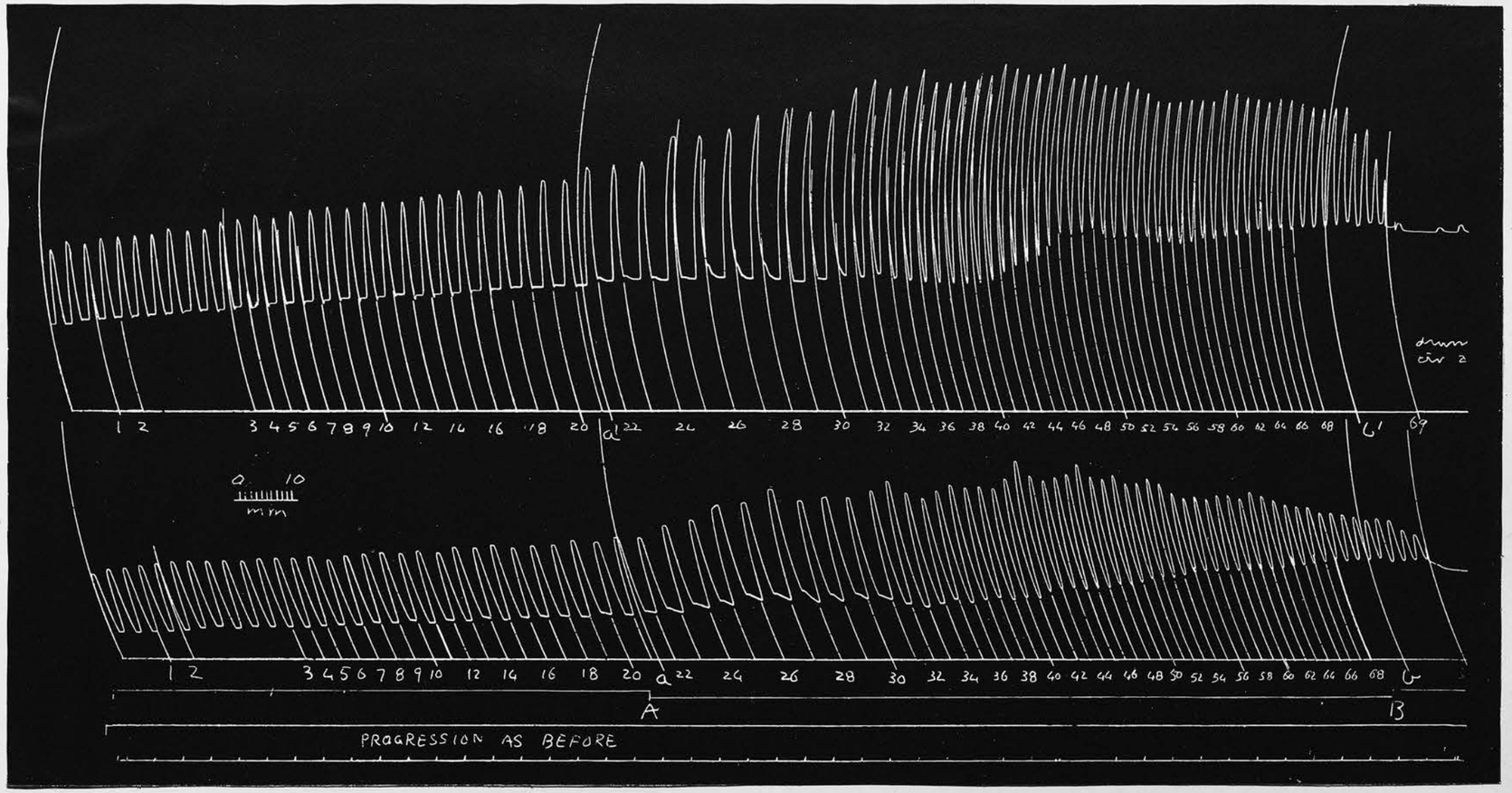


FIG. 14.

Cat, record 3512. Movements of progression under narcosis in the intact hind limbs before and during asphyxia. The trachea was completely closed between A–B of the signal line. Corresponding ordinates marked 1–68 show the relations between the two curves. At first the movements are seen to be of bilateral alternation. After the closure of the trachea at A (a,a') the 'beats' become slower and increase in size. The rate then increases and the 'beats' gradually become of bilateral synchronism.

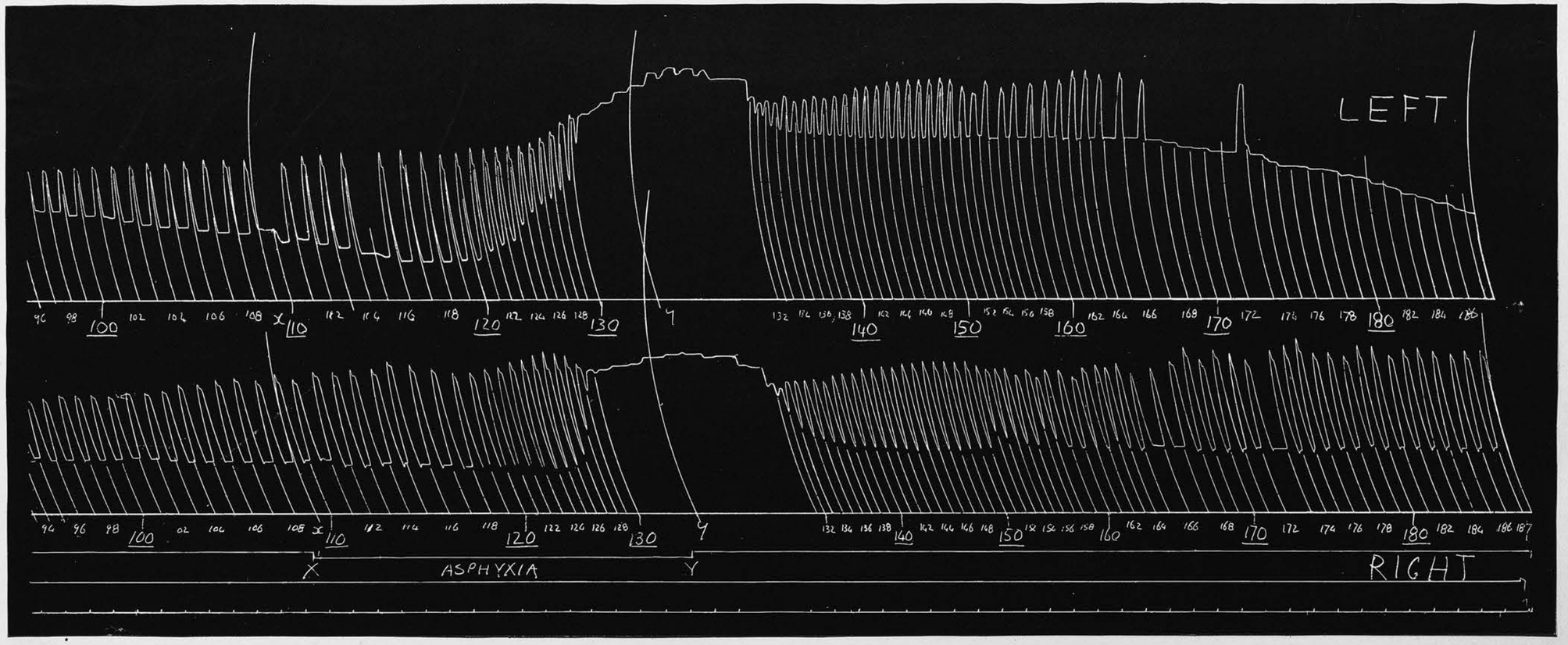


FIG. 15.

Cat, record 3520. Part of a record of the movements of the intact hind limbs during narcosis progression before, during, and after asphyxia by complete closure of the trachea (X-Y of the signal; ordinates x.x', y.y'). This shows a primary slowing in rate and increase in extent of the 'beats'. Their highest points first ascend, and then their lowest points do also while their rate increases. There is never true synchronism but there is a certain approximation to it. The climax of asphyxia is reached in an abolition of the beats and a state of marked maintained flexion. The asphyxia is then stopped and recovery takes place in the reverse order. The beats are then at first nearly synchronous and come to be alternate.

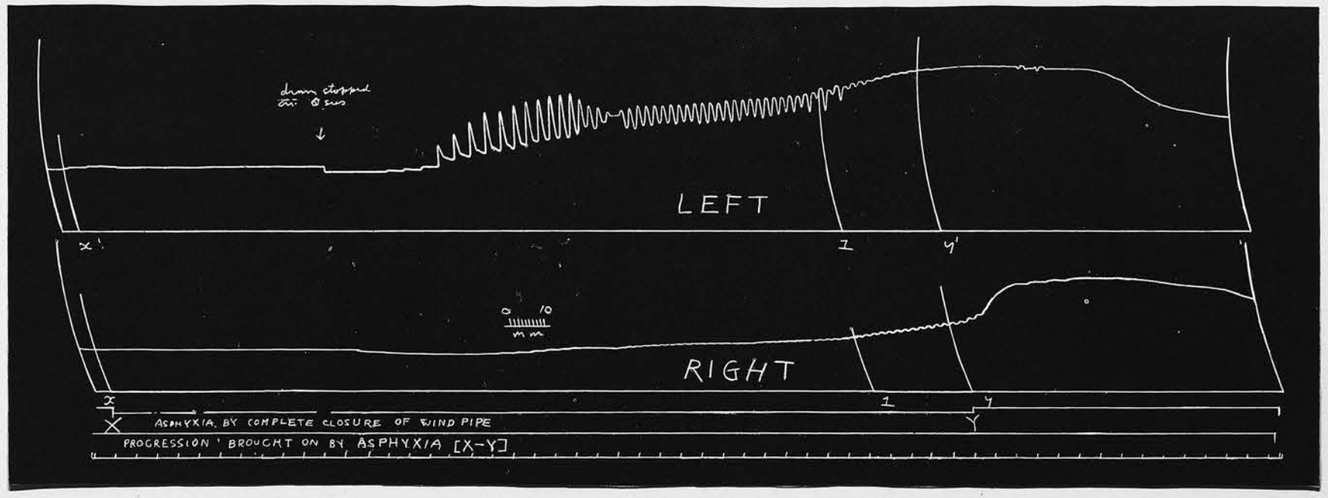
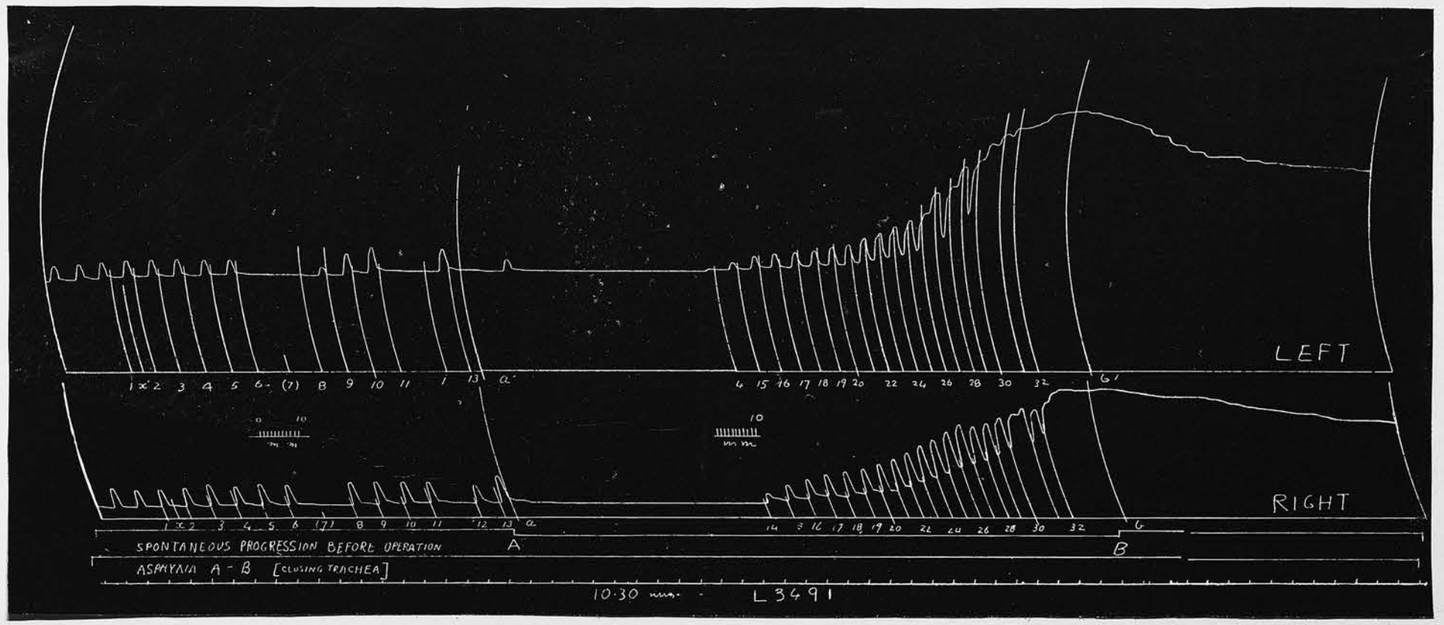


FIG. 16.

Cat, record 3438. This record demonstrates the production of movements of progression after the commencement of asphyxia at a period at which they were not normally occurring in narcosis. The movements are confined to the left limb almost entirely, but the right limb shews the production of maintained flexion.



LEFT.

RIGHT.

SIGNAL.

SECONDS.

FIG. 17.

cat, record 3491. From the same experiment as fig. 18. Here the asphyxia produces at first complete abolition of the beats which then re-appear and increase in extent before merging in maintained flexion. There is here no synchronism produced. Intact hind limbs.

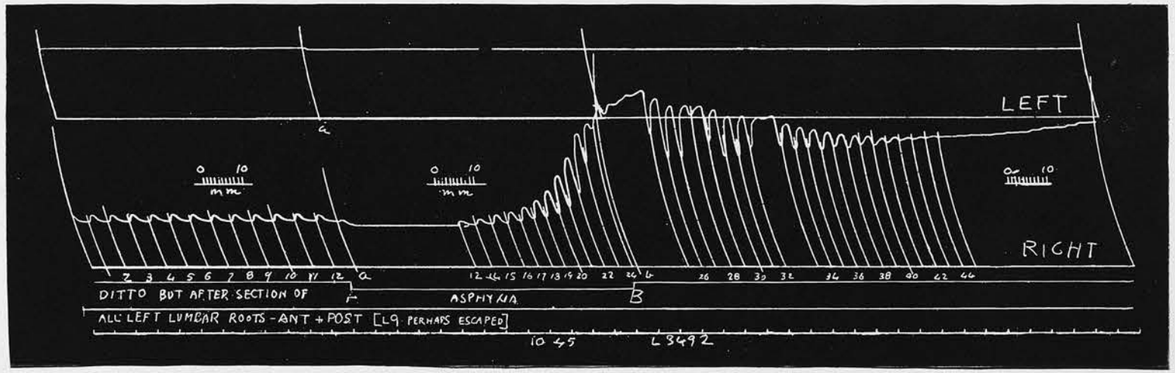


FIG. 18.

Cat, record 3492. This is from the same experiment as fig. 17 and was immediately following it in time. It shews movements of narcosis progression after section of all the left lumbar anterior and posterior spinal roots (with the possible exception of L9) — the movements, of course, being confined to the right hind limb. It also demonstrates the effect of asphyxia by closure of the trachea (A-B), and recovery from asphyxia. The commencement of asphyxia is here followed, for a space of about 6 seconds, by complete abolition of the beats which then reappear and increase in size.

