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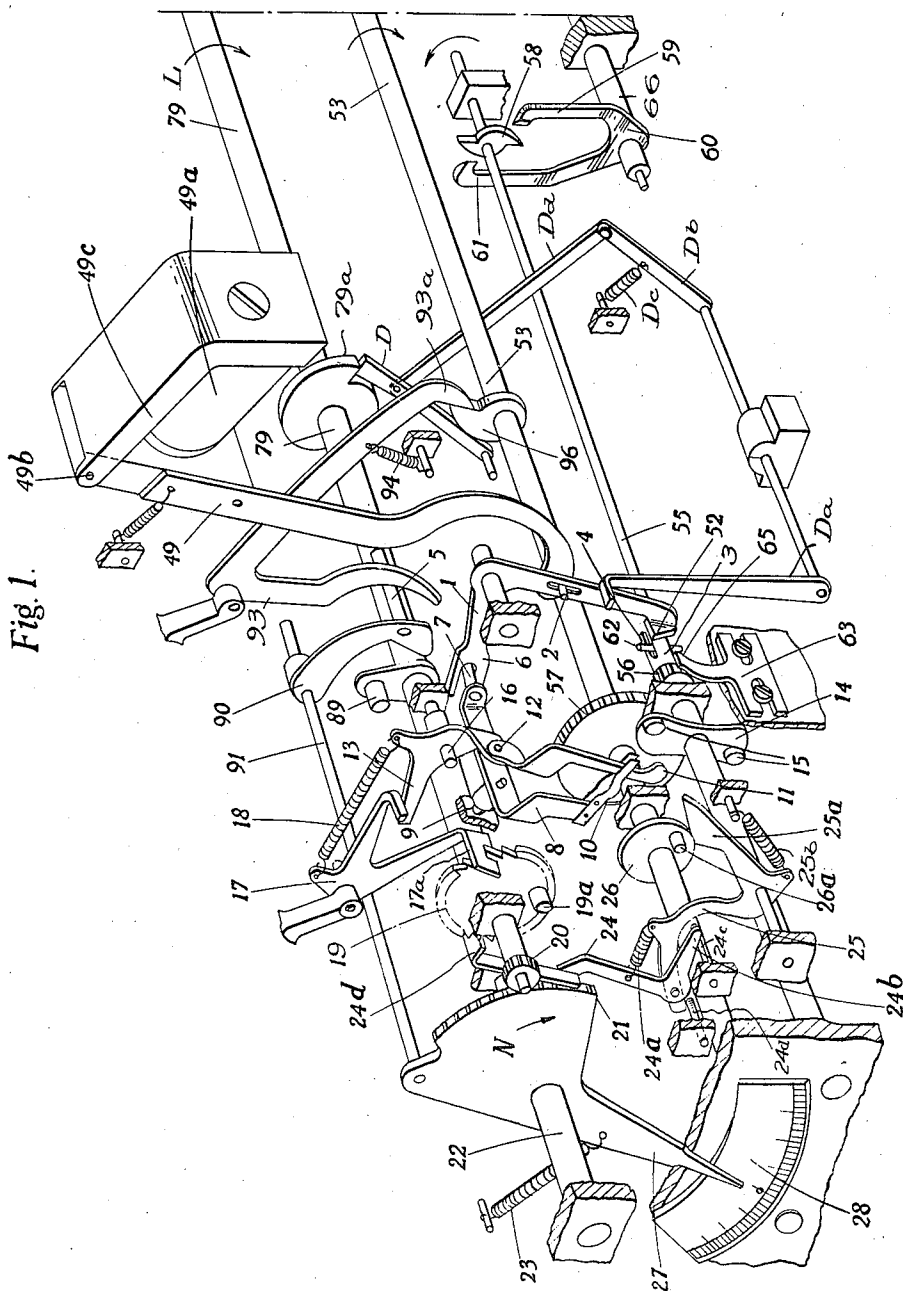
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2,217,864

