

Dec. 26, 1939.

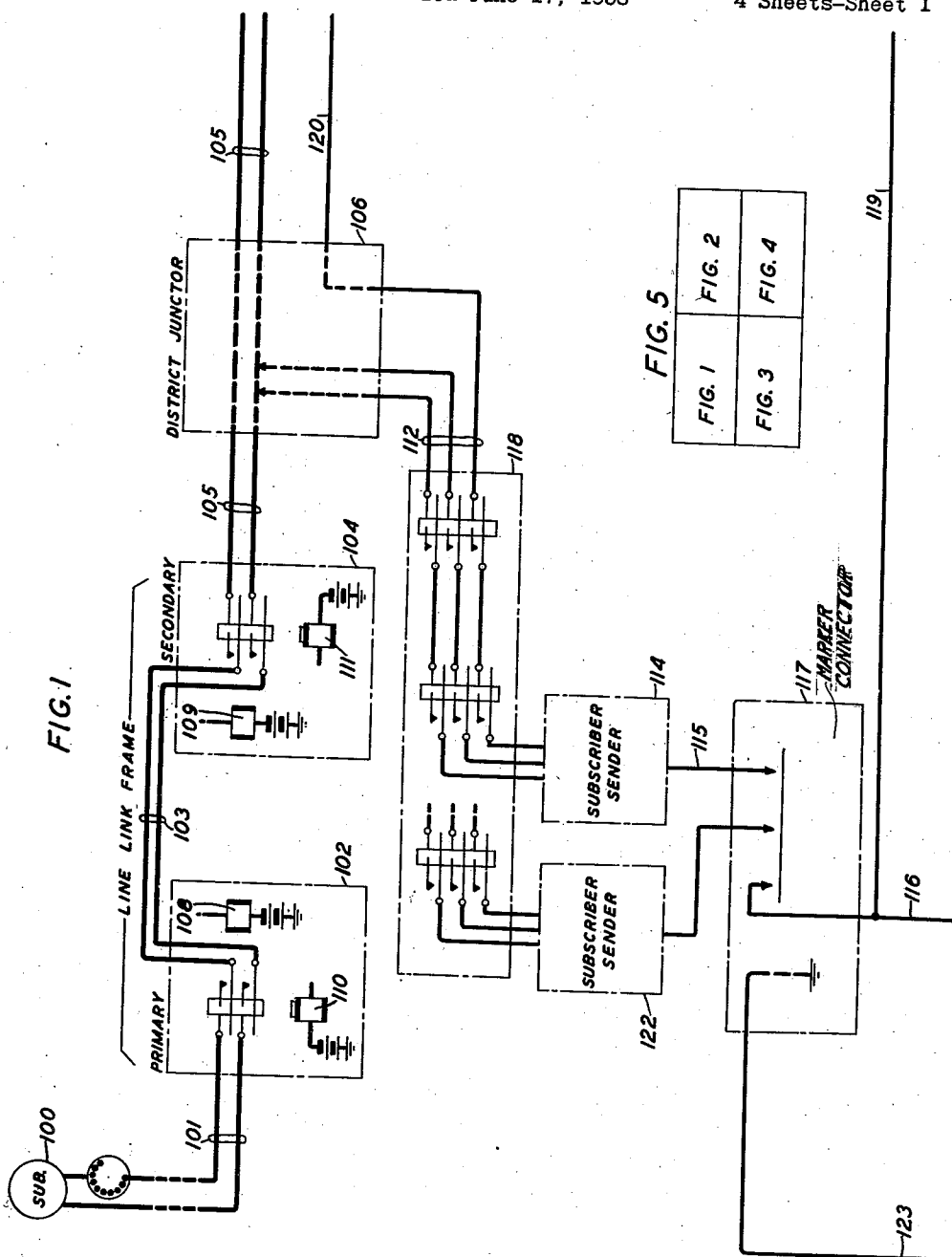
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2,184,844