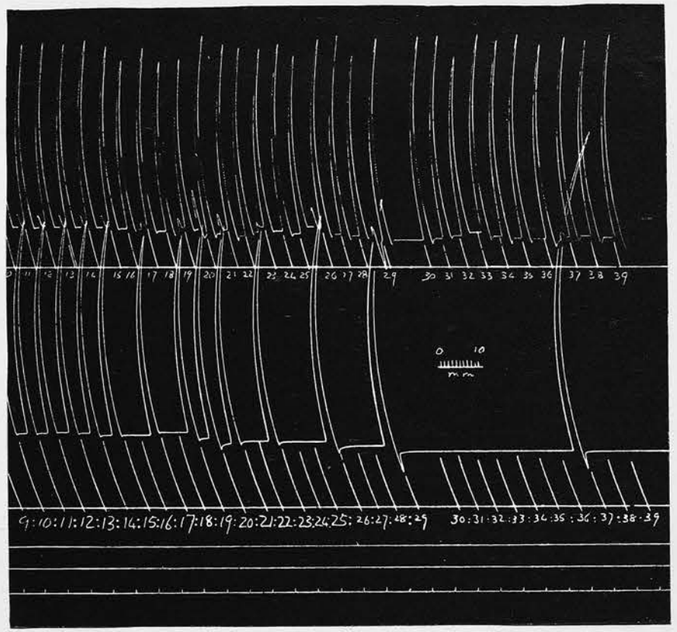


FIG. 19

Cat, record 2461, 5:vii:11. Part of a record of the movements of narcosis progression in the intact hind limbs. From the same experiment as the following two figures with which it is to be compared. The movements are at times confined to one limb and are then of quicker rhythm than when present alternately in both limbs.

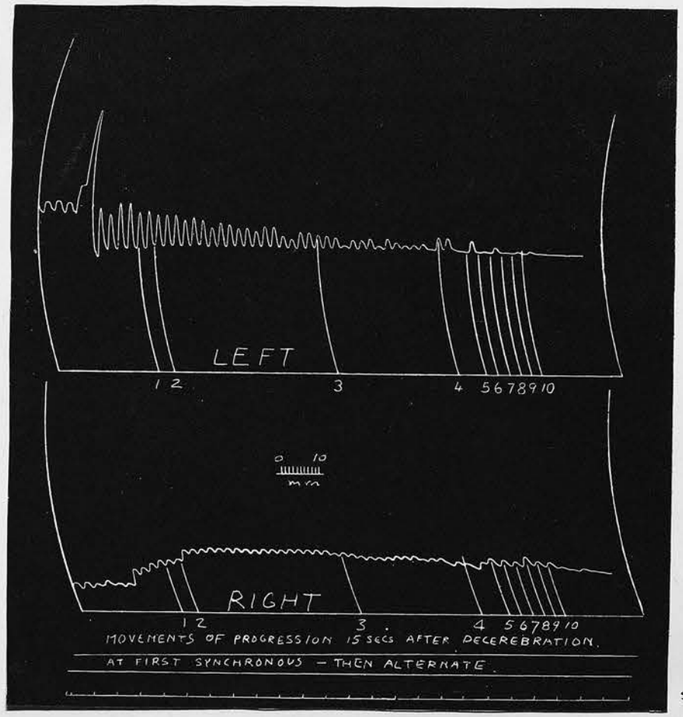


FIG. 20.

Cat, record 2462, 5:vii:11. From the same experiment. Narcosis progression was in progress just before the act of decerebration, and continued after it.

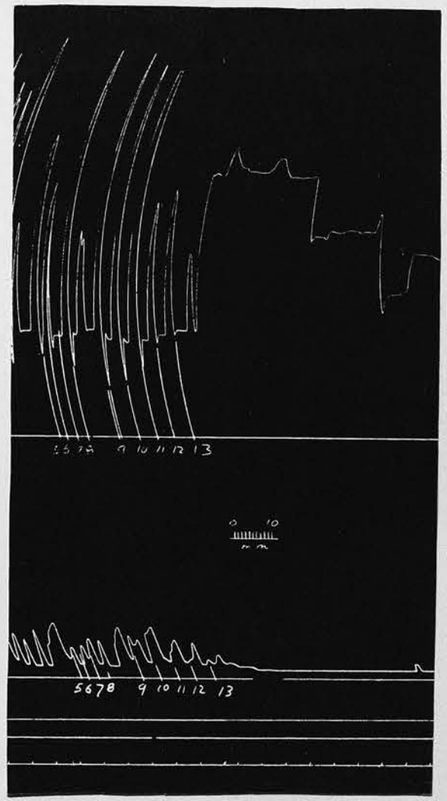


FIG. 21.

Cat, record 2465, 5:vii:11. From the same experiment. Progression in the isolated individual muscles produced by, and following, a rapid transection of the lower thoracic spinal cord. Compare with the two preceding figures. This shows a state of maintained flexor contraction following upon the second phase of the phenomenon. This is the only instance in which this occurred.

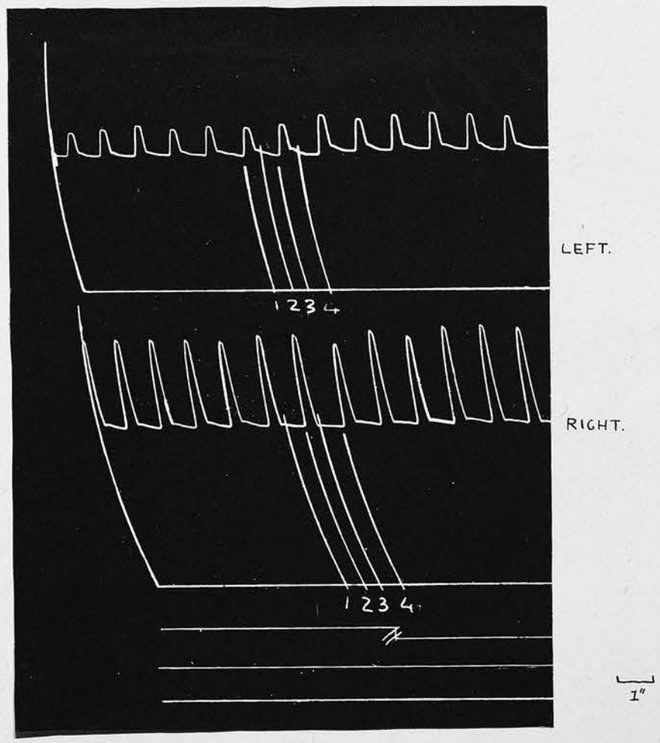


FIG. 22.

Cat, record 3128. Movements of narcosis progression in the intact hind limbs at the commencement of the experiment for comparison with the following figure.

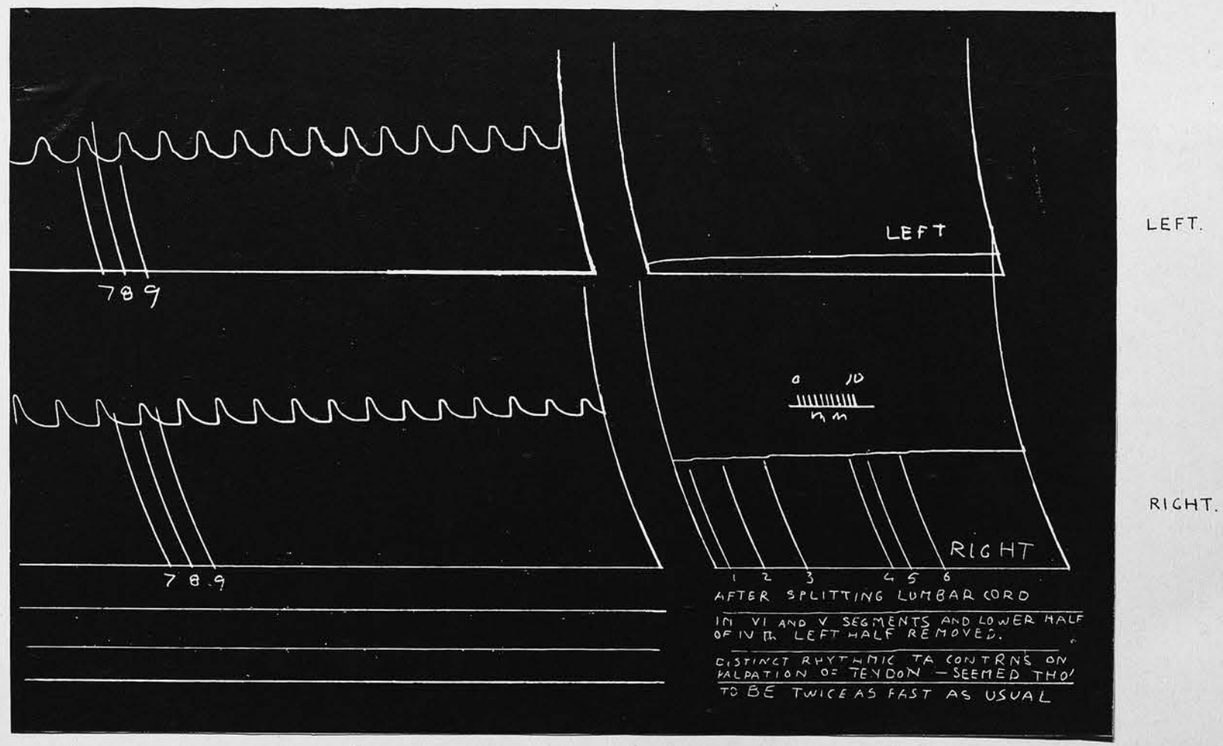


FIG. 23.

A. Cat, record 3130. Movements of narcosis progression in the same cat after removing the whole of the post-thoracic spinal cord caudal to the level of the entry of the lowest fibres of the VI.th post-thoracic posterior spinal root — I.E. after removal of the centres for the extension of the ankle.

B. Cat, record 3131. Taken immediately after the last and after the lumbar spinal cord had been split and the left half removed in the VI.th, V.th, and lower part of IV.th post-thoracic spinal segments — I.E. after removal of the centres for ankle-flexors on the left side. The small movements are undoubted flexion acts.

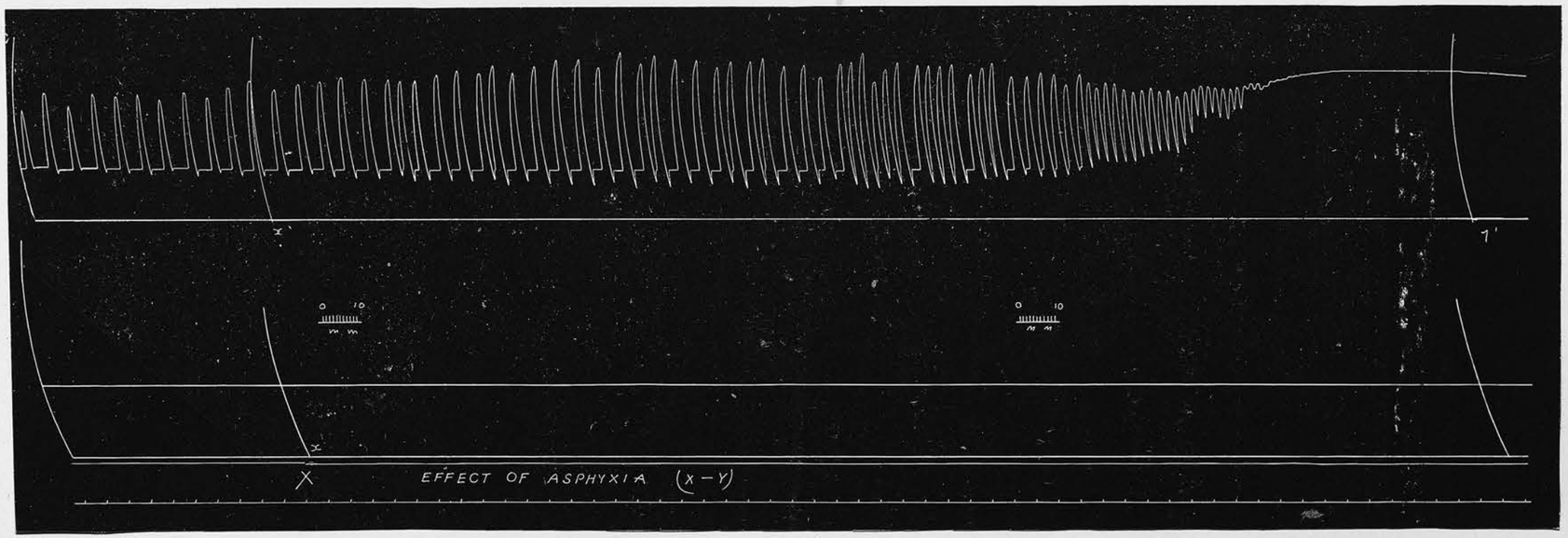
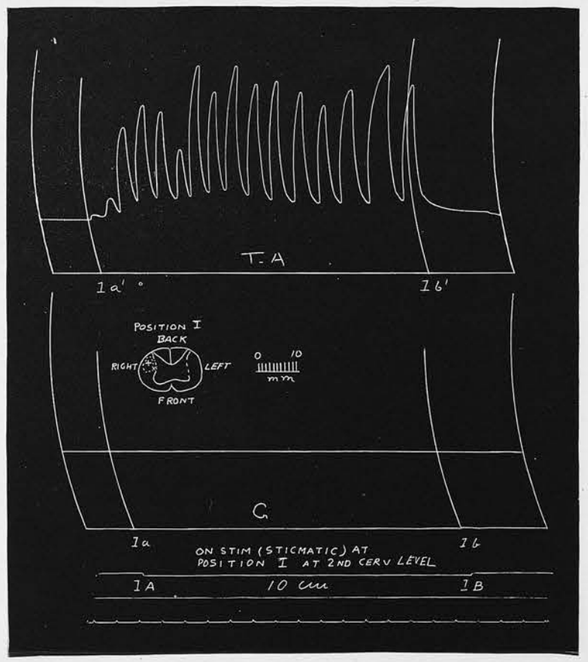


FIG. 24.

Cat, record 2610, 14:vii:11. Record of the movements of narcosis progression registered in the isolated muscles; and the effect thereon of asphyxia. The first part of the record, up to ordinates x, x', shews the movements of progression and that they are confined to the flexor muscle which exhibits beats, the forms of which are similar to those exhibited by the intact hind limbs. The remainder of the record, x, x' – 4, 4', shews the movements during asphyxia. These become at first greater – but not markedly slower – and then become much faster. There is in places an appearance of duplicated beats. Finally the lowest points in the beat, ascend and at last there is a condition of maintained flexor contraction uncomplicated by the beats. There are no extensor movements.



TIBIALIS ANTICUS.

GASTRO= =CNEMIUS.