START-STOP TELEGRAPH RECEIVING APPARATUS

Filed Nov. 29, 1937

4 Sheets-Sheet 1



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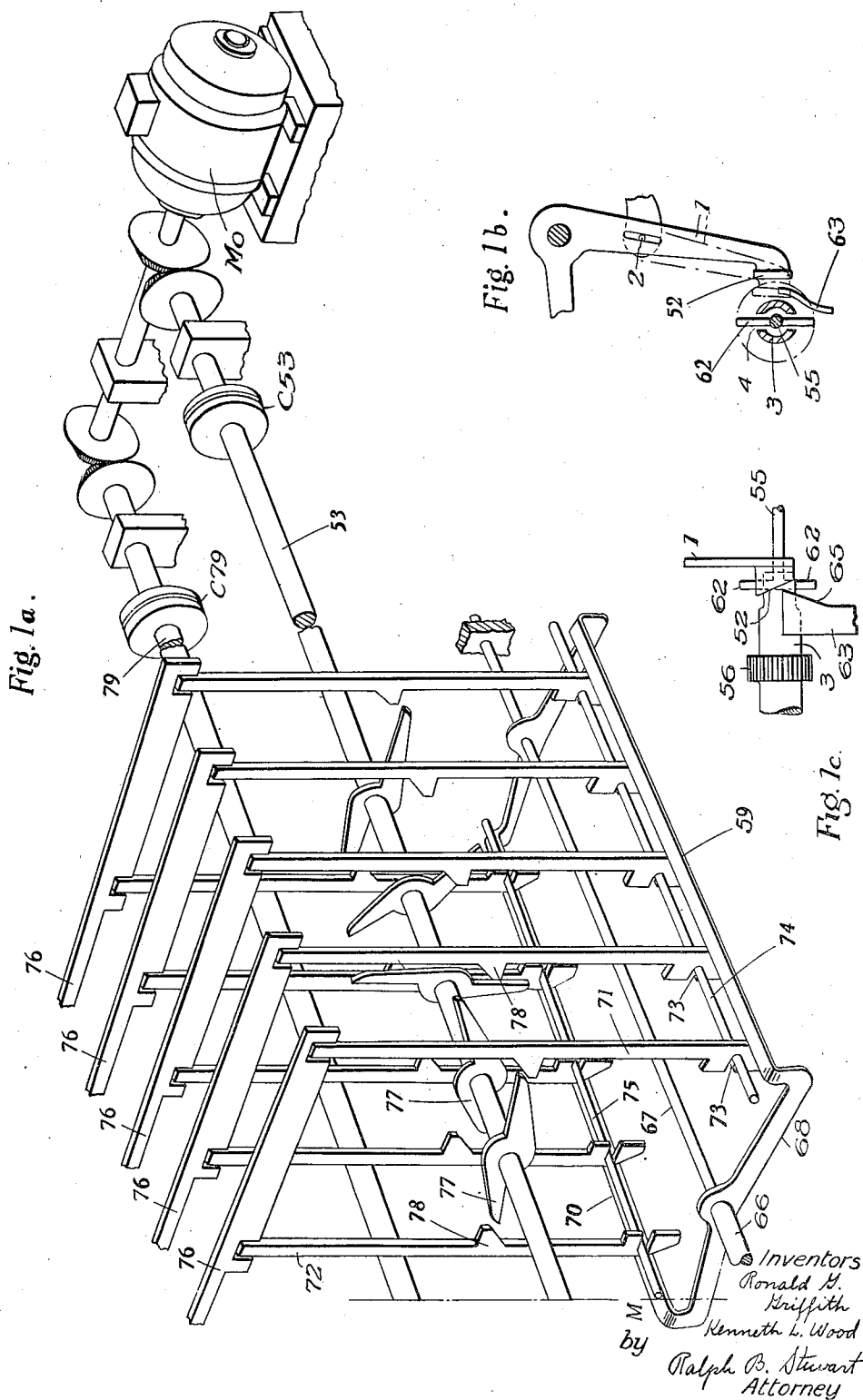
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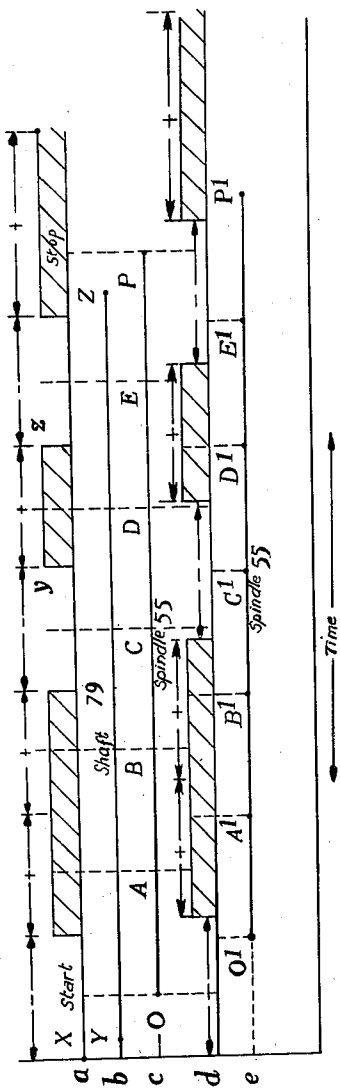


Fig. 2.

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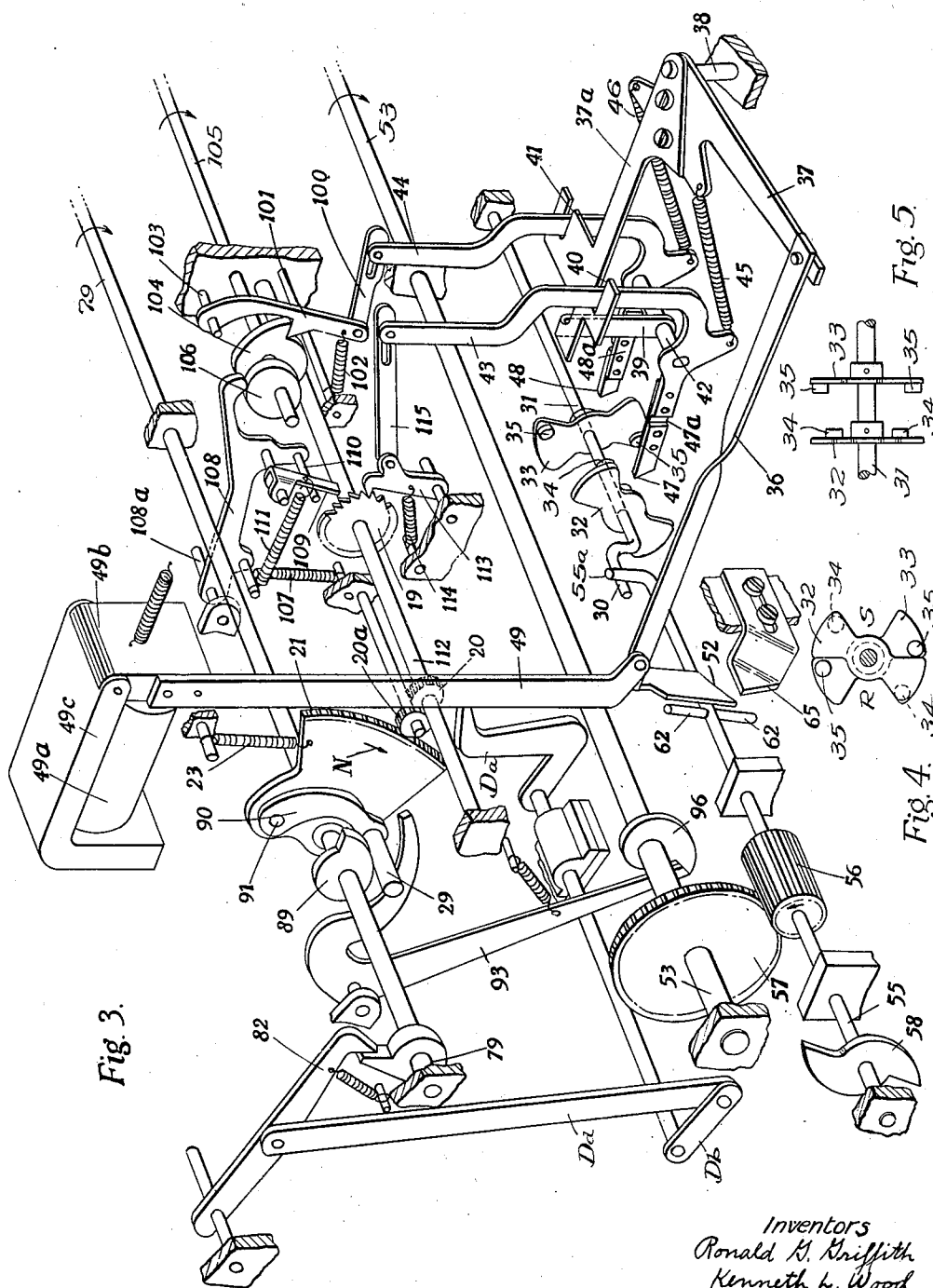
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START-STOP TELEGRAPH RECEIVING APPARATUS