TELEPHONE SYSTEM

Filed June 17, 1938

4 Sheets-Sheet 1



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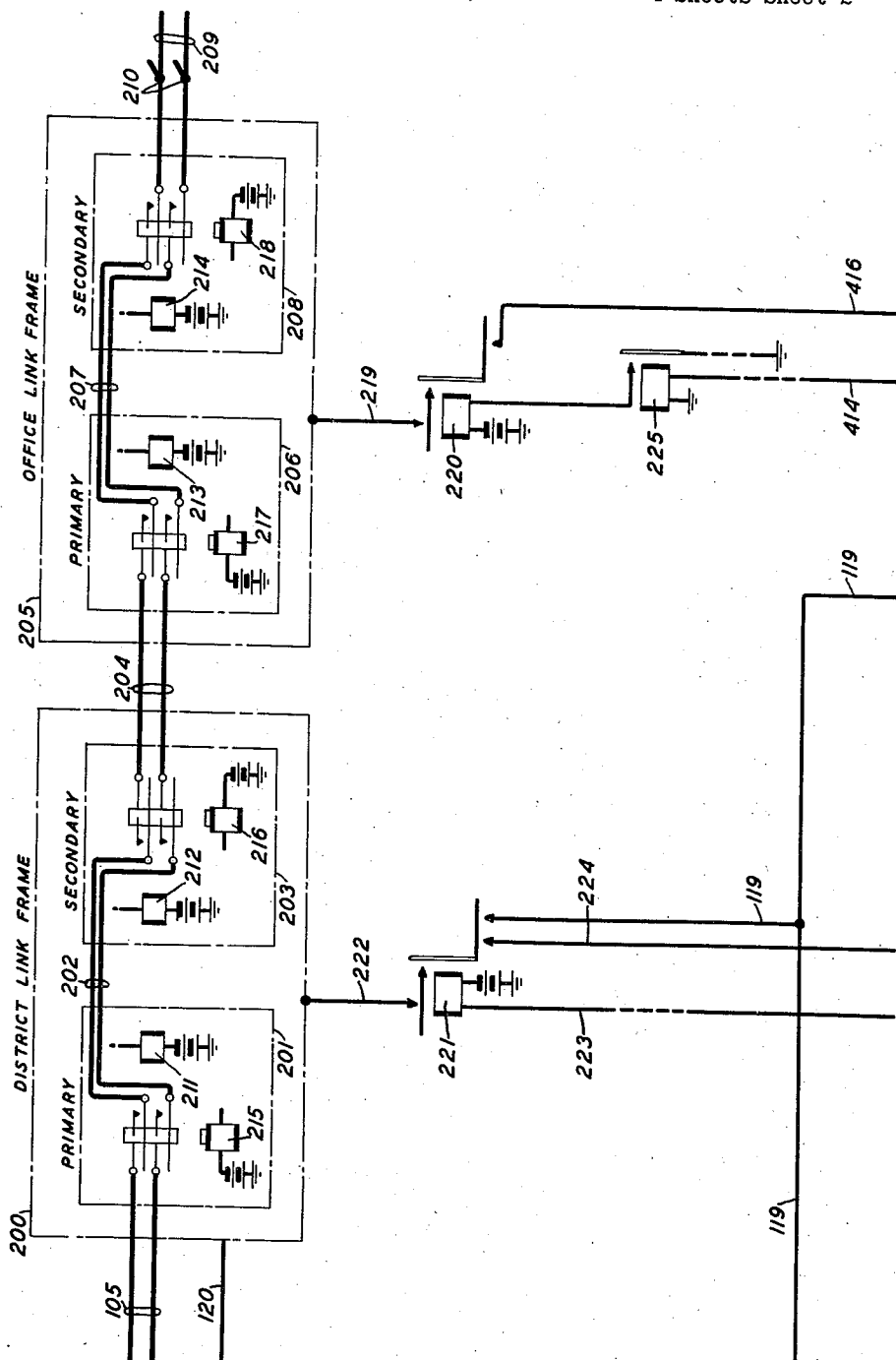
2,184,844