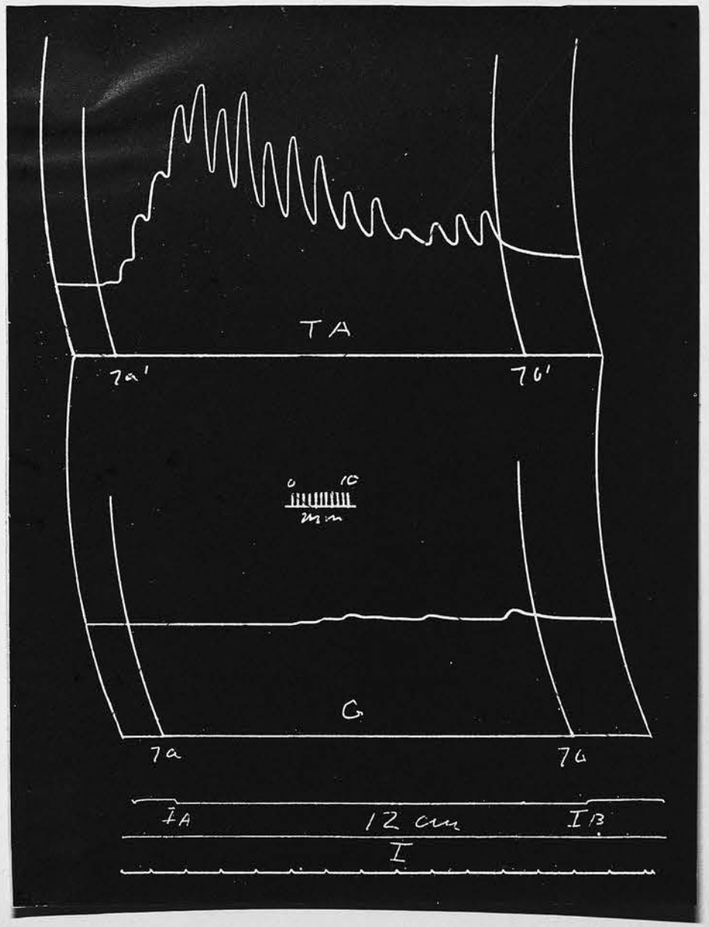
SIGNAL.

SECONDS.

FIG. 25.

Cat, record 2252, 27:vi:11. movements of pro= =gression in the isolated muscles on stigmatic stimulation of the cut surface of the cervical spinal cord at the point marked + in the small figure. The preparation was de-afferented. The stimulus was applied between points, IA and IB of the signal line.

FIGS 25, 26, AND 27 ARE FROM THE SAME EXPERIMENT.



TIBIALIS ANTICUS.

GASTRO= =CNEMIUS.

SIGNAL.

SECONDS.

FIG. 26.

Cat, record 2279, 27:vi:11. from the same experiment. Here there is a certain amount of maintained tonic contraction which forms a background for the rhythmic beats which are evoked in the same manner as before. The stim= =ulus was applied between points, IA and IB of the signal line. The small movements of the extensor occur in the opposite sense to the sym= =chronous flexor movements – decapitate and de-afferented preparation.

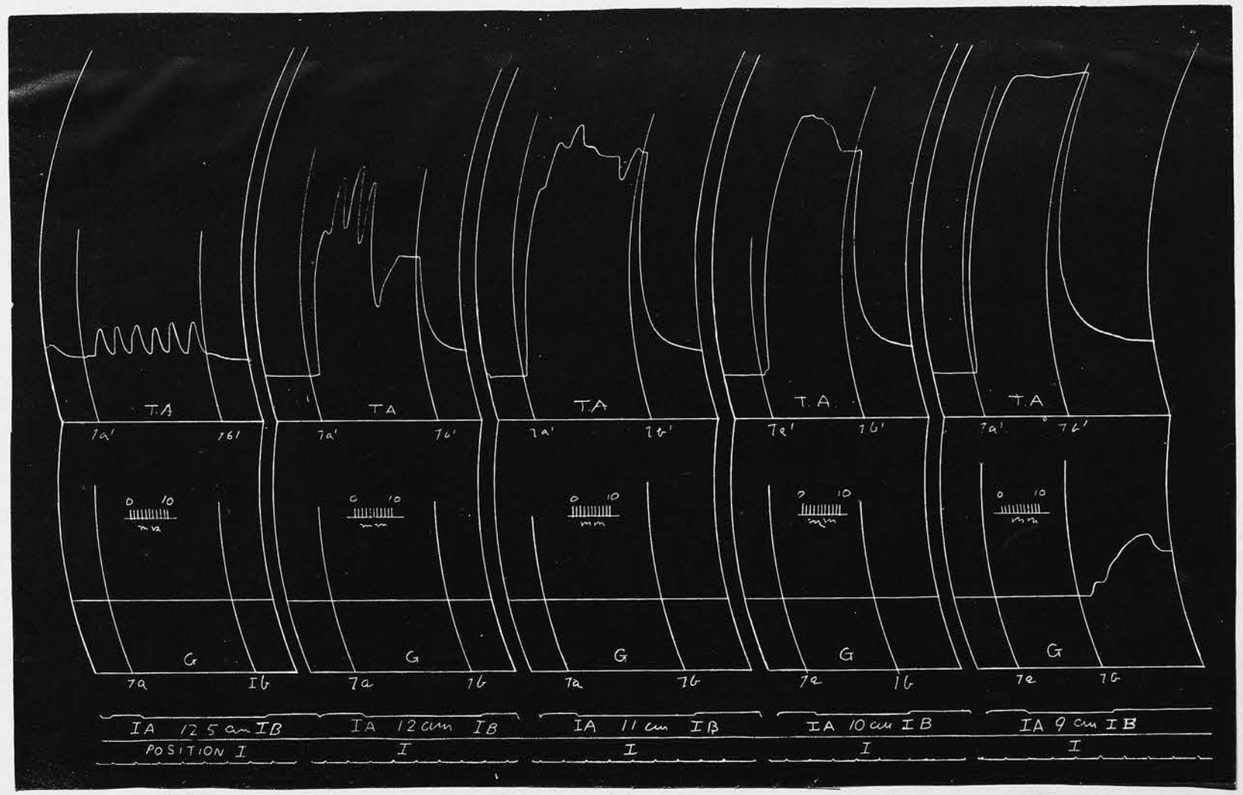


FIG. 27.

Cat, record 2263, 27:vi:11. From the same experiment as figs. 25, 26. a series of stimuli applied at minute intervals and in increasing strength, to the cut surface of the cervical spinal cord. The first evokes a reaction characterised by rhythmic beats of the flexor which have no foundation of maintained flexor contraction (i.e. each attains at the foot to the position of rest of the muscle). In the second reaction there are rhythmic beats, which are superposed upon a foundation of maintained flexor contraction (i.e. the beats at the lowest points of relaxation do not attain the position of rest). In the third reaction there is more maintained flexor contraction and the beats have almost disappeared. In the fourth reaction the beats have disappeared and the maintained flexor contraction is greater. In the fifth record the maintained contraction is still greater, there is no indication of beats, and on cessation of stimulation there is a well-marked extensor 'rebound' contraction — decapitate and de-afferentiate preparation.

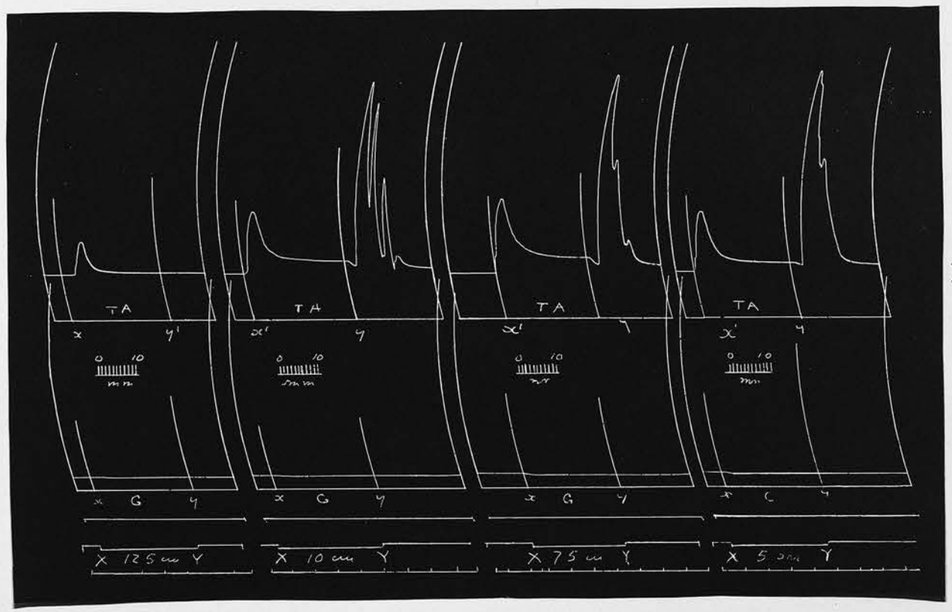


FIG. 28.

Cat, record 1672, 19:IV:11. A series of stimuli applied at minute intervals to the ipsilateral long saphenous nerve. These are marked by letters X – Y of the signal and by corresponding ordinates x, x'; y, y'. There is a rhythmic flexor rebound. For comparison with the ~~four~~ following figures - all from the same experiment.

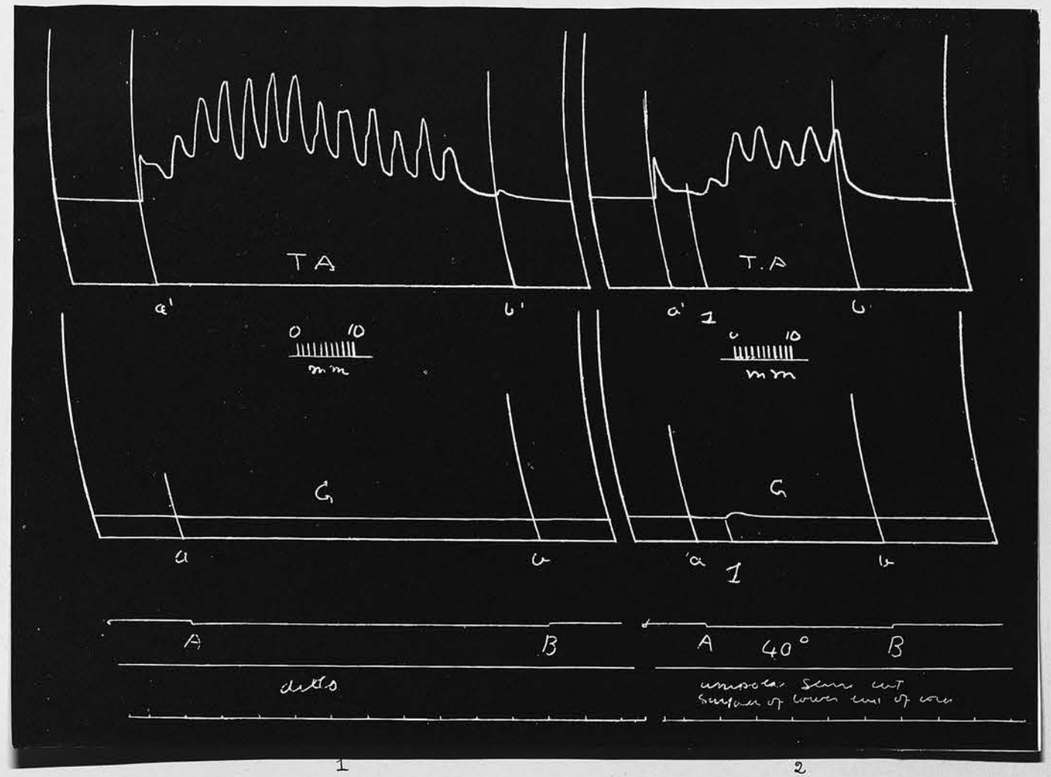
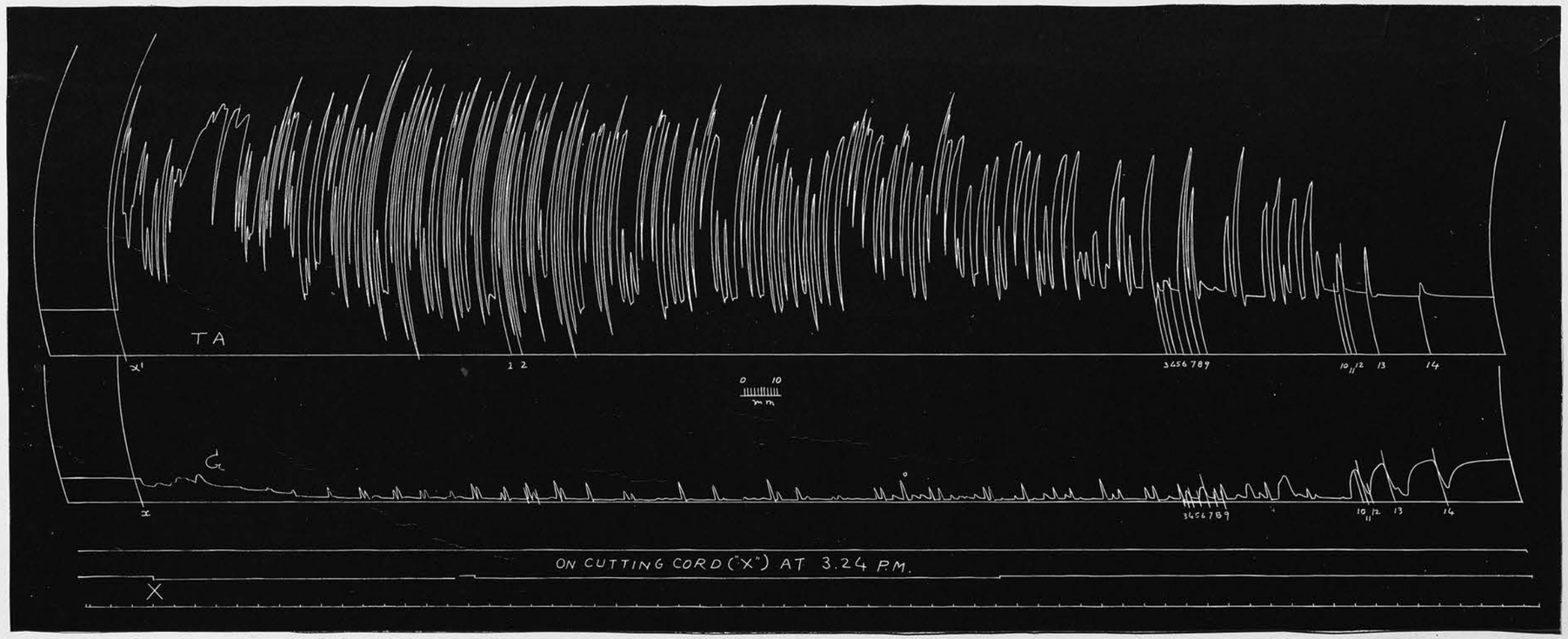


FIG. 29

Cat, record 1742, 19:IV:11. From the same experiment. movements of progression on stigmatic stimulation of the cut surface of the lower thoracic spinal cord. The times of commencement and termination of stimulation are denoted by the letters A – B. The single movement of gastrocnemius marked by ordinate 1 is accompanied by flexor relaxation.

This record was taken in time after that of fig 30, and of fig 31.



TIBIALIS ANTICUS.