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,217,864

START-STOP TELEGRAPH RECEIVING
APPARATUSRonald George Griffith and Kenneth Lindsay
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In Great Britain November 30, 1936

17 Claims. (Cl. 178—53.1)

This invention relates to devices for determining the phase relation between received signals and the receiving telegraph apparatus.

The invention aims at providing such a device, which may conveniently be of a mechanical nature, which will operate reliably in start-stop systems. The invention also aims at providing mechanism arranged automatically to adjust the phase of the receiving apparatus in respect of the received signals.

An object of the invention is to provide automatic phase correction of start-stop telegraph receiving apparatus whereby the apparatus may function properly even though the rate of received signal may vary. Specifically, the invention involves a time delay device actuated by the start impulse of the signal and operative after a predetermined time for starting the receiving apparatus, which is arranged to operate at normal speed, and the provision of a phase detecting device for controlling the time delay device to vary the time of starting of the receiving apparatus in response to changes in phase relation between the received signal and the operation of the receiver. In one form of the invention, the receiving apparatus operates to control the time delay device to advance the tripping of the receiver a predetermined amount for each cycle of operation and the phase detecting device is operative to retard the tripping of the receiver. In a second form of the invention, the phase detecting device includes two elements, one of which is responsive to an increase in the rate of received signal to advance the tripping of the receiver, while the other element is responsive to a decrease in the rate of received signal to retard the tripping of the receiver.

The invention further comprises the elements and combinations of parts set forth in the annexed claims.

In order that the invention may be clearly understood and readily carried into effect, two constructions in accordance therewith will now be described, by way of example, with reference to the accompanying drawings, in which:—

Figures 1 and 1a are perspective views illustrating different sections of a start-stop telegraph receiving apparatus, Figure 1 illustrating the releasing and phase correcting arrangement, while Figure 1a illustrates part of the selecting mechanism and the driving motor for the receiving apparatus;

Figure 1b is a fragmentary view, partly in section, illustrating the relation between certain cam elements in Figure 1;

Figure 1c is a side view of the lower part of Figure 1b;

Figure 2 is a diagram giving an indication of the manner in which the apparatus of Figure 1 functions;

Figure 3 is a perspective view showing a modified version of the apparatus in Figure 1; and Figures 4 and 5 are respectively front and side elevations of a detail of the apparatus shown in Figure 3.

Many of the parts shown in the accompanying drawings are equivalent to certain of the parts shown in Figure 3 in United States Patent No. 2,075,712, dated 30th March, 1937, and, where such equivalence exists, the same reference numerals are used in this specification as are used in the aforesaid figure.

The apparatus shown in Figures 1 and 1a is arranged to be operated under the control of start-stop signals each comprising five signal elements in addition to the start and stop elements. For each element an armature member 49 under the control of the receiving magnet 49a, lies in one of two positions. The armature member 49 is pivoted at 49b to a pole piece 49c of the receiving magnet. When the signal element is a marking element, a bell crank lever 1 is swung to a position (if it is not already in that position) such that a cam edge 52 is in the path of two diametrically-opposed setting pins 62, carried by a spindle 55, the armature member 49 being connected to the bell crank lever 1 through a pin and slot connection 2. For a spacing element, the bell crank lever 1 is swung (provided it is not already in the desired position) in an anti-clockwise direction (when viewed as in Figure 1) from the marking position to a position in which the cam edge 52 lies outside the circular path traversed by the tips of the setting pins 62. The spindle 55 is mounted so that it can be moved to and fro longitudinally in one direction by the engagement of the pins 62 with the cam edge 52 and in the opposite direction by engagement with a fixed cam edge 65. The rotary motion of the spindle 55 is derived from a sleeve 3 carrying a pinion 56 which meshes with a gear wheel 57 on a selecting cam shaft 53. The sleeve 3 is formed with slots 4 through which the pins 62 project, the engagement of the slots 4 with the pins 62 causing the spindle 55 to rotate with the sleeve 3 while permitting the spindle 55 to move longitudinally relatively to the sleeve 3 which does not undergo movement along its axis.

The selecting mechanism represented by the elements 68, 69, 70, 71, 72, 73, 75, 76, 77, and 78 in Figure 1a is conventional in construction and need not be described here, except to indicate that it corresponds to the construction disclosed in United States Patent No. 2,075,712. A constantly operating motor Mo is provided for driving the selecting cam shaft 53 through a suitable slip clutch C53, and the motor Mo also drives a starter shaft 79 through a slip clutch C79. Referring to Figure 1, the starter shaft 79 is held against rotation by means of a detent D

engaging an abutment on a cam 79a mounted upon shaft 79. Suitable mechanism is provided for releasing the detent D upon operation of the armature 49 in response to a start element. One example of such mechanism is illustrated in Figure 1 as comprising a pivoted lever Da having its free end abutting against the lower arm of lever I which is controlled by the armature 49. A second lever Db is mounted upon the same pivotal support as the lever Da and is operated by the lever Da against the action of a spring Dc, and lever Db releases the detent D through a link element Dd.

When a signal is received, the first element in that signal, which is the start element, causes the armature member 49 to act through the medium of the parts described above to release the detent D and thereby release a starter shaft 79, so that the latter is released for one revolution in the direction of the arrow L. A pin 89, carried by the starter shaft 79, thereby almost immediately engages an intermediate member 90, swinging the latter in an anti-clockwise direction about a spindle 91, so that a pin 5 on the intermediate member 90 pushes on a bell crank lever 93 and swings it in an anti-clockwise direction about its pivot against the action of a spring 94. Thus, a down-turned end 93a of the bell crank lever 93 is raised from engagement with a stop 96 and the selecting cam shaft 53 is permitted to rotate through one revolution until the radial stop 96 again engages the down-turned end 93a of the bell crank lever 93 which is lowered by the spring 94 immediately the pin 89 has moved past the intermediate member 90. The gear ratio between the pinion 56 and the gear wheel 57 is such that, during this revolution, that is to say, during the receipt of the complete signal consisting of the start element, the five signal elements and the stop element, the sleeve 3 and spindle 55 make three complete revolutions in the direction of the arrow M.