TELEPHONE SYSTEM

Filed June 17, 1938

4 Sheets-Sheet 2

FIG. 2



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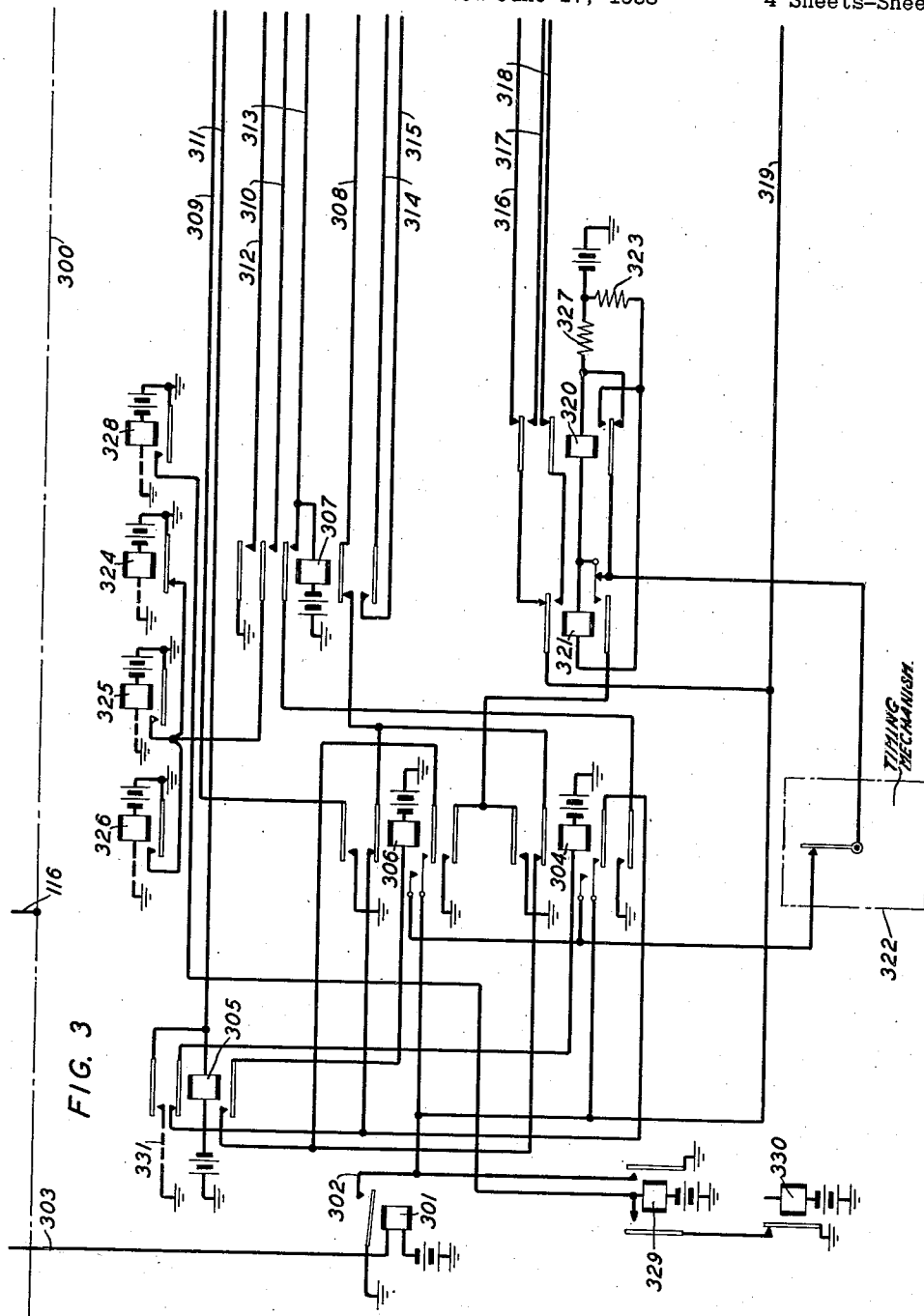
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TELEPHONE SYSTEM