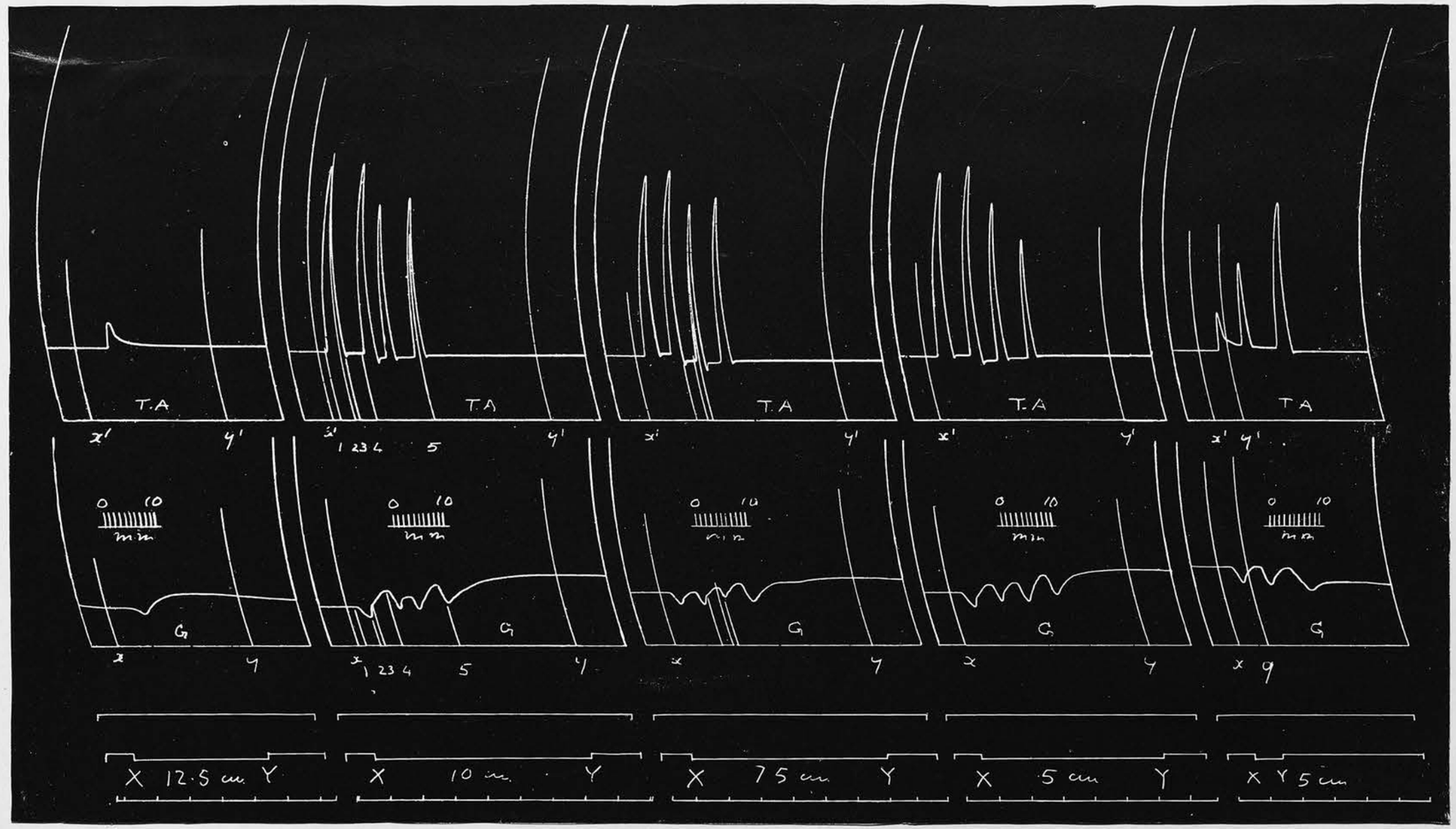
GASTRO= =CNEMIUS.

SIGNAL.

SECONDS.

FIG. 30.

Cat, record 1736, 19:iv:11. Record of movements of progression obtained on rapid section of the lower thoracic spinal cord — isolated muscles. It commences with main= =tained flexor contraction and extensor relaxation. There is then a period of rapid and extensive but irregular 'beats' — the 'balanced' phase. Finally a phase of extensor maintain= =ed contraction. Compare with the preceding and following figures.



TIBIALIS ANTICUS.

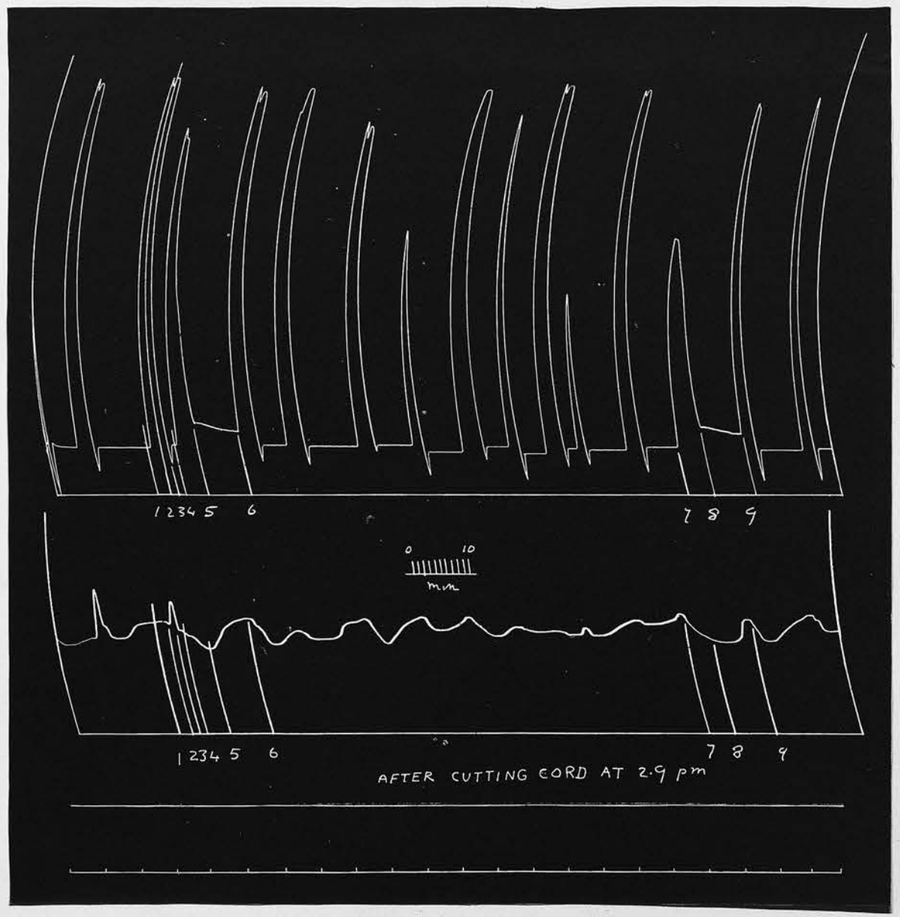
GASTRO= =CNEMIUS.

SIGNAL.

SECONDS.

FIG. 31.

cat, record 1709, 19:IV:11. From the same experiment but before section of the spinal cord. A series of simple peripheral stimuli applied at minute intervals and with increasing strength of stimulus to the ipsilateral long saphenous nerve, the response is markedly rhythmic.



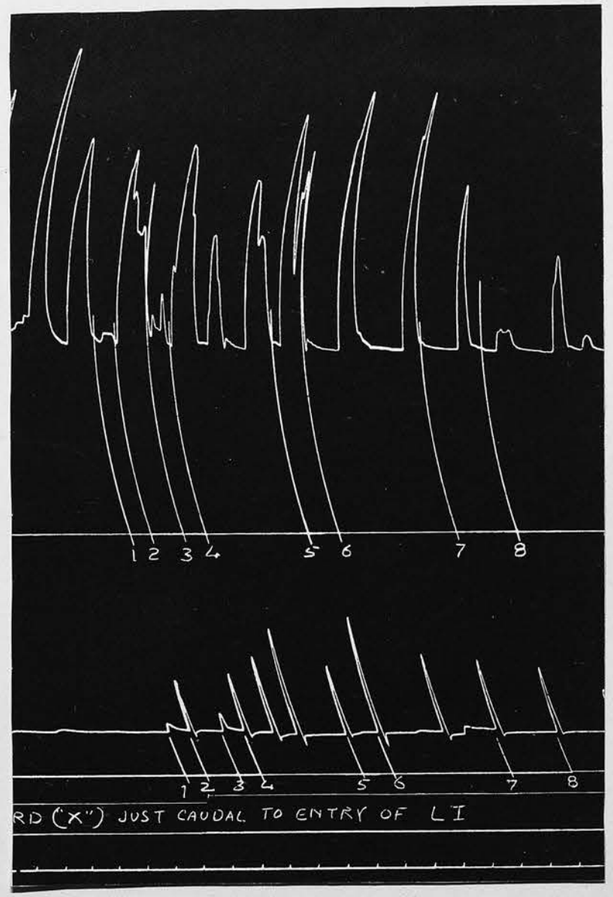
TIBIALIS ANTICUS.

CASTRO= =CNEMIUS.

SECONDS.

FIG. 32

Cat, record 1257, 29:iii:11. movements of progress= =ion in the isolated muscles on section of the lower thoracic spinal cord – 'balanced' phase only (the others not being recorded). The flexor 'beats' are of somewhat irregular rate, and the extensor shews reciprocally synchronous movement. These seem to be of two kinds – a slow rise and fall and a rapid additional movement (e.g. at ordinates 2) which resembles a 'rebound' contraction.



TIBIALIS ANTICUS.

GASTRO= =CNEMIUS.

SECONDS.

FIG. 33.

Cat, record 3387, 23:xi:11. movements of progression in isolated muscles on section of the lower thoracic spinal cord. The flexor 'beats' are very irregular, and their relaxation phases are accompanied by 'rebound'-like extens= =sor contractions. A part only of the record is here reproduced.

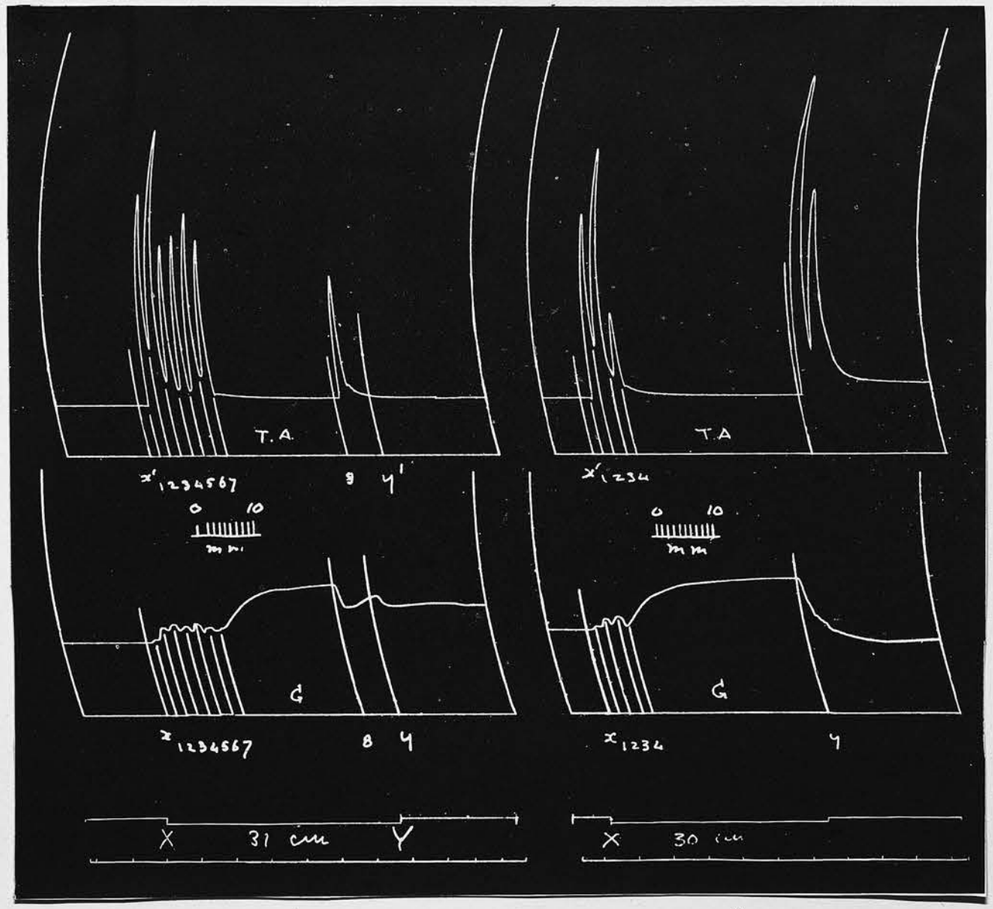


FIG. 34.

Cat, record 657, 17:ii:11. Record of two simple reflex reactions obtained at minute intival on stim= =ulation of the ipsilateral long saphenous nerve (X-Y). The reactions are markedly rhythmic and the beats are present reciprocally in the two muscles. In the second reaction there is a rhythmic flexor rebound, and in both there is a maintained extensor contract= =ion during the latter part of the period of stimul= =ation. — Decerebrate preparation.

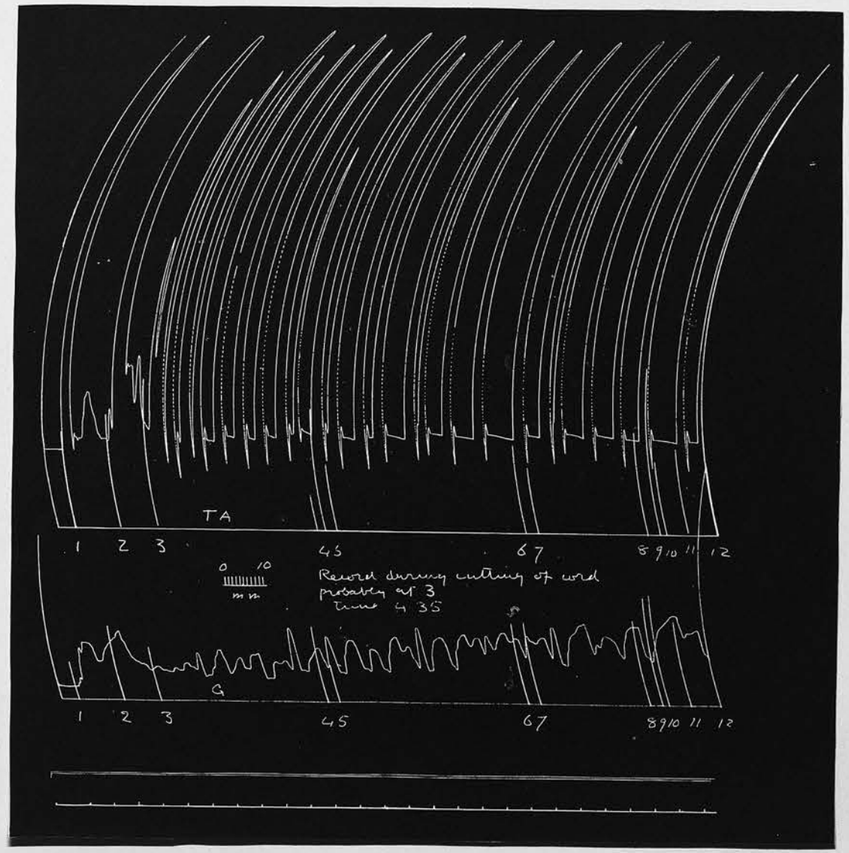


FIG. 35.

Cat, record 692, 17:ii:11. From the same exper= =iment. Progression on section of the lower thoracic spinal cord. There is a very small first phase and practically the whole of the record consists of the second phase. The third is not shewn.