The spindle 55 carries a cam member 58 which moves to and fro integrally with the spindle 55 in accordance with the nature of the signal elements and coacts with setting mechanism such as that shown in the aforementioned United States Patent No. 2,075,712 for setting up a permutation, corresponding to the signal received, on five permutation members, equivalent to the members 76 in the said prior patent.

The setting and selecting mechanism is illustrated partly in Figure 1 by the elements 58, 59, 60, 61 and 66, and partly in Figure 1a by the elements 66, 68, 69 and 70 to 73, respectively, the elements being numbered with the same reference numerals employed in the patent.

The nature of a perfectly formed received signal is shown by the line a in Figure 2. The start element is a negative or spacing element. The next five elements are ++--+-, which permutation is peculiar to the signal in question, and the last element, which is one-and-a-half times the length of the other elements, is the positive or marking, stop element. Now, if the signal elements are being transmitted so that each occupies a period of time which is correct in relation to the setting of the receiving mechanism, the start shaft 79 will be released at the point Y (Figure 2) which is very slightly later than the point X, which represents the instant at which the beginning of the start impulse at the receiver occurs, and the pins 62 on the spindle 55 move into position to coact with the cam edge 52 at the points A, B, C, D and E which represent instants occurring substantially in the

middle of each signal element. From the foregoing it will be appreciated that the horizontal line b in Figure 2 represents one complete revolution of the start shaft 79, while the horizontal line c in Figure 2 represents three revolutions of the spindle 55 and sleeve 3. The point Z in line b represents the point at which the start shaft 79 completes its revolution, while the points O and P represent the instants at which the sleeve 3 and spindle 55 start and finish their three revolutions corresponding to the signal.

Owing to the fact that the form of the received signal elements is not in practice such that they can usually be represented in the rectangular fashion shown by the line a in Figure 2, but is liable to be considerably distorted, it is very important that the points A, B, C, D and E should occur at instants which are located as closely as possible at the centres respectively of the consecutive signal element periods as it is the centre parts of the signal elements that suffer least from distortion. Otherwise misselection would occur due to the cam edge 52 not being positioned correctly at the instant of selection when one of the pins 62 arrives in position to coact with the cam edge for the purpose of positioning the cam member 53 in accordance with the corresponding signal element. Signals are likely to suffer from a number of distortions such as bias distortion, characteristic distortion, fortuitous distortion and speed distortion. Considering the question of speed distortion, and supposing there exists a speed difference between the speed of the transmitting motor and that of the receiving motor, and supposing the transmitting mechanism is running slow, the signals, instead of being represented by a line such as the line a in Figure 2, take a form such as that represented by the line d in Figure 2, each signal element being too long. In this case, if the sleeve 3 and spindle 55 started to rotate at the point O, line c, the instants D and E in the rotation of the sleeve 3 and spindle 55 would occur very near the ends of the signal elements represented by the line d, as can be seen in Figure 2. It is necessary, in such a case as this, if the elements are to be selected correctly, for the instant O, at which the sleeve 3 and spindle 55 start to rotate, to occur further from the instant X at which the start element arrives at the receiving mechanism. The period by which the start of the sleeve 3 and spindle 55 lags behind the start of the starter shaft 79, must be increased, and the present invention provides mechanism by which the phase relationship between the shaft 79 and the sleeve 3 can be varied automatically in accordance with the changes in the lengths of the signal elements received.

The bell crank lever I, which is swung in a plane at right angles to the axis of the spindle 55 each time a signal element of one kind follows a signal element of a different kind, is formed at one end with a fork 6 which engages a pin 7 on a lever 8, pivoted about an axis 9 at right angles to the axis of the bell crank lever I. The lever 8 carries a pair of leaf springs 10 which hold between them a feeler or tongue member 11, the lower end of which always lies in a plane substantially at right angles to the axis of the shaft 53. The tongue member 11 is pivotally mounted at its upper end about an axis 12, parallel to the axis 9, upon a lever member 13. Now, supposing the bell crank lever I is in the spacing position and is then swung inwards towards the spindle 55 to the marking position,

not affected by these blades. On the other hand, if the rotation of the spindle 55 is in advance of the movement of these extensions 47 and 48, the extension 48 of the bell crank lever 44 will abut against the left hand face of the blade 33 so that further movement of the extension 48 is prevented and the spring 43a yields, and soon afterwards one of the cams 35 on the blade 33 will act on the extension 48 of the bell crank lever 44 and swing the latter against the action of the spring 46 about the axis of the pin 42. When this happens, the upper end of the bell crank lever pulls on a link 100 and swings a detent 101 about an axis 103 against the action of a spring 102. The detent 101 is thereby moved out of engagement with a stop member 104 on a shaft 105. The latter is yieldingly driven through a slipping clutch arrangement by the motor of the receiving apparatus. As soon, therefore, as the shaft 105 is released, it makes one revolution. At the end of this revolution the shaft 105 is again stopped by the engagement of the stop member 104 with the detent 101 which, by that time, has returned to its initial position because the cam 35 on the blade 33 has moved past the extension 48 of the bell crank lever 44. During the single revolution of the shaft 105, a cam 106 on that shaft allows a spring 107 to swing a lever 108 downwards about its pivot 108a, the lever 108 being against raised to its initial position by the cam 106 towards the end of the revolution of the shaft 105. In the downward movement of the lever 108, a pawl 109, pivoted to the lever 108, and normally held against a stop 110 on the lever 108 by a spring 111, engages a ratchet wheel 19 on a shaft 112 carrying a pinion 20. The latter is thus stepped round through a small angle. The pinion 20 meshes with a further pinion 20a, which, in turn, meshes with a gear segment 21 so that the latter is turned through a small angle in the direction of the arrow N against the action of a spring 23. When the pawl 109 is raised again from engagement with the ratchet wheel 19, the latter is prevented from returning to its initial position, under the action of the spring 23, by a detent 113, which is held against the ratchet wheel by a spring 114. This movement of the gear segment 21 in the direction of the arrow N results in the pivotal axis 91 of the intermediate member 90 being moved to a position such that, when the starter shaft 79 is released by the action of the start element in the next signal, the cam 89 acts through the pin 29 on the bell crank lever 93 later after the commencement of the start element than was the case with the previous signal. The movements of the spindle 55 are, therefore, brought more closely into phase with the incoming signal than was previously the case.