Filed June 17, 1938

4 Sheets-Sheet 3



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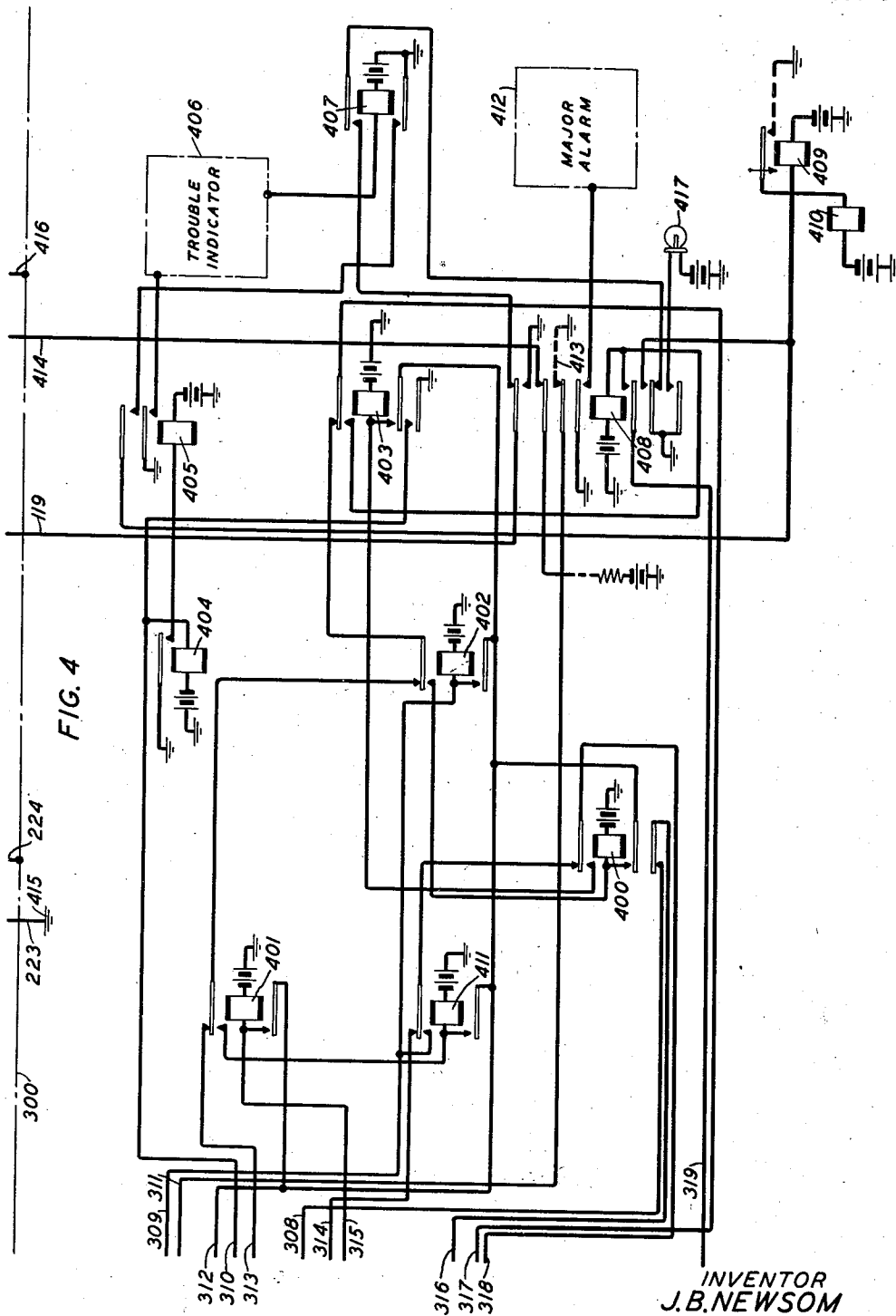
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2,184,844

TELEPHONE SYSTEM

Filed June 17, 1938

4 Sheets-Sheet 4



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2,184,844

TELEPHONE SYSTEM

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Application June 17, 1938, Serial No. 214,349

8 Claims. (Cl. 179—25)

This invention relates to telephone systems and particularly to those in which conversational connections are established wholly or in part by means of automatic switching equipment.

5 The objects of the invention are to reduce the holding time of the common mechanism that controls the operation of the selective switches; to increase the efficiency of the equipment; and otherwise to secure improvements in systems of this character.

10 In telephone exchanges of large capacity and especially in those employing switches of the cross-bar type for establishing connections it has been found advantageous to provide common register senders and markers in the central offices for receiving the designation information from the subscribers and for utilizing this information to control the selective operation of the switches in the extension of the connections.

20 Since the markers in particular comprise a substantial part of the central office equipment, it is, of course, desirable to reduce as much as possible the number of these mechanisms required to handle the traffic through the office. And since the number of markers required to handle the traffic depends to a great extent upon the time required by a marker to dispose of each individual call served, any reduction that can be achieved in the holding time of the marker results correspondingly in a reduction of the equipment needed in the office.