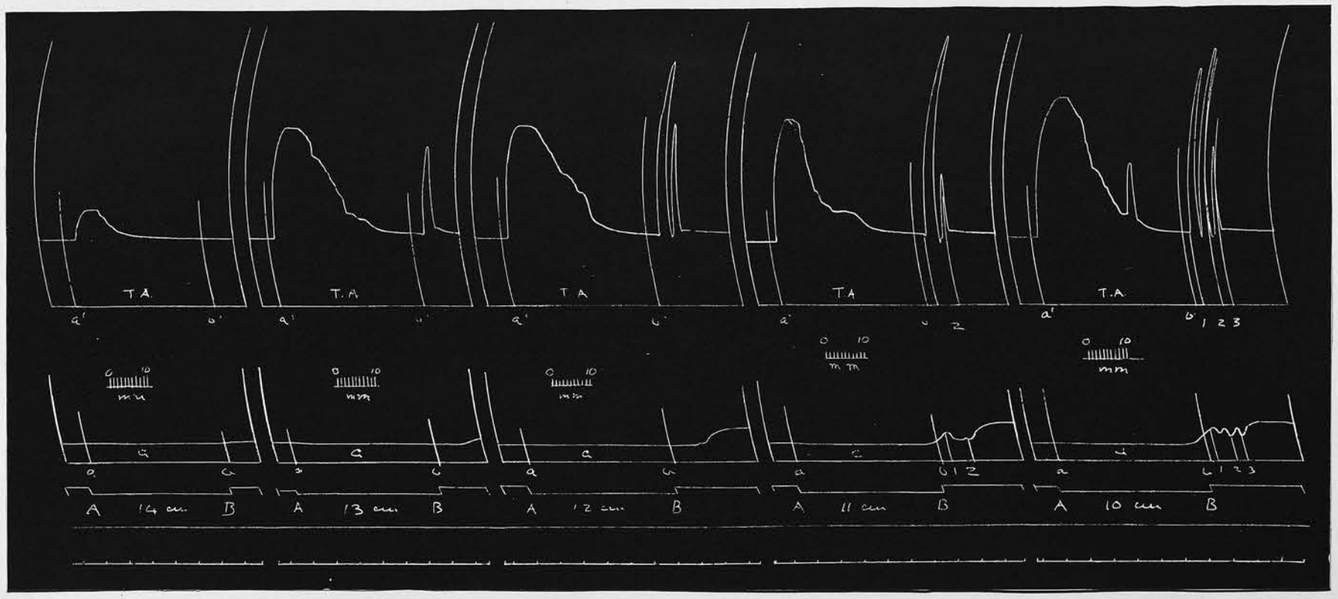


FIG. 36.

Cat, record 1211, 17:iii:11. a series of contralateral flexion reflex reactions taken at minute intervals and with increasing strength of stimulus. There is a rhythmic wound in which a large is associated with a small beat. For comparison with the following two figures from the same experiment – decerebrate preparation.

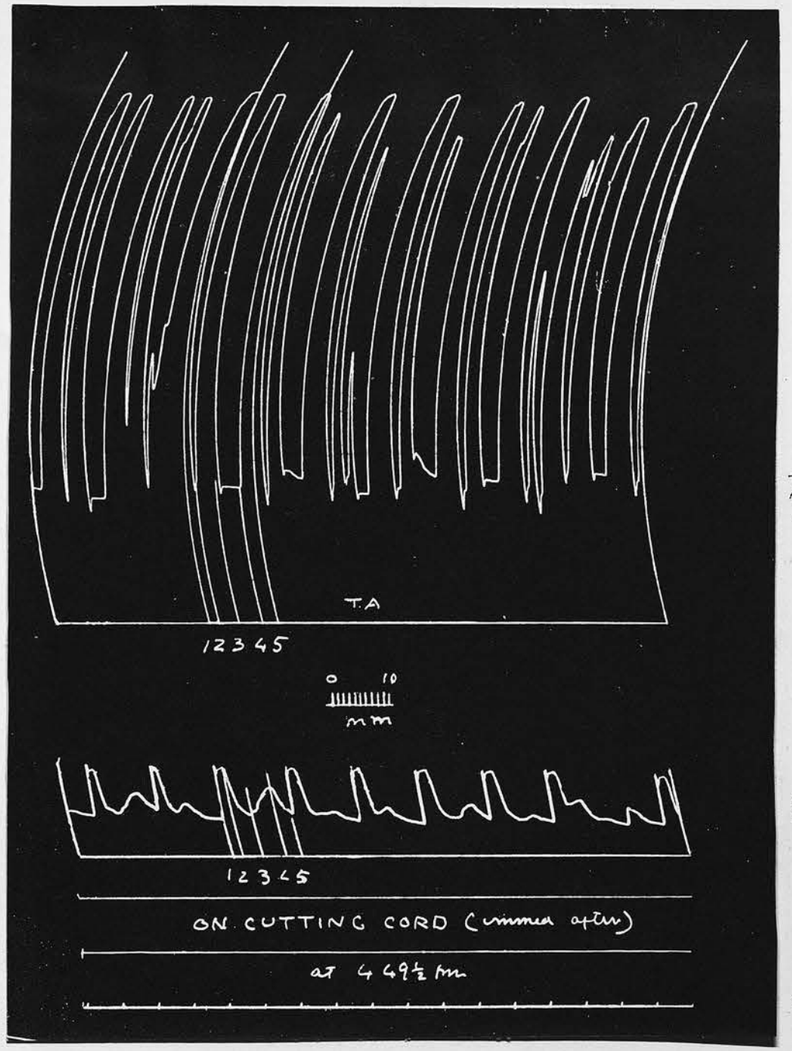


FIG. 37.

Cat, record 1217, 17:iii:11. Movements of progression on cutting lower thoracic spinal cord – 'balanced' phase only here recorded. The flexor beats are arranged in groups of two and the extensor shews two forms of move= =ments. Compare with figs. 36, 38.

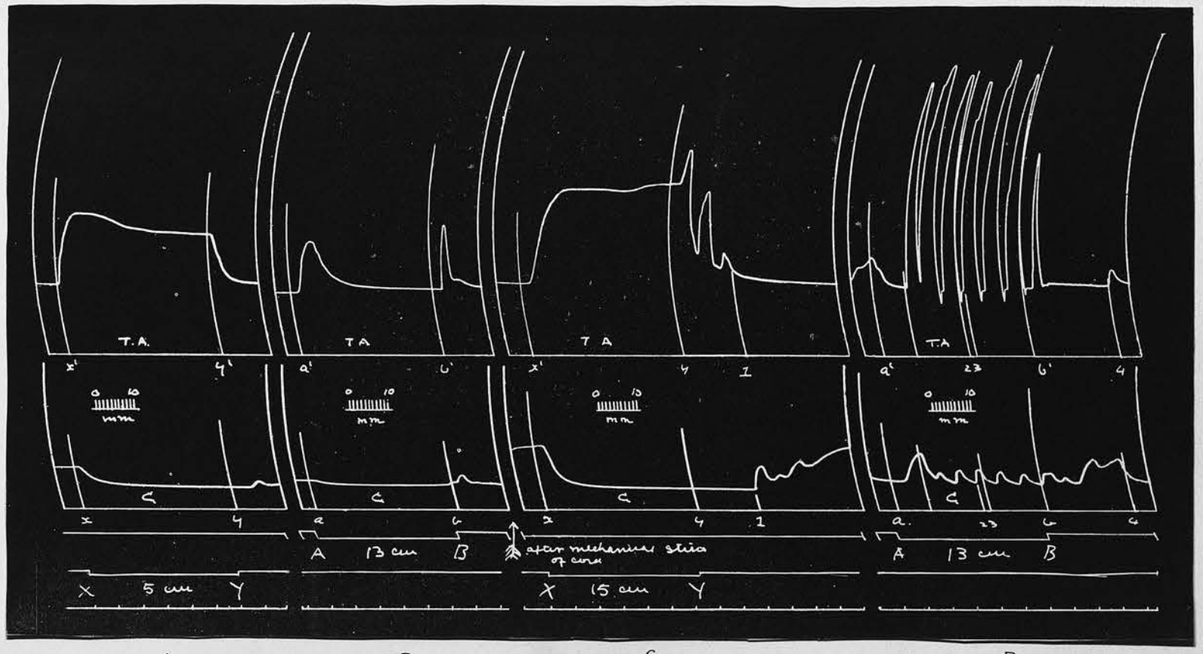


FIG. 38.

Cat, record 1234, 17:iii:11. Records of simple reflex reactions to ipsilateral (A and C) and to contralateral (B and D) stim= =uli, before and after mechanical stimulation of the upper end of the cut lumbar spinal cord. The reactions are taken at minute intervals and the stimulation of the cord applied at the point marked by the arrow. The reactions before this are simple and the contralateral is one of flexion. After the mechanical stim= =ulation the ipsilateral stimulus evokes a flexion response which is followed by a rhythmic rebound. The contralateral stimulus evokes a rhythmic reaction during its process. Com= =pare this with the two preceding figures from the same experi= =ment – low spinal preparation.

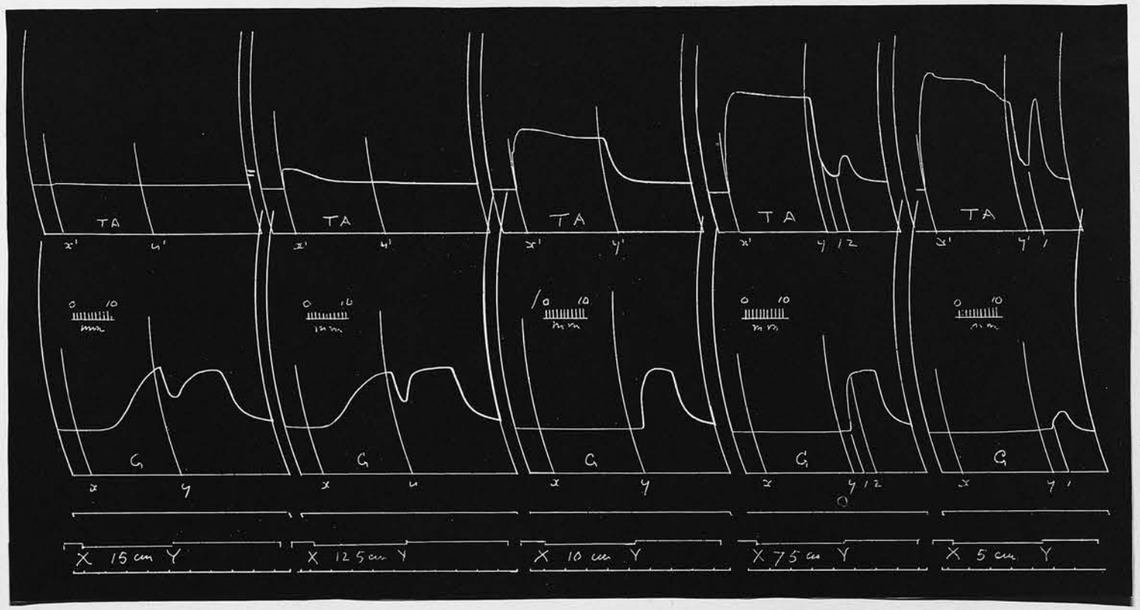


FIG. 39.

Cat, record 2063, 16:vi:11. Record of five succeeding simple ipsilateral reflex reactions taken at minute intervals and with increasing strength of stimulus. The reaction is first that of ipsi= =lateral extension. Then flexion first appears. It increases and the extension during stimulation disappears completely. This seems to suggest a double conditioning (flexion + extension) of the simple reflex. From the same experiment as figures 40 -42 — Decerebrate preparation, de-afferented.

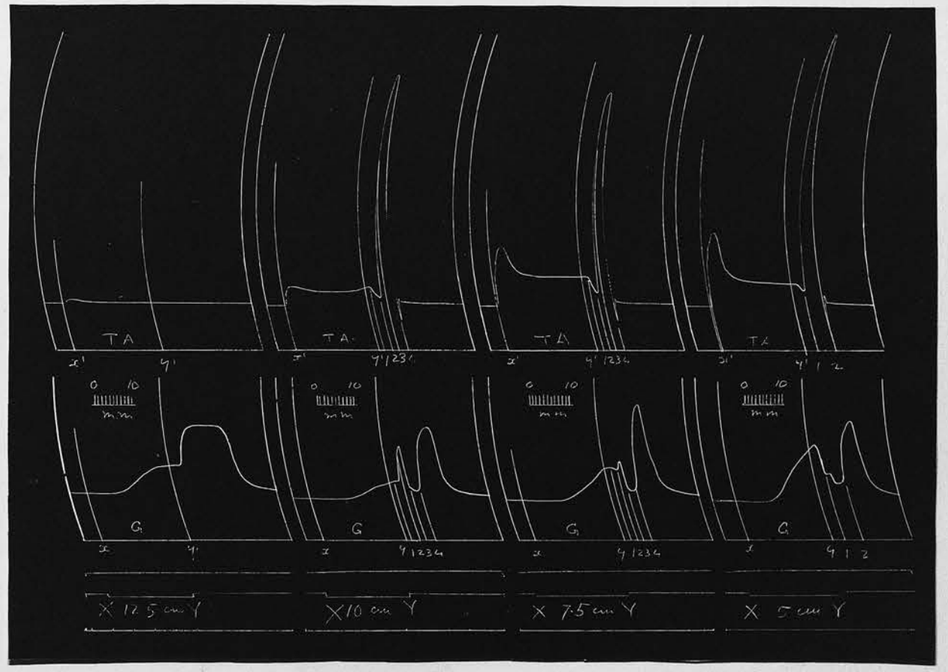


FIG. 40.

Cat, record 2079, 16:vi:11. From the same experi= =ment. a series of simple ipsilateral reflex reactions which shew the same phenomenon with the exception that the extensor contraction never completely disap= =pears — Decerebrate preparation, de-afferented.

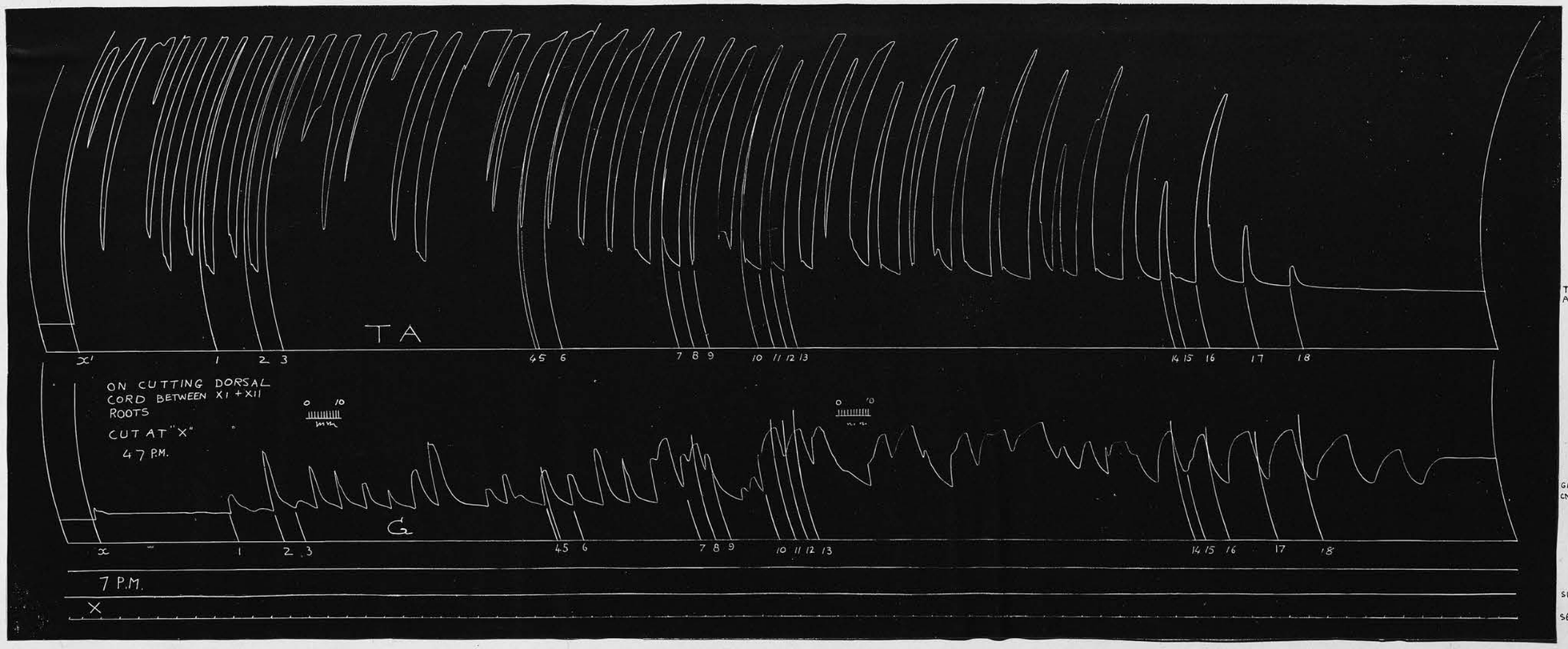


FIG. 41.