If, after the extensions 47 and 48 of the bell crank levers 43 and 44 have been moved across the planes of the blades 32 and 33 by a marking movement of the armature member 49, a spacing element arrives at the receiving apparatus, the armature member 49 will move so as to cause the extensions 47 and 48 to move back across the planes of the blades 32 and 33 from the right hand sides to the left hand sides of these blades, as viewed in Figures 3 and 5. If, during this movement the phase relationship between the received signals and the selecting interval is correct, the extensions 47 and 48 of the bell crank levers 43 and 44 will move through one of the gaps R and S (Figure 4) without hindrance. If, however, the movement of the bell crank levers 43 and 44 is late in relation to the movement of the spindle 55,

the extension 47 of the bell crank lever 43 will bear against the right hand face of the blade 32, so that the movement of the extension 47 is temporarily held up and one of the cams 34 on the blade 32, by acting on this extension 47, will swing the latter against the action of the spring 45 about the axis of the pin 42. The upper end of the bell crank lever 43 then, by acting through a link 115, pulls the detent 113 against the action of the spring 114, away from the ratchet wheel 19. This permits the spring 23 to pull the gear segment 21 through a small angle in a direction opposite to that of the arrow N. The effect of this is to alter the phase relationship between the movement of the start shaft 79 and the movement of the spindle 55 in such a way that for the next signal the spindle 55 is started somewhat earlier in relation to the start shaft 79. The cam 58 of Figure 3 operates a selector mechanism in the same manner as cam 58 in Figures 1 and 1a, and reference may be had to Figures 1 and 1a, or to Figure 3 of U. S. Patent No. 2,075,712 for the details of this mechanism.

The selecting means including the spindle 55 in the constructions described above, is, as previously mentioned, adapted to set up permutations in accordance with the received signals upon permutation members. The latter may be operative to control re-transmitting apparatus, mechanism for perforating tape, or printing apparatus.

We claim:

1. In start-stop telegraph receiving apparatus, the combination of a start-stop receiver including a releasable detent for stopping said receiver after each cycle of operation, a time delay device for releasing said detent in response to the start impulse in each signal combination, means for detecting abnormal phase difference between the operation of said receiver and the incoming signals, and means operated by said phase detecting means for controlling said time delay device to vary the time of release of said detent following receipt of the next start impulse.

2. Telegraph receiving apparatus according to claim 1 and including means responsive to each cycle of operation of said receiver for controlling said time delay device to advance the releasing of said detent, and said phase detecting means being operative to delay the release of said detent.

3. Telegraph receiving apparatus according to claim 1 wherein the start-stop receiver operates at the normal transmitting speed, and the phase detecting means embodies means responsive to an increase in the rate of received signals above the normal rate for controlling the time delay device to advance the releasing of said detent and a second means responsive to a decrease in the rate of received signals below the normal rate for controlling the time delay device to retard the release of said detent.

4. In start-stop telegraph receiving apparatus, a starter member arranged to be released at the beginning of each signal received and to undergo a constant amount of movement during that signal, selecting means adapted to undergo cyclic movements at a rate corresponding to the rate at which signals are received, mechanism operatively connecting said starter member and said selecting means for initiating each cycle of movement of said selecting means soon after the initiation of each movement of said starter member, a movably-mounted member responsive to incoming signals, means responsive to changes in the phase relationship between the movement of said movably-mounted member and said cyclic

movements of said selecting means, and further mechanism under the control of said last-mentioned means for controlling the aforesaid connecting mechanism to adjust the time intervening between the start of said starter member and the start of the corresponding cycle of movement of said selecting means.

5. In start-stop telegraph receiving apparatus, in combination, a blade member adapted to rotate a plurality of times during the receipt of each signal, a movably-mounted member responsive to incoming signals, a feeler member, a yielding connection, between said feeler member and said movably-mounted member, organised so that said movably-mounted member moves said feeler member across the plane of rotation of said blade member upon the receipt of consecutive signal elements of different kinds, cam means on one face of said blade adapted, in the event of said feeler member abutting against that face when moved as aforesaid, to impart a further component of movement to said feeler member, whereby said feeler member is rendered responsive to an advance in the timing of the rotation of said blade member relatively to received signals.

6. In start-stop telegraph receiving apparatus, in combination, a starter shaft adapted to be released upon receipt of the start element in each signal, a selecting member adapted to rotate through a predetermined angle during the receipt of each signal under the control of said starter shaft, control mechanism interposed between said starter shaft and said selecting member organised to vary the time interval between the release of said starter shaft and the initiation of said rotation, and means, responsive to changes in the duration of received signals, in operative relation with said control mechanism to vary said time interval.

7. In start-stop telegraph receiving apparatus, a movably-mounted member responsive to received signals, a pair of feeler members mounted for to-and-fro motion in timed relationship with said movably-mounted member, a member adapted to rotate about an axis through a predetermined angle during the receipt of each signal and formed with radial stop surfaces located so as to impede the motion of one of said feeler members when moving in one direction and to impede the motion of the other of said feeler members when moving in the other direction in the event of the phase relationship between the motion of said rotatable member and the to-and-fro motion of said feeler members having certain predetermined values but to permit said feeler members to move to-and-fro freely in the event of said phase relationship having certain other predetermined values, said rotatable member being formed also with cam projections on said stop surfaces arranged to impart movements selectively to said feeler members transverse to their to-and-fro motion in the event of the movements of said feeler members being impeded as aforesaid, and means responsive to said transverse movements of said feeler members for adjusting said phase relationship.