30 The several markers have access to the same frames of switches. And, because only one marker at a time is permitted to make connection with a particular frame, it follows that some of the average holding time of a marker results from the fact that it is required to wait until a preceding marker has released the switch frame with which the waiting marker desires to make connection. Because of this competition between markers in reaching the switch frames, any abnormal condition that may develop in one of the markers might result in prolonging unduly the waiting time of other markers.

45 The foregoing objects and the desirable advantages explained above are achieved, according to a feature of this invention, by means of a system in which the successive functions of the marker, from the time it is seized for use until it has completed its operations, are divided into stages, and predetermined intervals of time are measured beginning with each of the stages. When the marker is first seized, the measurement of a relatively long predetermined interval begins, this interval being sufficient, if the marker proceeds

normally, to enable the marker to complete all of its functions up to the time it is ready to make connection with the switches it is to control. In addition this interval also includes a period during which the marker is permitted to wait in the event another marker is engaged with the frame of switches. When the marker makes connection with the switch frame, the measurement of a relatively short interval of time begins, this interval also being sufficient, if the marker proceeds normally, for the marker to complete its switch controlling functions and release from the switch frame.

15 If, during either of these stages, the marker encounters trouble and fails to proceed, the corresponding predetermined interval expires, and means then becomes effective to force the retirement of the marker. Since the interval running concurrently with the time a first marker is connected to a frame of switches is shorter than the allowable waiting period of a second marker, the first marker will be forced to release from the frame if it encounters trouble before the expiration of the long period running against the waiting marker. With this provision it is not possible for a marker that encounters trouble while it is connected to a frame of switches to force other waiting markers to time out and release. Thus it is possible to supervise the markers in all of their functions and to record any occurrence of trouble that may occur in any one of them and at the same time to prevent one marker from interfering unduly with the regular performance of other markers.

35 Another feature of the invention is a system in which the marker is arranged to serve two different calls simultaneously and in which the timing intervals are provided for each call whether the marker serves the call alone or along with a second call. As soon as the marker is seized for a call, it begins to time an interval corresponding to its first stage of operation, and during this time the marker cannot be seized for a second call. However, after the marker has progressed into its second stage of operation in connection with the first call, it may be seized for a second call. In this event the timing mechanism continues to time the interval corresponding to the second stage of the first call, and, when the marker has completed its functions in connection with the first call, the timing mechanism is restored to normal and immediately begins to measure the first predetermined interval for the first-stage operation of the marker in connection with the second call. In this manner the marker

may be continuously in use in connection with successive calls during busy traffic periods, and the timing mechanism operates to measure the predetermined intervals for the different stages of operation in connection with each successive call.

These and other features of the invention will be described more fully in detail in the following specification and also in the appended claims.

In the drawings accompanying this specification:

Figs. 1 to 4, when arranged in the order shown in Fig. 5, illustrate a portion of a central office telephone system.

Fig. 1 shows conventionally a subscriber's station connected over a line with a district junctor circuit through the cross-bar switches of a line link frame; and it also shows in diagrammatic manner two subscriber senders, a sender selector frame, and a marker connector;

Fig. 2 shows by an abbreviated representation the extension of the circuit of Fig. 1 through the cross-bar switches of district and office link frames, respectively, to an outgoing trunk; and

Figs. 3 and 4 show a part of one of the common markers, the purpose of which is to control the selective operation of the district and office switches shown in Fig. 2.

Referring now to the drawings, the subscribers' lines, such as line 101, terminate in primary cross-bar line switches 102 at the central office. The primary switches 102 and the secondary switches 104 constitute the line link frames which serve to extend calling subscribers' lines through to the district selectors.

The district selectors, comprising the primary switches 201 and the secondary switches 203, are arranged in frames, known as district link frames. These district selectors serve to further extend calling subscribers' lines to the office selector switches, which are also arranged in frames, known as office link frames. One of these office link frames, comprising the primary cross-bar switches 206 and the secondary cross-bar switches 208, is illustrated in the drawings. The office selectors have access to the outgoing trunks, which either extend to other switching equipment in the same office or to distant offices. One of these trunks, trunk 209, is illustrated in the drawings.