Cat, record 2098, 16:vi:11. Record of movements induced in the de-afferented isolated muscles on rapid section of the lower thoracic spinal cord. The three phases are clearly seen. It will be noticed that in the end of the second phase and beginning of the third the flexor contractions are markedly preceded in time by the corresponding extensor relaxations – ordinates 14, 15, 16, 17, 18; and that the extensor relaxations persist after the disappearance of the flexor contractions — De-afferented preparation.

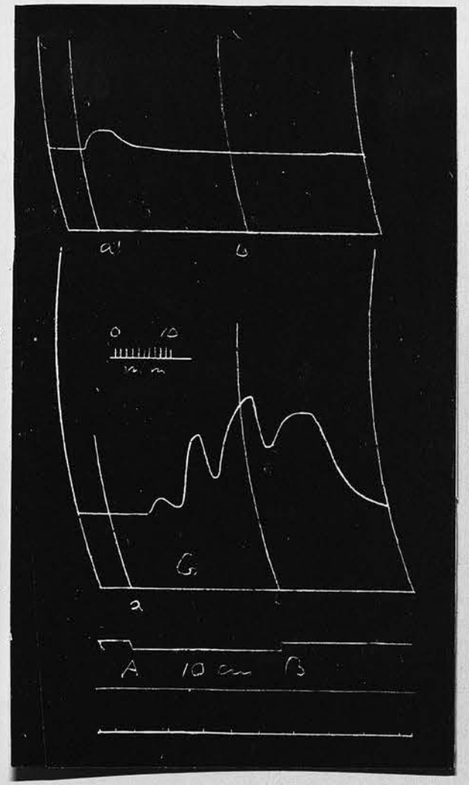
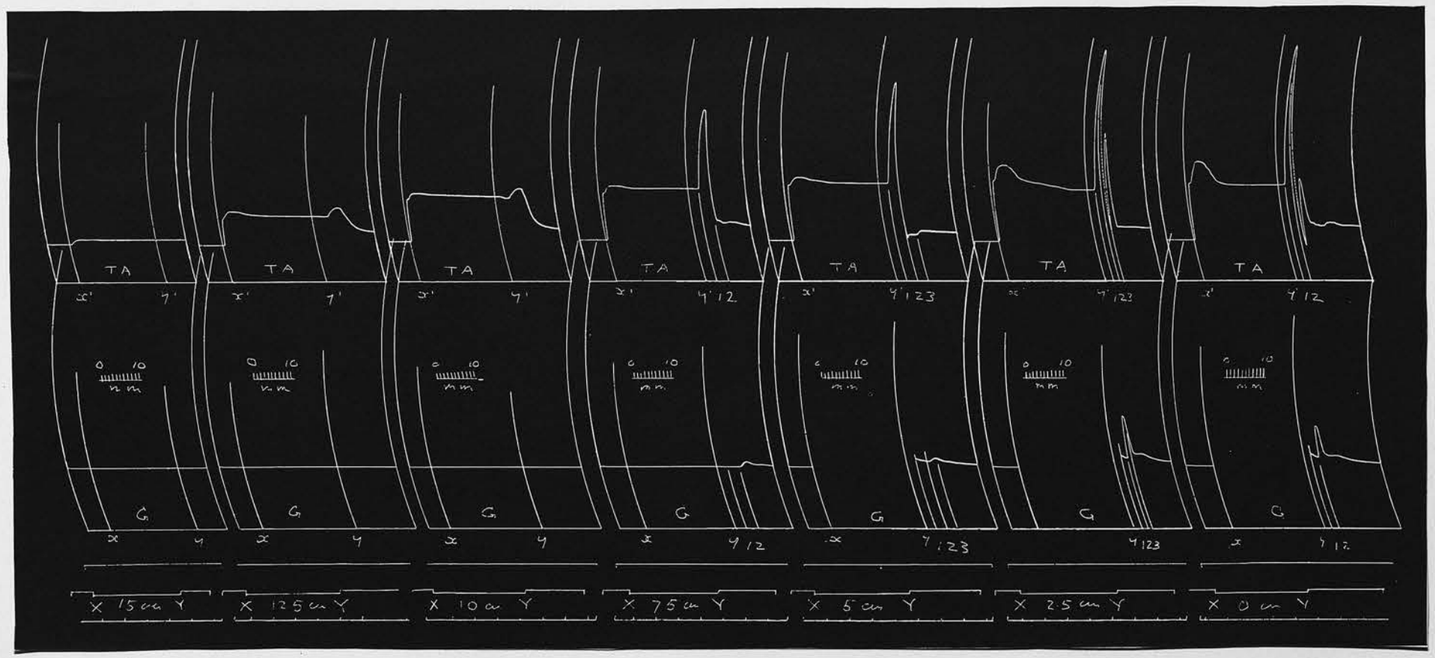


FIG. 42.

Cat, record 2100, 16:vi:11. a simple reflex reaction obtained – almost immediately after the preceding figure – in response to contralateral stimulation. The reaction is first flexion and then rhythmic extension. On comparison with the preceding figure this reaction appears to be a reproduction of the phenomena in the third phase – i.e. after ordinates 18 — De-afferented low spinal preparation.



TIBIALIS ANTICUS.

GASTROCNEMIUS.

SIGNAL.

SECONDS.

FIG. 43.

Cat, record 2122, 19:vi:11. a series of ipsilateral reflex reactions taken at minute intervals and with increasing strengths of stimulus. To demonstrate the genesis of a rhythmic flexor 'rebound' for comparison with the following figure from the same experiment – Decerebrate and de-afferented preparation.

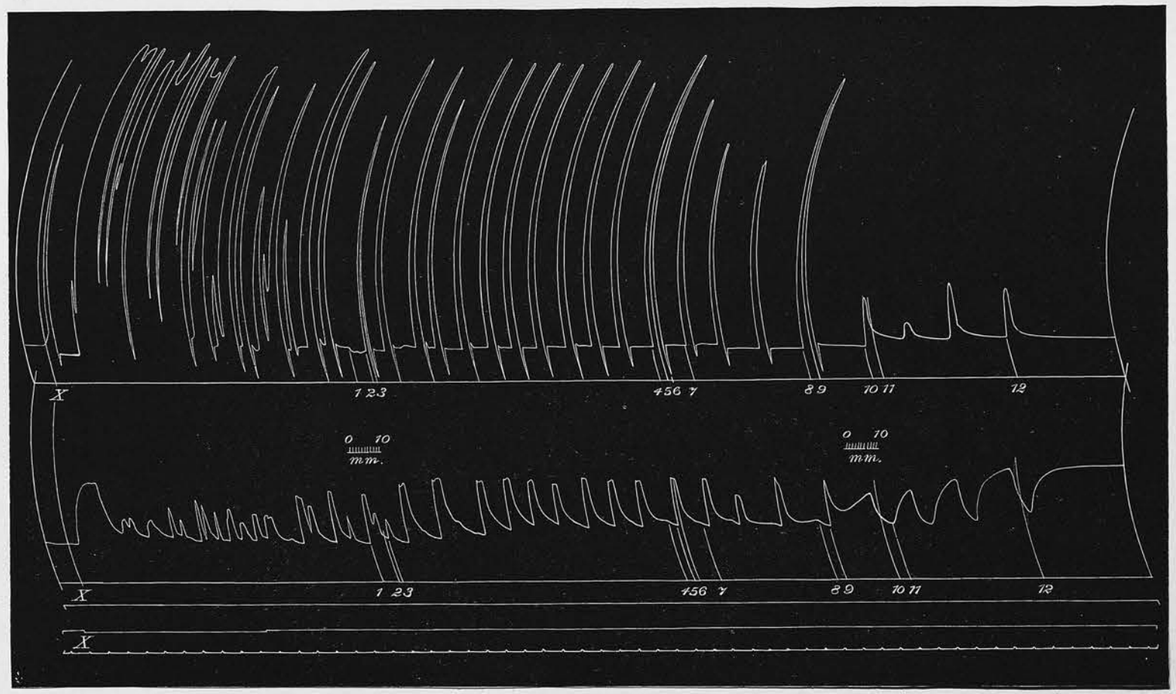
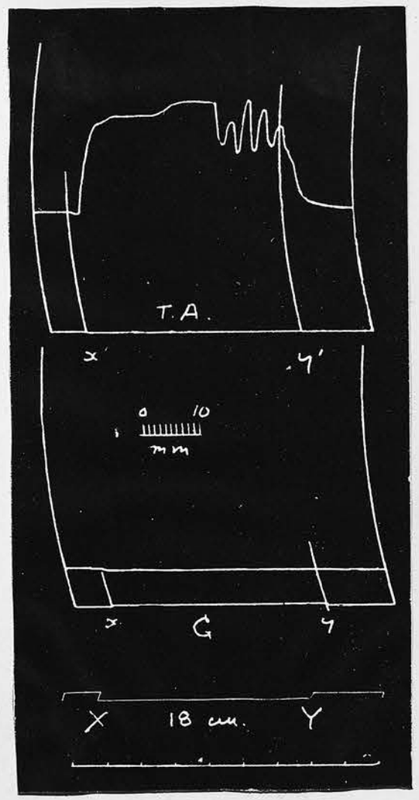


FIG. 44.

Cat, record 2203, 19:vi:11. Record of movements of progression induced in de-afferented isolated muscles on section of the lower thoracic spinal cord at 'X'. This record is a typical example of the phenomenon. The first phase is short – there seems really to be a primary alternation of a first and third phase and then the commencement of the first phase proper. This shews irregular interruptions of the maintained flexor contraction and gradually merges in the second, or 'balanced' phase. Here the flexor beats are very regular and the relaxation of each is accompanied by a 'rebound'-like extensor contraction. This phase merges in the third – that of maintained extensor contraction. The 'rebound'-like extensor movements begin to disappear about ordinate 8; and thereafter the extensor movements appear as relaxations of a state of maintained contraction – de-afferented preparation.



TIBIALIS ANTICUS.

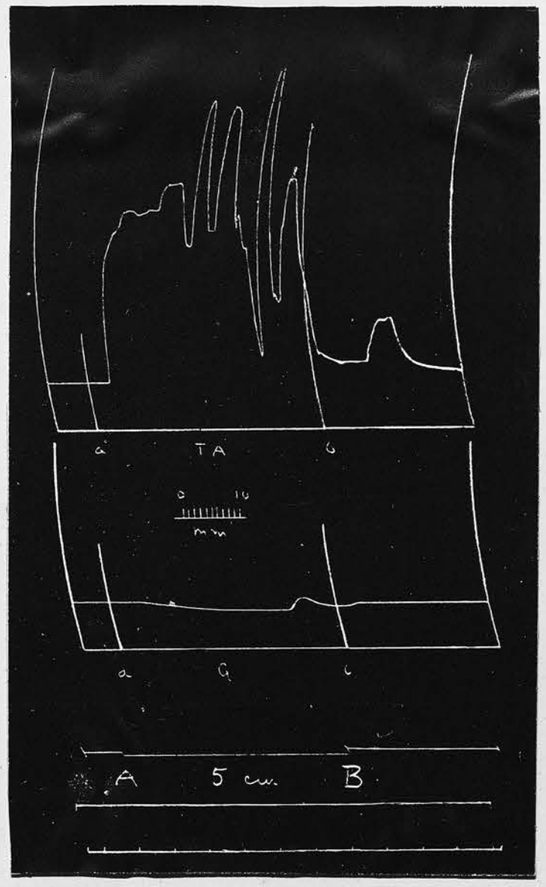
GASTRO=CNEMIUS.

SIGNAL.

SECONDS.

FIG. 45.

Cat, record 546, 13:ii:11. a simple ipsilateral reflex stimulus. The reaction is at first one of main=tained flexor contraction and (slight) extensor relaxation. Suddenly there is a fall in the level of the maintained flexor contraction and this is followed by restitution, another partial re=laxation, restitution, etc – The whole forming a series of beats the summits of which corres=pond in level with the level of maintained flex=or contraction — Decerebrate preparation.



TIBIALIS ANTICUS.

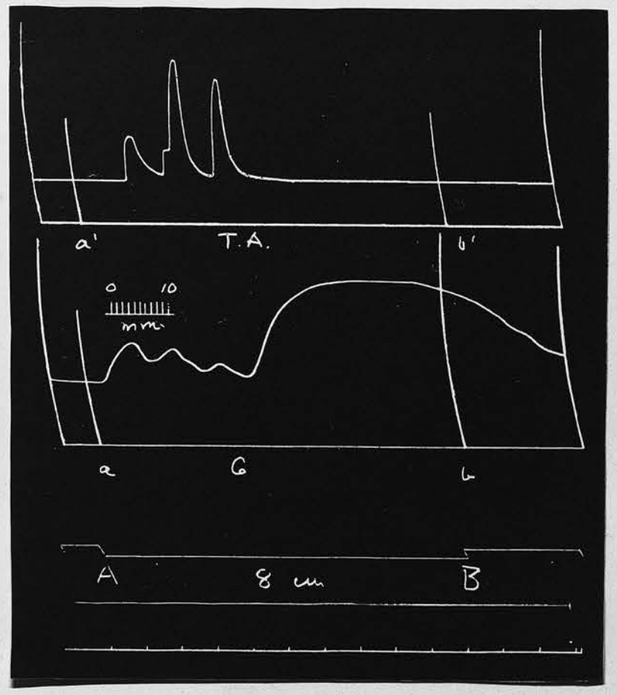
GASTRO=CNEMIUS.

SIGNAL.

SECONDS.

FIG. 46.

Cat, record 1028, 14:iii:11. This and the follow=ing figure are from the same experiment. Here a simple contralateral reflex stimulus evokes at first a reaction of maintained flexor contraction and extensor relaxation. The flexor contraction soon becomes rhythmic – in this resembling fig. 45 — decerebrate preparation.



TIBIALIS ANTICUS.

GASTRO=CNEMIUS.

SIGNAL.

SECONDS.

FIG. 47.

Cat, record 1034, 14:iii:11. From the same exper=iment as fig. 46. Here a simple stimulus applied to the contralateral long saphenous nerve evokes a reaction at first characterised by extensor con=traction. This is then complicated by three flexor beats which are accompanied by extensor relaxat=ions. Thereafter the maintained extensor contraction increases and is unbroken — decerebrate preparation.