8. In start-stop telegraph receiving apparatus, a starter member arranged to be released at the beginning of each signal received and to undergo a constant amount of movement during that signal, selecting means adapted to undergo cyclic movements at a rate corresponding to the rate at which signals are received, mechanism operatively connecting said starter member and said

selecting means for initiating each cycle of movement of said selecting means soon after the initiation of each movement of said starter member, a movably-mounted member responsive to incoming signals, a controlled member mounted for to-and-fro motion, mechanism operatively connecting said selecting means and said controlled member and adapted to move the latter through a predetermined distance in one direction for each signal received, means responsive to changes in the relationship between the instants of selection and the times of duration of successive received signal elements, said last-mentioned means being operative, upon responding to said changes, to move said controlled member in the other direction, and further mechanism under the control of said controlled member for influencing said first-mentioned connecting mechanism to adjust the time intervening between the start of said starter member and the start of the corresponding cycle of movement of said selecting means.

9. In start-stop telegraph receiving apparatus, in combination, a movably-mounted member responsive to receive signals, a feeler member mounted for to-and-fro movement in two intersecting paths, a driving connection, including a yielding member, enabling said first mentioned member to impart to-and-fro movement to said feeler member along the first of said paths, a rotor member adapted to undergo a predetermined quantum of angular movement during the receipt of each signal and formed and located periodically to intersect the first of said paths during said angular movement, said rotor member being arranged to impart movement to said feeler member in the second of said paths in the event of the relationship between the movements of said feeler member and said rotor member causing these two last-mentioned members to contact, and mechanism responsive to movements of said feeler member in said second path.

10. In start-stop telegraph receiving apparatus, in combination, a starter member adapted to be released upon receipt of the start element in each signal, a selecting member adapted to rotate through a predetermined angle during the receipt of each signal, control mechanism adapted to release and arrest said selecting member under the control of said starter member, an armature member responsive to received signals, a feeler member mounted for to-and-fro movement in two intersecting paths, a driving connection, including a yielding member, enabling said armature member to impart to said feeler member to-and-fro movement in the first of said paths, a rotor member organised to rotate in timed relationship with said selecting member and arranged during its rotation periodically to intersect the first of said paths, said rotor member being also arranged to impart movement to said feeler member in the second of said paths in the event of the phase relationship between the movements of said feeler member and said rotor member causing these two last-mentioned members to contact, and mechanism in operative relation with said control mechanism and with said feeler member for varying the time interval between the release of said starter member and the release of said selecting member in response to movements of said feeler member in said second path.

11. In start-stop telegraph receiving apparatus, in combination, a movably-mounted member mounted for to-and-fro motion in accordance with received signals, a pair of feeler members each mounted for to-and-fro movement in one

the lever 8 will simultaneously be swung in a direction such that the leaf springs 10 swing the tongue member 11 about the axis 12. The result of this is that the tip of the tongue member 11 passes across the plane containing a rotor member in the form of a flat two-armed blade 14, fixed to the sleeve 3. If the signals have elements which are substantially of the predetermined length indicated by the line *a* in Figure 2, the tongue member 11 will generally be swung across the plane containing the blade 14 at instants when the blade 14 is in a position such as that shown in Figure 1, so that the tongue member 11 does not contact with the blade 14. If, however, the signal elements are too long, having the form indicated by the line *d* in Figure 2, the blade 14 will reach a position such that it will impede the movement of the tongue member 11, the latter being held up by engagement with the left-hand face of the blade 14, while the lever 8 moves further and one of the leaf springs 10 yields. Thereupon, one of two small cams 15 on the face of the blade 14 will engage the tip of the tongue member 11 and swing it, together with the lever 13, about the axis 16 of the latter in a plane at right angles to the axis of the sleeve 3. This movement of the lever 13 results in one end thereof, with which one end of a bell crank lever 17 is held in engagement by a spring 18, swinging the bell crank lever 17 in an anti-clockwise direction so that a detent end 17a thereof releases a ratchet wheel 19. The ratchet wheel 19 is fixed coaxially to a pinion 20 meshing with a gear segment 21, which is mounted to swing about an axis 22, coaxial with the axis of the start shaft 79. The gear segment 21 is loaded by a spring 23, so that, when the ratchet wheel 19 is released, the gear segment 21 is swung through a small angle in the direction of the arrow N. The angle through which the gear segment 21 moves is quite small because very soon after the ratchet wheel 19 has been released, it is again engaged by the detent end 17a of the bell crank lever 17, which is returned to its initial position by the spring 18 as soon as the sleeve 3 has moved far enough for the blade 14 to move out of engagement with the tongue member 11.

The extent to which the gear segment 21 is moved in the direction of the arrow N, in any one complete signal, depends upon the number of transits from the spacing to the marking position of the bell crank lever 1 that occur in that signal, assuming that the signal elements are of such a nature as to cause the coaction between the blade member 14 and the tongue member 11. The movement of the segment 21 in the direction of the arrow N causes the spindle 91 of the intermediate member 90 to be moved to a position such that the pin 89 on the starter shaft 79 will act on the intermediate member 90, and therefore trip the shaft 53 and start spindle 55 later after the commencement of the start element in the next signal than was the case for the previous signal. The result of this is that the instant O (Figure 2) is moved from the position shown in line *c* towards the position O' shown in line *e*, the latter position being reached after the receipt of several signals should the speed difference be such as that illustrated. When the phase of the spindle 55 is thus shifted, the points A, B, C, D and E take up the positions A', B', C', D' and E' in line *e*, being brought closer to the mid-points in the signal elements represented by the line *d*, and provid-

ing maximum margin under these conditions for the other distortions previously mentioned.