The switch controlling equipment in the central office comprises a number of common register senders and a number of common decoder markers. The function of the register senders, such as the senders 114 and 122 illustrated diagrammatically, is to receive the designation information sent by the calling subscribers and to pass this information to idle switch controlling markers. The function of the markers, one of which is illustrated in abbreviated form in Figs. 3 and 4, is to decode the designation information received from the sender and to use this information for associating itself with and for testing the desired group of trunks outgoing from the office frames, for associating itself with the proper district and office switch frames, and for testing the links of these frames, and for operating the switches to extend the calling line over an idle path through to an idle trunk in the proper direction.

When, therefore, a subscriber initiates a call, his line is automatically extended over the primary and secondary line switches to an idle district trunk 105 terminating on a district frame 200. To effect this connection the magnets 108

and 110 of the primary cross-bar switch 102 and the magnets 109 and 111 of the secondary cross-bar switch 104 are operated. At the same time the subscriber's line and the district trunk 105 are extended over conductors 112 by way of a sender selector frame 118 to an idle register sender 114. The subscriber dials the number of the wanted line, and the impulses are recorded in the sender 114. Thereupon the sender 114 causes the operation of the marker connector 117, illustrated diagrammatically, to connect the sender to an idle decoder marker, such as the one illustrated in Figs. 3 and 4. This connection extends over a multiplicity of conductors illustrated by the lines 116 and 119. Following this the information in the sender is transferred to the marker, and the marker decodes this information, determines the trunk group desired, and then causes the operation of the office frame connecting mechanism, illustrated by the relays 220 and 225, to associate the marker with the office frame 205 containing the desired group of outgoing trunks. After the trunks have been tested and an idle one has been found, the marker then proceeds to operate the district frame connector, illustrated by the relay 221, to associate itself with the particular district frame in which appears the district trunk 105, over which the calling line has been extended. When the marker has succeeded in connecting itself with the district frame, a signal is sent to the sender, and the sender thereupon causes the release of the connector 117, severing the connection between the sender and the marker by way of conductors 116 and 119. The marker, however, is still in communication with the sender by way of the district frame connector 221 and the circuits 106, illustrated diagrammatically, which are individual to the district trunk 105. The marker now proceeds to control the operation of the district and office selectors to complete the connection from the trunk 105 through to the selected idle trunk 209. The connection through the district frame is effected by operating the magnets 211 and 215 of the primary cross-bar switch 201 and the magnets 212 and 216 of the secondary cross-bar switch 203. Similarly the connection through the office frame is made by operating the magnets 213 and 217 of the primary office switch 206 and by operating the magnets 214 and 218 of the secondary office switch 208. The marker then releases and returns to common use.

After the marker has been disconnected from sender 114 by the release of connector 117, it may be seized again by a second sender 122 by the reoperation of connector 117 or by another connector. This enables the marker to work on two calls at the same time.

Since a plurality of markers may have calls at the same time which are to be completed by way of the same district and office frames, it is necessary to arrange the circuits of the frame connectors so that only one marker can be connected to the district frame 200 and to office frame 205 at a time. If a second marker has been seized and wishes to make connection with these frames while the first marker is connected thereto, the second marker will be required to wait until the first marker has completed its function and released the frames.

Each of the markers is equipped with timing mechanism, including a machine-driven interrupter 322 and a number of relays, for measur-

ing three different periods of time, during each of which the marker, if operating normally, will complete certain of its functions.

The first period is measured from the seizure of the marker until certain necessary information for establishing the call has been received from the sender, such information being the office code, number of the district frame to which the calling line has access, class of service, etc. This is the so-called decoder stage of operation. It has been found satisfactory to make this period 1.15 seconds minimum, with an allowable variation to 2.45 seconds maximum since this time is ample for the normal functioning of the marker during this stage of its operation.

The second period is measured from the seizure of the marker until the office and district link frames have been connected. It has been found satisfactory to make this period 7.65 seconds minimum, with an allowable maximum of 8.95 seconds. This period covers the time required for the decoder stage plus a period of waiting to enable another marker, in the so-called marker stage and which has previously connected to the aforesaid district link frame, to establish the outgoing trunk connection or if unsuccessful to time out and release.

The third period is measured from the connection of the office and district link frames until the call is completed and the marker restores to normal. This is the marker stage of operation. It has been found satisfactory to make this period 2.45 seconds minimum with an allowable maximum of 3.75 seconds. This period is sufficiently long to enable the marker to establish the outgoing trunk connection provided no abnormal condition exists, before it times out but is sufficiently less than the 7.65-8.95 seconds of the second measured period to enable the marker to release from the frame before a waiting marker is forced to release.