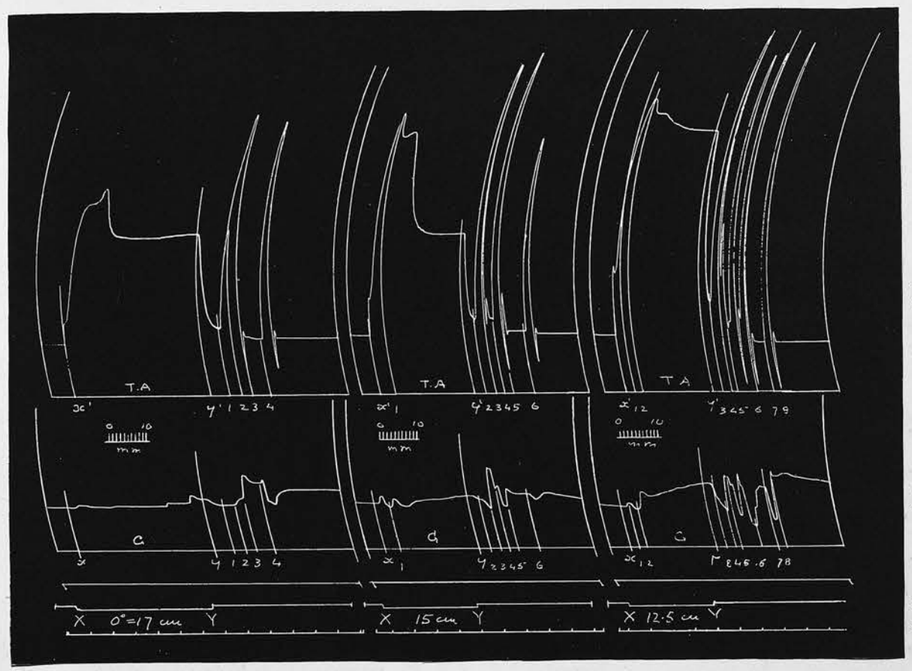


FIG. 48.

Cat, record 1543, 10:iv:11. a series of simple fusion reflexes exhibiting rhythmic rebound on cessation of stimulation at ordinates y, y' — decerebrate preparation — for comparison with figures 49, 50.

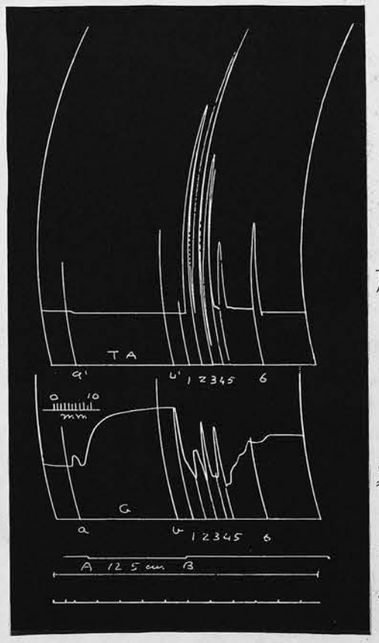


FIG. 49.

Cat, record 1551, 10:iv:11. a single contralateral extension reflex which exhibits a rhythmic flexor rebound on cessation of stimulation at 'B'. — decerebrate preparation — for comparison with figures 48, 50.

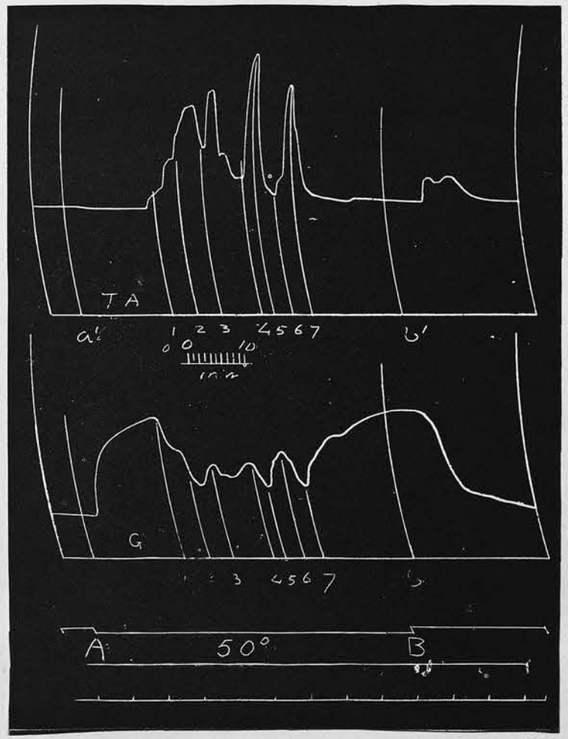


FIG. 50.

Cat, record 1588, 10:iv:11. a single contralateral extension reflex in which the maintained extensor contraction is broken by the appearance of a rhythmic flexor contraction. For comparison with figures 48, 49 — decerebrate preparation.

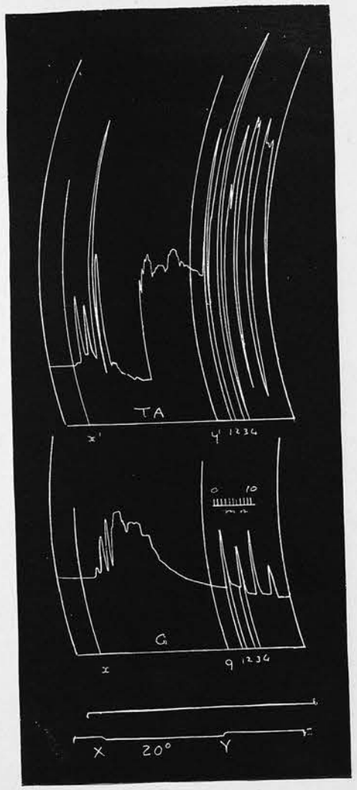


FIG. 51.

Cat, record 1993, 13:vi:11. A simple ipsilateral reflex reaction. This demonstrates in the first place a rhythmic reaction in both muscles, and in the second place a rhythmic rebound. To compare with the following 4 figures from the same experiment. Preparation decerebrate and partially de-afferented i.e. flexor proprioceptive afferents intact but extensor afferents cut.

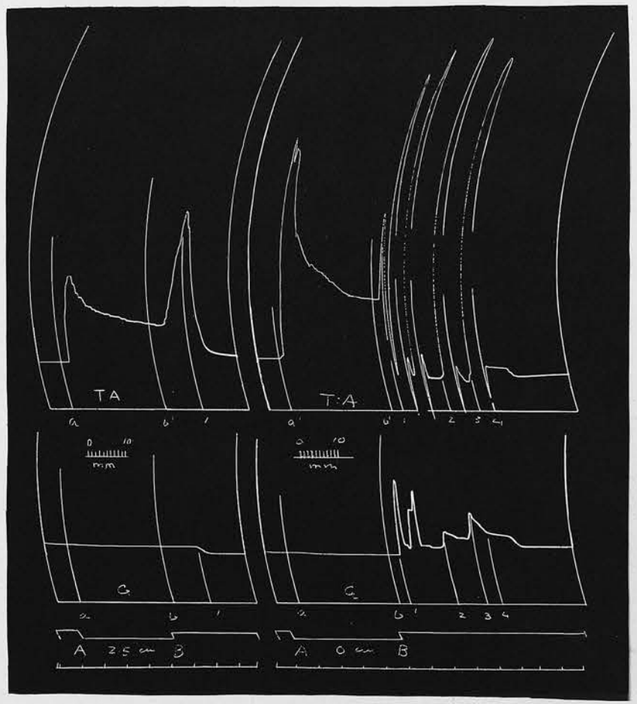


FIG. 52.

Cat, record 1995, 13:vi:11. From the same experiment. Two contralateral flexion reactions which show a rhythmic rebound on cessation of stimulus. For comparison with figs. 51, 53, 54, 55 — Preparation decerebrate and partially de-afferented.

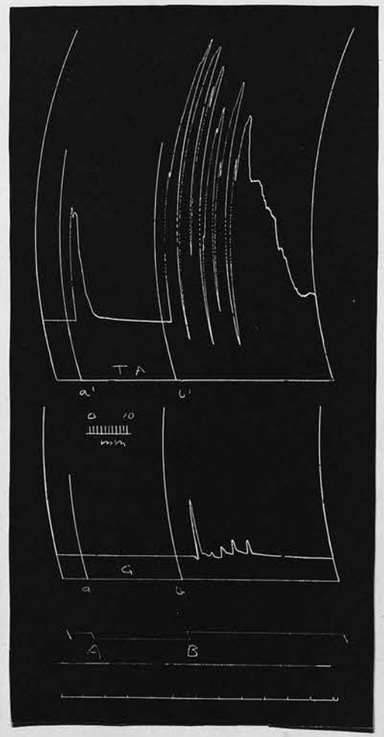


FIG. 53.

Cat, record 2001, 13:vi:11. From the same experiment. Contralateral flexion and a rhythmic rebound — Preparation decerebrate and partially de-afferented.

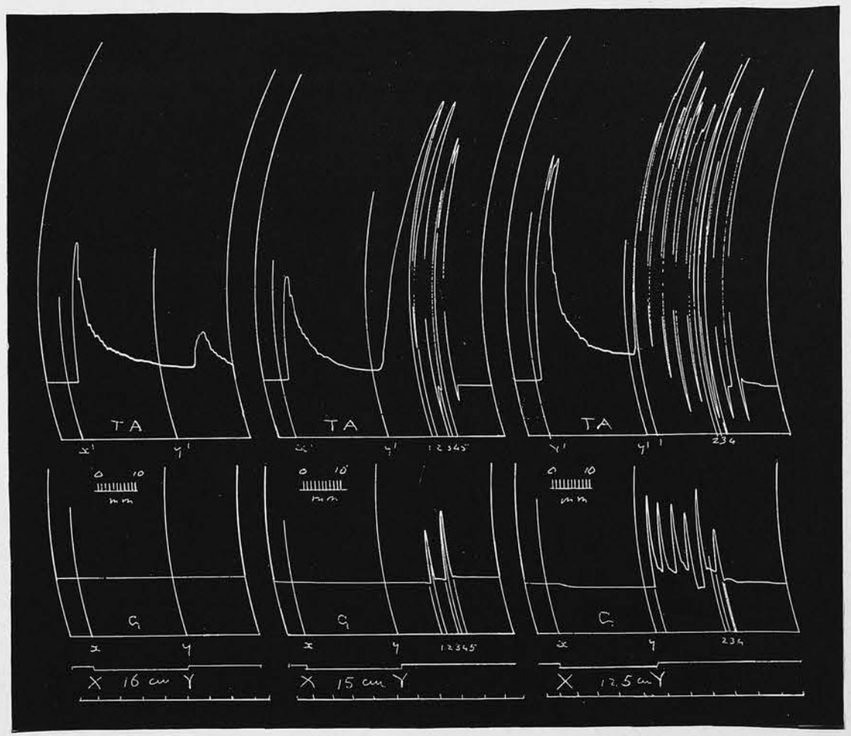


FIG. 54.

Cat, record 1998, 13:vi:11. Three simple ipsilateral reflex reactions of increasing strength of stimulus to show the genesis of a rhythmic flexor rebound. The figure is from the same experiment as figs. 51, 52, 53, 55. – Preparation decerebrate and partially de-afferented.

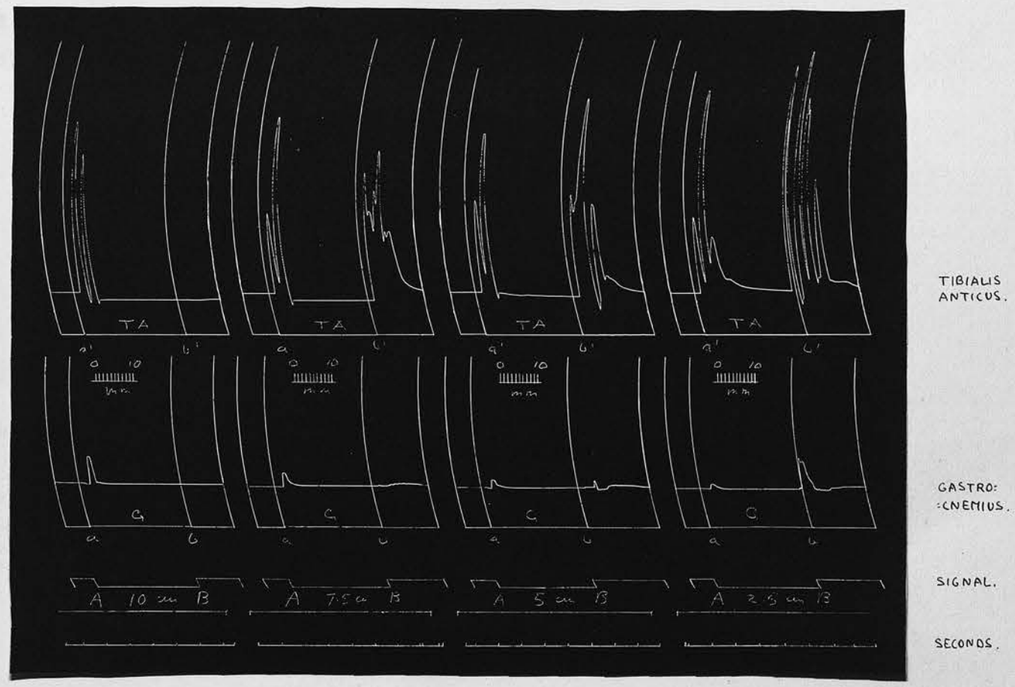


FIG. 55.

Cat, record 2012, 13:vi:11. From the same experiment. a series of contralateral reactions which show a rhythmic flexor reaction during stimulation and rhythmic flexor rebound after it – Preparation decerebrate and partially de-afferented.

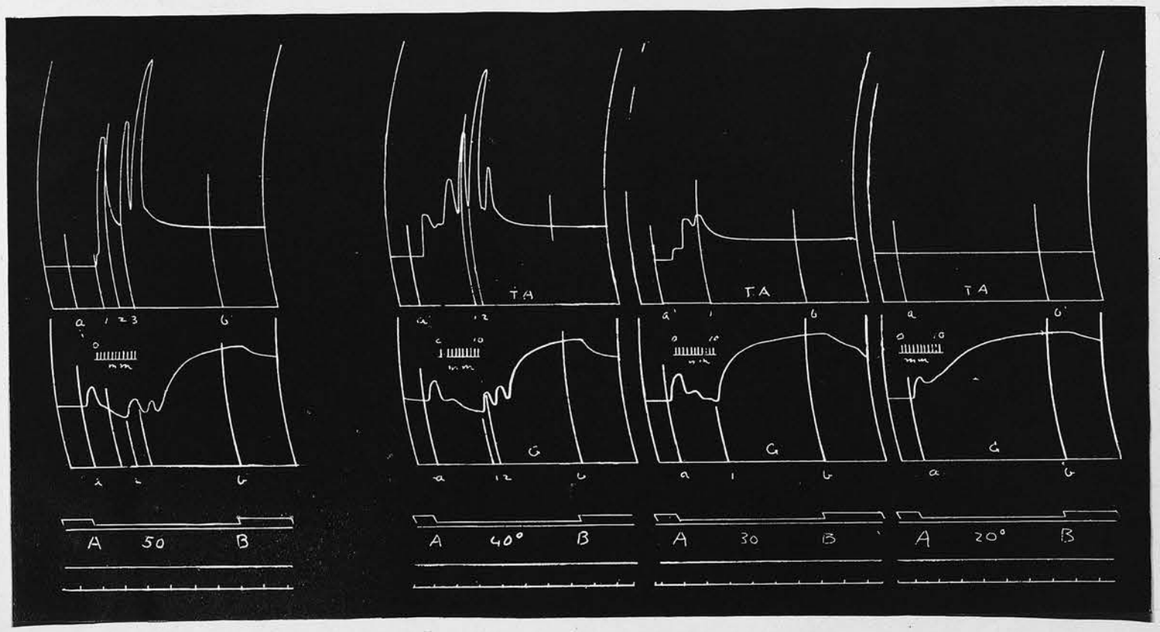


FIG. 56.

Cat, record 1075, 15:iii:11. a series of four simple con= =tralateral reflex reactions taken at minute intervals and with increasing strength of stimulus. a rhythmic flexor contraction complicates the three first reactions but dis= =appears completely with increased strength of stimulus. Compare with figs 57, 58, 59 – from the same experiment — decerebrate preparation.