It will be appreciated that in the event of signals, having signal elements shorter than those represented by the line *d*, arriving after the elements which are too long, i. e., as shown by line *d* (Figure 2), the gear segment 21 will have to be moved in a direction opposite to that of the arrow N. Mechanism is, therefore, provided for periodically moving the gear segment 21 in a direction opposite to the arrow N. This mechanism includes a pawl member 24 pivoted to a two-armed lever 25, one arm 25a of which lies in the path of a pin 26a on a disc 26, on the selecting cam shaft 53. For each revolution of the selecting cam shaft 53, the pin 26a acts on the lever 25 so as to lift the pawl member 24. As the latter is lifted, an extension 24d thereof is swung into engagement with the ratchet teeth by a spring 24a and during this movement, a tail 24b of the pawl continues to engage a fixed stop 24c. As the pawl member 24 is further lifted, the extension 24d steps the ratchet wheel 19 round through a small angle in a clockwise direction so as to move the gear segment 21 in a direction opposite to the arrow N. In this further upward movement of the pawl member 24, the tail 24b is lifted clear of the fixed stop 24c. The position of the intermediate member 90, and accordingly the time at which the shaft 53, sleeve 3, and spindle 55 are tripped relatively to the time at which the starter shaft 79 is tripped, depends upon the balance between the movements of the pawl 24 and of the bell crank lever 17, the pawl 24 being arranged to act uniformly throughout the operation, i. e., once for each signal, and the bell crank 17 being arranged to act in accordance with the relationship between the timing of the sleeve 3 and the periods occupied by the consecutive signal elements. The lever 25 is normally urged in an anti-clockwise direction by spring 25b so that the end of the lever 25 will normally rest against the fixed stop 24d.

The operation of the apparatus may be made clearer by considering the behaviour of the parts just at the instant when the spindle 55 is set in accordance with the fourth code element *y-z* in the signal represented by the line *a* (Figure 2). The cam edge 52 will already have been swung inwards when half this signal element has been received, i. e., at the instant D in Figure 2. When this condition obtains, the blade 14 does not interfere with the tongue member 11. Further, there is no interference between these two members when the position of the spindle 55 is selected in accordance with any of the other elements in the signal. The result is that the ratchet wheel 19 is affected only by the extension 24d of the pawl member 24 and the gear segment is stepped round only in the direction opposite to that of the arrow N, so that the instant O at which the spindle 55 is released for the next signal is caused to move slightly closer to the instant Y (Figure 2) at which the shaft 79 is released for that signal. The result is that the spindle 55 is released earlier in relation to the release of the shaft 79, so that the instants A, B, C, D and E at which the spindle 55 is positioned in accordance with the signal elements are moved slightly from the centres of the signal elements, towards the left in Figure 2. Accordingly, a point is reached at which the blade 14 and the tongue member 11 interfere with each other so that the ratchet wheel 19 and the gear segment 21 are acted upon in a manner such as to cause the point O to move back to the position

shown by the line *c* in Figure 2. It will be seen, therefore, that during the receipt of signal elements of a length which may be regarded as the standard length for the receiving mechanism in question, the phase relationship between the spindle 55 and the shaft 79 fluctuates slightly. When, due to a speed difference between the receiving and transmitting mechanism, the length of the signal elements becomes abnormal, that is to say, when the signal elements are too long, as shown by the line *d* in Figure 2, or are too short, similar fluctuations, of course, still occur, but the balance of movements of the segment 21 is such that the phase relationship between the shaft 79 and spindle 55 is changed.

In order that the phase relationship between the received signal elements and the selecting interval may be visible, the gear segment 21 is formed with a pointer 27 that moves over a scale 28 of a length corresponding to that of a standard signal element. The position of the pointer gives an indication of the instant in each signal element at which the spindle 55 is set in accordance with that element. It will be understood that the setting of the spindle 55 may consist simply in leaving it in the axial position in which it is already located, as will happen when the signal element in question is a spacing element, or it may consist in moving the spindle 55 to the other of its two alternative axial positions.

In the construction described, it is necessary to prevent unlimited movement of the ratchet wheel 19 in either direction which might take place if the speed difference between the transmitting and receiving motors exceeded practical limits. Accordingly, a stop pin 19a is fixed to the ratchet wheel 19 and is so located that it cannot rotate past the detent end 17a of the bell crank lever 17 in an anti-clockwise direction. Further, a gap is provided in the ratchet teeth to limit the amount of clockwise movement that can be imparted to the ratchet wheel 19 by the extension 24d of the pawl member 24.

The bell crank lever 17 may be arranged to close contacts which cause a bell to be rung or other alarm to be actuated when the received signal elements and the selecting interval become out of phase to a predetermined extent. In fact, the invention includes apparatus as shown in Figure 1 but without the ratchet wheel 19 and associated mechanism for controlling the phase relationship between the shaft 79 and the spindle 55, and including only mechanism, such as the aforesaid bell or other alarm arrangement, for giving a warning signal.

Referring to the apparatus shown in Figure 3, it will be seen that this also includes a spindle 55 which can be moved longitudinally in accordance with received signals. The mechanism also includes a starter shaft 79 which is released for one revolution when the start impulse in a received signal results in the lifting of a detent 82. The detent 82 may be released by the armature 49 through a mechanism similar to that employed in Figure 1 and represented by the pivoted lever Da having its free end bearing against the armature 49 and arranged to operate the lever Db, which in turn releases the detent 82 through the link Dd. Soon afterwards, a cam 89 on the shaft 79, by acting on a pin 29 on an intermediate member 90, pivoted about an axis 91, releases a bell crank lever 93 from a stop 96 on a selecting cam shaft 53. It will be seen that the cam 89 by camming on the pin 29, causes the latter, by cam action, to swing the detent 93 about its pivotal

axis. It will be understood that selecting cam shaft 53 and the starter shaft 79 are driven from a suitable source of power through the usual slip clutches in the same manner as shown in Figure 1a. Also, as in the previous construction, the gearing 56, 57 between the shaft 53 and the spindle 55 is such that the latter makes three complete revolutions for each signal received. Moreover, the spindle 55 carries a pair of diametrically-opposed setting pins 62 which cooperate with a cam edge 52 which is moved by the armature member 49 into or out of the path of the tips of the pins 62. The armature member 49 is operated by a signal receiving magnet precisely similar to the magnet 49a, 49c of Fig. 1. When a marking element is received, the cam edge 52 is in a position such that one of the pins 62 engages it, with the result that the spindle 55 is moved to the right by cam edge 52. Upon the continued rotation of the spindle 55 it is moved back to the left by the engagement of the other pin 62 with a fixed cam edge 65. If the next signal element is a marking element, the spindle 55 will be moved back to the right, otherwise it will remain in its left hand position. In this construction the spindle 55 is bent over at one end 55a so that it engages a crank portion 30 on a further spindle 31, the bearings, not shown, of the latter, being such that it is prevented from moving longitudinally while it rotates with the spindle 55. A pair of rotor members in the form of thin blades 32 and 33 are fixed to the spindle 31 and their relative positions are as shown in Figures 4 and 5. The blade 32 carries a pair of diametrically opposed cams 34 while the blade 33 carries a pair of diametrically opposed cams 35.