While the system disclosed is not limited to the use of cross-bar switches of any particular type, reference may be had to the patent to Reynolds 2,021,329 of November 19, 1935, for an understanding of the construction and operation of a switch suitable for use in such systems. Because of the complicated nature of these systems, and since it is not necessary to an understanding of the invention that the system in all of its details be disclosed, much of the circuits and equipment has been eliminated in the present disclosure for the sake of simplicity. And in the following descriptions reference will be made to numerous operations which are not fully disclosed in all of their details. Wherever such references occur it will be understood that the circuits and equipment so referred to are already known, and in particular reference is here made to the following for detailed disclosures for all operations and equipment referred to herein but not specifically disclosed: Carpenter Patent 2,093,117, issued September 14, 1937; and Carpenter application Serial No. 214,356, filed June 17, 1938.

The following detailed description, when read in connection with the drawings, will give a more complete understanding of the invention.

Let it be assumed that the subscriber of station 100 originates a call and thereby causes the associated line 101 to be extended through primary switch 102, link 103, secondary switch 104, and conductors 105 to the district junctor 106. Connection is then made over a plurality of conductors, represented by lines 112 with a

subscriber sender represented by the box 114. A sender selector switch with an associated control circuit which is used in establishing this connection is represented conventionally by the device 118. When the sender is connected, the subscriber receives dial tone and dials the office code of the directory number of the called station, not shown. This causes the connecting device 117 to function and connect sender 114 to the marker of Figs. 3 and 4, over the plurality of conductors represented by lines 115, 116 and 119.

As soon as the marker is connected as aforesaid, a normally operated relay 301 is caused to release by the opening of a circuit indicated by the line 303, extending to and controlled by the marker connector 117. Relay 301 in releasing grounds the timing conductor 302, thereby starting the timing of the first or decoder phase of marker operation, which was hereinbefore discussed. As before stated, this period has been conveniently fixed between limits of 1.15 and 2.45 seconds, which period is sufficiently great to enable this phase of marker operation to be completed, assuming that no abnormal condition exists. The before-mentioned ground on conductor 302 causes the operation of relay 304 in a circuit traced from battery through the winding of relay 304, break contacts of relays 305, 306 and 307, over conductor 308, through lower break contacts of relay 400, over conductor 316, upper break contacts of relays 320 and 321 to the ground on the timing conductor 302.

In tracing the operating circuit for relay 304 it was assumed that the marker circuit was not engaged with two simultaneous calls as it may be, provided one call is in the decoder stage before-mentioned and another call is in the marker stage. When a call is in the marker stage, the marker is connected to the district link and office link frames and is engaged in the establishment of the connection from the district junctor 105 to the outgoing trunk leading to the office in which the called line is located. If there is a call in the marker stage, which is a condition to be hereinafter discussed, relay 305 will be operated, the circuit of relay 304 will be open and this latter relay accordingly does not operate at this time. Before relay 304 can operate relay 305 must release, due either to the successful completion of the connection to the outgoing trunk or to the timing out of the marker due to an abnormal condition encountered in connection with the marker stage.

Assuming now, therefore, that there is no call in the marker stage and that relay 304 operated, this relay then locks in a circuit from battery through the winding of relay 304, break contacts of relay 305, and lower middle make contacts of relay 304 to ground on conductor 302. This ground is extended through the lower innermost make contacts of relay 304 to the contacts of interrupter 322. It has been found satisfactory to predetermine the closed and open periods of this interrupter at 0.15 second and 1.15 seconds, respectively. When relay 304 operates, relay 321 operates through the contacts of interrupter 322, immediately, if these interrupter contacts should already be closed, or subsequently, after a short interval, when these contacts finally close. The circuit for relay 321 may be traced from battery through resistance 323, winding and lower normally closed contacts of relay 321, contacts of interrupter 322, and lower innermost contacts of relay 304 to the ground on conductor 302.