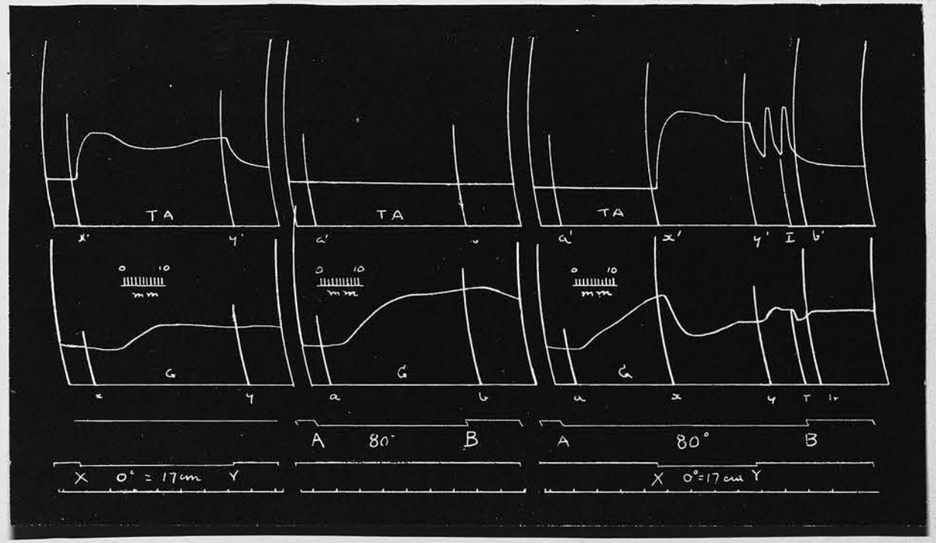


FIG. 57.

Cat, record 1099, 15:iii:11. a record demonstrating the genesis of a rhythmic reaction following a comp= =ounding of stimuli. The first reaction is a simple ipsilateral one but shews simultaneous contraction of both muscles. The second reaction is a simple contra= =lateral extension one. In the third the contralateral stimulus has been first applied and, during its application, compounded with the ipsilateral. This gives flexor contraction and extensor relaxation and, after cessation of the ipsilateral stimulus, a rhythmic flexor movement. This resembles a rhythmic rebound but was not present before – decerebrate preparation, compare with figs. 56, 58, 59 from the same experiment.

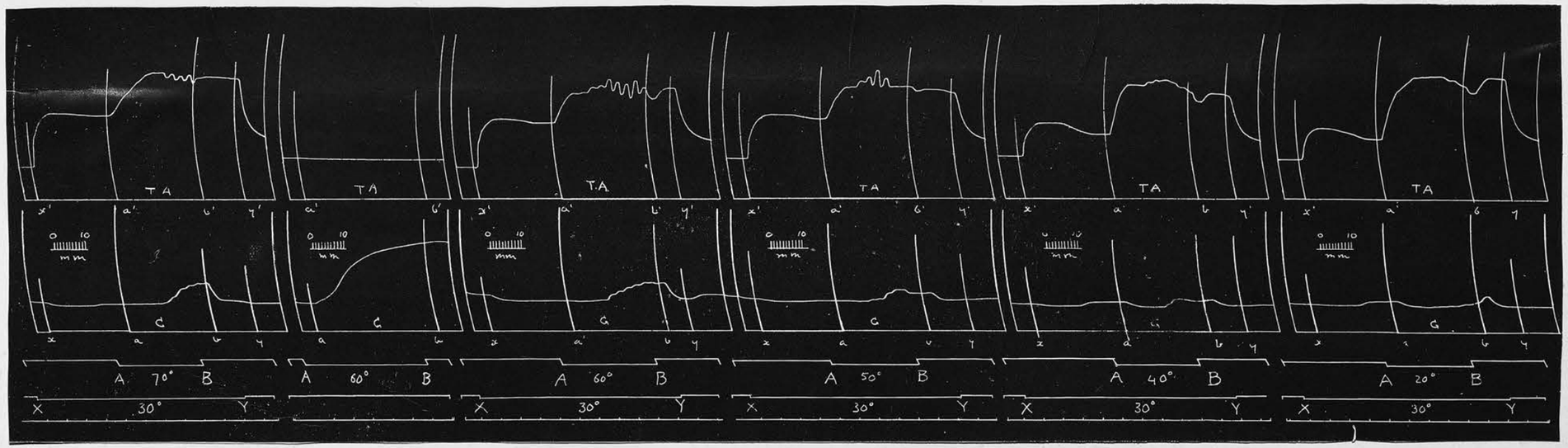


FIG. 59

Cat, record 1114, 15:iii:11. a series of compounded ipsilateral and contralateral stimuli taken at minute intervals. The second is a pure contralateral extension reflex and shows nothing but maintained extensor contraction. In the first, third, fourth, fifth, and sixth reactions an ipsilateral stimulus of constant strength is applied for about 10 seconds and during its application a contralateral stimulus of ever increasing strength is compounded with it for about 4 seconds. In the first reaction this causes an increase of the maintained flexor contraction and this is rhythmic. At the same time there is an extensor rhythmic contraction which has a long latency. In the 3rd. reaction these are more marked. In the fourth the extensor contraction is less. In the fifth there is little extensor contraction, but an increased additional flexion which is now arrhythmic. In the last reaction there is no gastrocnemius contraction and the additional flexor contraction is greater than before. This series shows a rhythmic phenomenon which occurs at a certain state of balance of antagonistic stimuli and is then abolished by the increase of the value of one of them — decerebrate preparation.

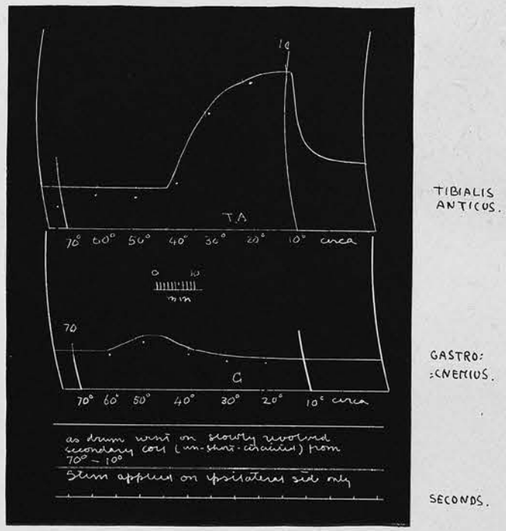
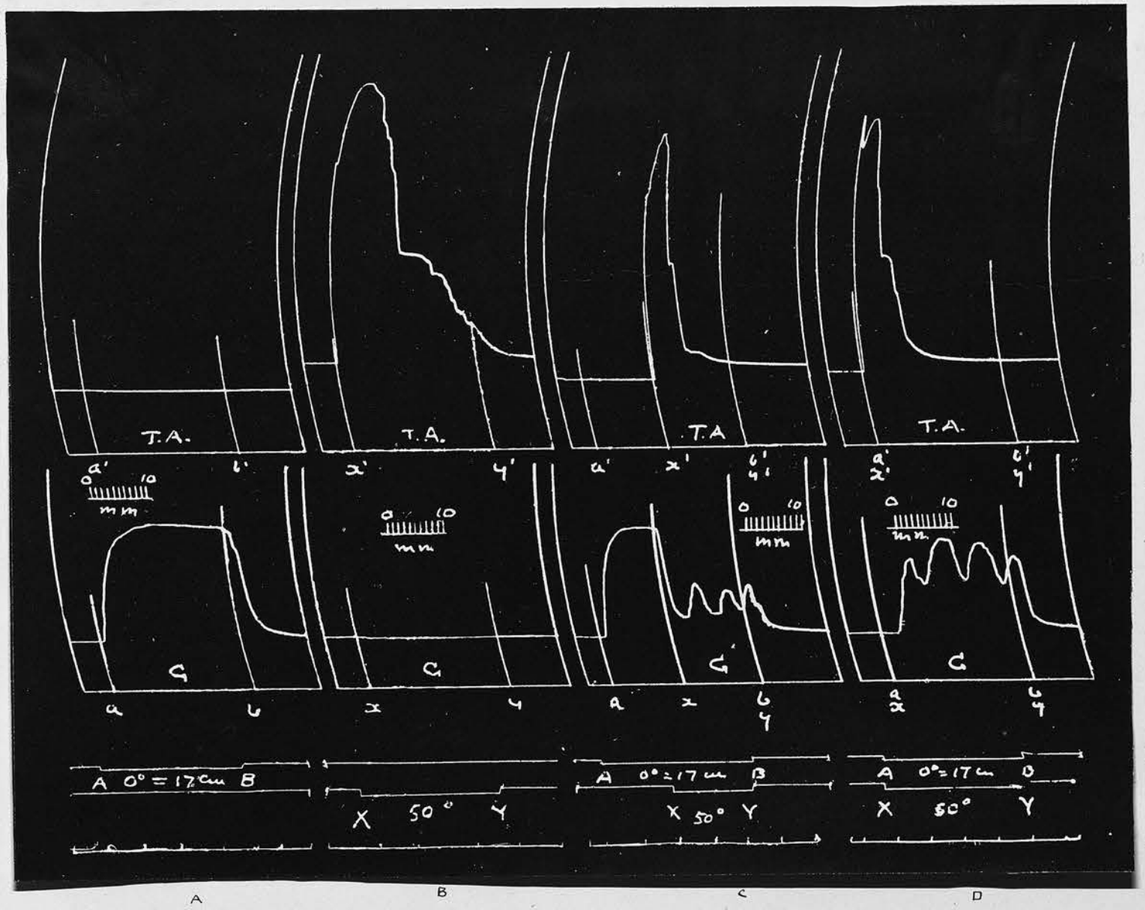


FIG. 58.

Cat, record 1110, 15:iii:11. a single record in which an ipsilateral stimulus was gradually increased in strength as the drum ran. The reaction is first one of extensor contraction and flexor contraction occurs later as the strength of stimulus is increased. This lends support to the view of the combination of excitatory effects in each centre in response to a simple stimulus — decerebrate preparation.



TIBIALIS ANTICUS.

GASTROCNEMIUS.

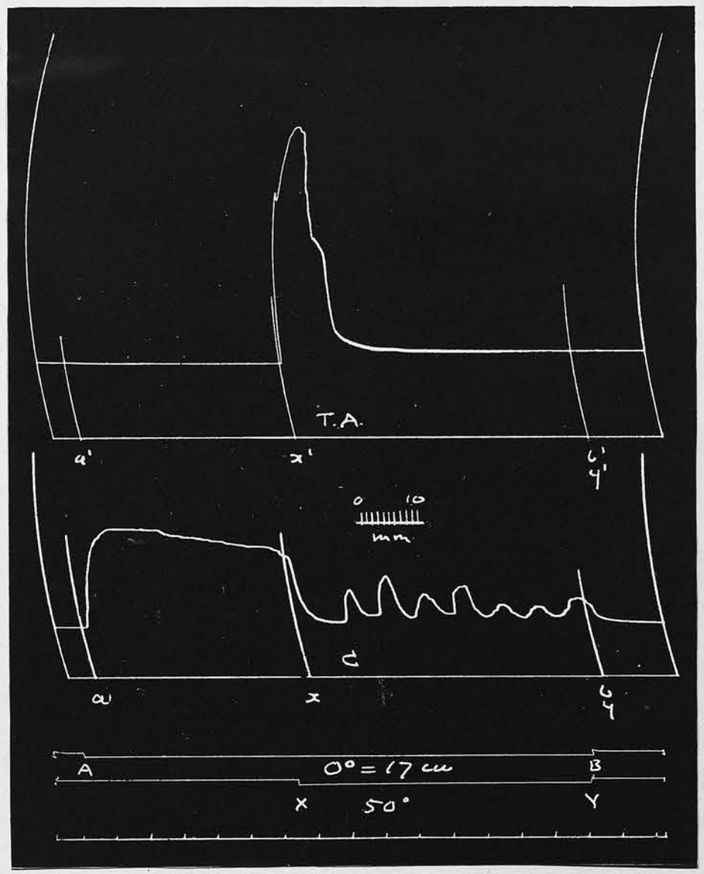
SIGNAL.

SIGNAL.

SECONDS.

FIG. 60.

Cat, record 1368, 31:iii:11. This and the following two figures from the same experiment. a series of four reflex reactions. The two first are simple contralateral extension (A) and ipsilateral flexion (B) reflexes respectively. The contraction phenomenon is confined in them to one of the recording muscles. In the third reaction (C) the contralateral extension reaction was evoked and the ipsilateral stimulus subsequently compounded with it. The extensor reaction then became rhythmic. In the fourth reaction (D) the two stimuli were applied synchronously. The latency of the extensor contraction was increased and it was rhythmic from the beginning — Decerebrate condition and low spinal preparation.



TIBIALIS ANTICUS.

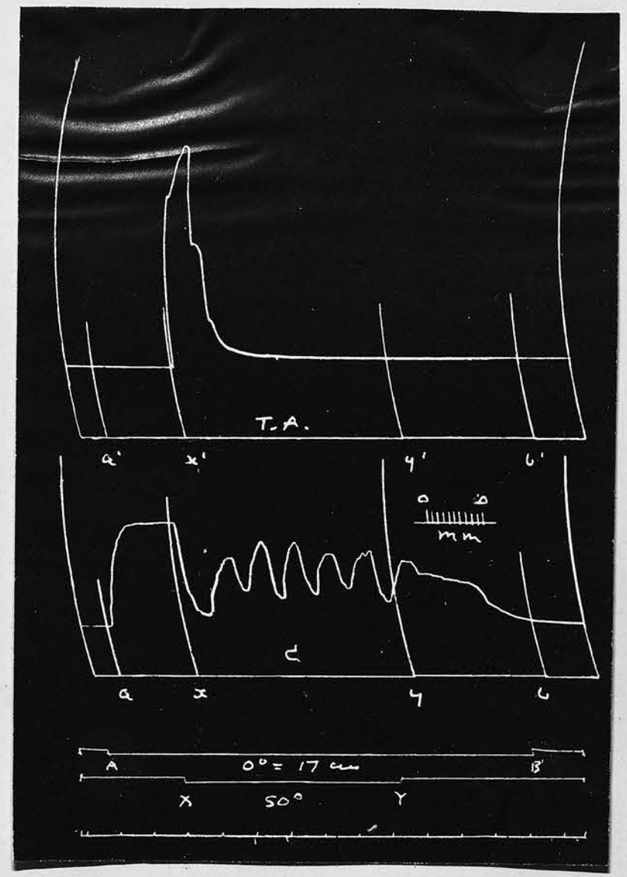
GASTROCNEMIUS.

SIGNAL.

SIGNAL.

Fig. 61.

Cat, record 1374, 31:iii:11. From the same experiment as fig. 60. Here the ipsilateral stimulus is applied after a longer duration of the uncomplicated contralateral stimulus and at once makes the reflex rhythmic — Low spinal preparation.



TIBIALIS ANTICUS.

GASTROCNEMIUS.

SIGNAL.

SIGNAL.

Fig. 62.

Cat, record 1377, 31:iii:11. From the same experiment as figs. 60, 61. Here the ipsilateral stimulus is applied in time after the commencement of the contralateral and taken off again while that still runs. The contralateral stimulus becomes of rhythmic effect during the compounding with it of the ipsilateral. This is seen in the rhythmic movement of the extensor muscle when both stimuli are in action; and it will be observed that the extensor reaction again becomes one of maintained contraction after the cessation of the ipsilateral stimulus and when the contralateral is again running alone — Low spinal preparation.