The armature member 49 is connected by a link 36 to a bell crank lever 37, mounted to rock about the axis of a spindle 38. One arm of the bell crank lever 37a is formed with a downwardly projecting portion 39 and also with two lateral portions formed with slots 40 and 41. The downwardly projecting portion 39 carries a pin 42 projecting horizontally on each side thereof. Further, bell crank levers 43 and 44 are pivotally mounted respectively at the ends of the pin 42 and are held by springs 45 and 46 with their upwardly extending portions in engagement with the inner ends of the slots 40 and 41.

As the armature member 49 is swung in accordance with the received signals to and fro in a plane at right angles to the axis of the spindle 55, the bell crank lever 37, together with the bell crank levers 43 and 44, are swung as a unit about the axis of the spindle 38. When this occurs, feeler members in the form of horizontal extensions 47 and 48 of the bell crank levers 43 and 44 pass across the vertical planes containing the blades 32 and 33. The horizontal extensions 47 and 48 are supported by leaf springs 47a and 48a from the bell crank levers 43 and 44 so that they can swing transversely to the bell crank levers 43 and 44 but not in other directions relatively to those levers.

If the phase relationship, between the release of the spindle 55 and the transverse movement of the extensions 47 and 48 of the bell crank levers 43 and 44, is such that the longitudinal movements of the spindle 55 are selected substantially at the instants when the mid-points in the signal elements reach the receiving apparatus, the extensions 47 and 48 will pass through one of the gaps R and S (Figure 4) between the blades 32 and 33. The movement of the extensions 47 and 48 of the bell crank levers 43 and 44 is therefore

path in timed relationship with said movably mounted member and for to-and-fro movement in an intersecting path, a pair of rotor members allocated respectively to said feeler members and adapted to undergo a predetermined quantum of angular movement during the receipt of each signal, each rotor member being formed and positioned periodically to intersect the said first mentioned path during said angular movement and to move the associated feeler member in its intersecting path in the event of the phase relationship between these rotor and feeler members causing them to contact, and mechanism responsive to the movements of said feeler members in their intersecting paths.

12. In start-stop telegraph receiving apparatus, in combination, a pair of feeler members each mounted for to-and-fro movement in two intersecting paths, a movably-mounted member responsive to received signals for moving each feeler member to-and-fro in the first of its paths, a pair of rotor members organised to undergo a predetermined quantum of rotation during each signal and each organised to co-act with an associated one of said feeler members to impede the latter in its movement in its first path and move it in its second path, in the case of one feeler in the event of an advance and in the case of the other feeler in the event of a retardation in the timing of the rotation of said rotor members relatively to said movably mounted member, and means responsive to the movements of said feelers in their second paths for controlling said timing.

13. In start-stop telegraph receiving apparatus, in combination, a controlled member mounted for to-and-fro movement, loading means tending constantly to urge said controlled member in one direction, mechanism for releasing and arresting said controlled member, mechanism for moving said controlled member against the action of said loading means, a rotary member adapted to undergo a predetermined quantum of angular movement during the receipt of each signal, a movably mounted member responsive to receive signals, and means operatively associated with said last mentioned member and with said rotary member and organised to operate one of said mechanisms in the event of the time relationship between the movement of said rotary member and the movements of said movably mounted member being slow and the other of said mechanisms in the event of said time relationship being fast.

14. In start-stop telegraph receiving apparatus, in combination, a selecting cam shaft mounted for rotation and for longitudinal movement, means for causing said cam shaft to rotate through three revolutions for each received signal, a movably mounted member responsive to received signals for moving said cam shaft longitudinally in accordance with the nature of the elements in the signals, a two-armed blade organised to rotate in one plane with said selecting cam shaft and formed with cam members projecting respectively from the arms of said blade, a feeler member organised for to-and-fro motion across the plane of rotation of said blade, connecting means, operatively associated with said movably-mounted member, organised upon the passage of one element of a signal which is of a different kind from the previous element in that signal to move said feeler across said plane whereby, in the event of said selecting cam shaft being

advanced in its phase relationship with the received signal elements, the movement of said feeler member is delayed by said blade and one of the said cam projections engages said feeler member, and means responsive to such engagement operative to correct the relationship between the rotation of said selecting cam shaft and received signal element.

15. In start-stop telegraph receiving apparatus, in combination, a movably-mounted member responsive to received signals, a selecting member adapted to undergo a constant amount of rotation during the receipt of each signal and organised to co-act with said movably-mounted member so as to undergo longitudinal movements in accordance with the character of the different elements in the signal, a feeler member arranged to partake of the movements of said movably mounted member and operatively associated with said selecting member to be selectively actuated in accordance with the time relationship between the said rotation and the movements of said movably-mounted member, and means for adjusting said relationship under the control of said feeler member.

16. In start-stop telegraph receiving apparatus, in combination, a starter member arranged to be released for rotation at the beginning of each signal received and to undergo a constant amount of movement during the signal, a second member adapted to undergo cyclic movements at a rate substantially corresponding to the rate at which the elements in a signal are received, a detent member organised to release and arrest said second member, an intermediate member interposed between said detent member and said starter member and organised to be positioned selectively in accordance with the time delay required between the release of said starter member and the release of said second member, an armature member mounted to undergo movements in accordance with received signals, and means under the control of said armature member and of said second member for positioning said intermediate member in accordance with the phase relationship obtaining between the movements of said armature member and the cyclic movements of said second member.

17. In start-stop telegraph receiving apparatus, in combination, a starter member arranged to be released at the beginning of each signal received and to undergo a constant amount of movement during each signal, a second member adapted to undergo cyclic rotary movement at a rate substantially corresponding to the rate at which the elements in a signal are received, two two-armed blade members adapted to undergo rotary movements in timed relationship with said second member, a pair of feeler members associated respectively with said blade members and mounted to undergo to-and-fro movements across the planes of rotation of their respective blade members at a rate corresponding to signal element rate, said blade members and said feeler members having a hit-and-miss relationship and means for adjusting the time relationship between the cyclic movements of said second member and the signal elements in accordance with the co-action between said blade members and said feeler members.

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