Relay 321 in operating locks through its lower normally open contacts to ground on the upper make contacts of relay 304. Relay 320, however, at this time does not operate, since a shunting ground is connected through contacts of interrupter 322 and lower break contacts of relay 320. When the contacts of interrupter 322 open, removing this shunting ground, relay 320 then operates from battery through resistance 327 and winding of relay 320 to the ground that is holding relay 321. When contacts of interrupter 322 close for a second time, relay 321 is shunted down and releases. The shunting ground is connected through contacts of interrupter 322 and lower make contacts of relay 320. Relay 320, however, continues to hold through lower normally closed contacts of relay 321 to the ground on the contacts of interrupter 322. When interrupter 322 opens its contacts for the second time, then relay 320 also releases and the first cycle of operation and release of relays 320 and 321 is completed. When interrupter 322 closes its contacts for the third time then the second cycle for relays 320 and 321 begins, and this cyclic action continues as long as relay 304 remains operated.

On the second closure of interrupter 322, when relay 321 releases, but relay 320 is still held operated through contacts of interrupter 322, a circuit is closed for operating relay 307. This circuit may be traced from battery through the winding of relay 307, over conductor 313, break contacts of relays 401, 402 and 403, over conductor 317, upper operated make contacts of relay 320, upper break contacts of relay 321 to ground on timing conductor 302. Relay 307 in operating locks through its upper innermost contacts to ground on the lower outermost contacts of relay 304. On the basis of the aforementioned closed and open periods for interrupter 322 of 0.15 second and 1.15 seconds, respectively, it is seen that a period of at least 1.15 seconds must elapse after the grounding of timing conductor 302, before relay 307 can operate while the maximum period cannot exceed 2.45 seconds. Relay 307 operated closes a circuit from battery through the winding of relay 404, over conductor 316 and upper middle contacts of relay 307 to ground through operated contacts of relay 325 or relay 326 or break contacts of relay 324 provided some abnormal condition exists. The circuits of these three relays are not shown here. When all the necessary information has been properly received from the subscriber sender 114, such as the office code, district frame indication, class of service, etc., relays 325 and 326 will be released and relays 324 and 328 will be operated and consequently relay 404 will not operate under this condition. Assuming that some abnormal condition does exist and as a result thereof the circuit for relay 404 is closed either at the end of a 1.15 seconds minimum or 2.45 seconds maximum period, then relay 404 in operating operates relay 405, calling in a trouble indicator, indicated only by a box 406, to record the nature of the trouble so as to facilitate the maintenance of the apparatus. After the trouble has been recorded, relay 407 is operated from the trouble indicator, which connects ground from lower break contacts of relay 408, upper contacts of relay 407, upper outermost break contacts of relay 408, to the trouble release conductor 119, which is extended to the sender 114 by way of connector 117 and one of the conductors 115. A relay in the sender is operated, causing the sender to discon-

nect itself from the marker, and the marker also restores to normal.

In the before-given discussion it was assumed that the marker timed out due to the existence of an abnormal condition during the decoder stage. Let it be assumed now, that no irregular condition was encountered during this stage and that relay 404 did not operate. Since the marker proceeds normally in its first stage, relay 328 operates and causes relay 329 to operate. Relay 329 locks to release control relay 330 and grounds the timing conductor 302. This insures that the timing mechanism will continue to function during the second and third stages of marker operation, because the relay 301 will reoperate before the marker finishes with the call, provided a second call is not received in the meantime. Relays 320 and 321 continue to function. When relay 321 operates for the second time at the beginning of the second cycle for relays 320 and 321, a circuit is now closed through contacts of relay 307 for operating relay 401. This circuit is traced from battery through the winding of relay 401, over conductor 315, lower outer operated contacts of relay 307, over conductor 314, upper break contacts of relays 411 and 400 over conductor 318, upper inner break contacts of relay 320, upper make contacts of relay 321 to ground on the timing conductor 302. Relay 401 locks through its lower contacts, over conductor 312 to ground on the upper outermost contacts of relay 307. Assuming interrupter periods of 0.15 second closed, 1.15 seconds open, an additional minimum period of 0.15 second plus 1.15 seconds equal to 1.3 seconds must elapse after the operation of relay 307 before relay 401 operates as before described. The total minimum elapsed time from the closure of ground on timing conductor 302 to the operation of relay 401 is accordingly 1.15 plus 1.30 equals 2.45 seconds.

With relay 321 operated and relay 320 released, relay 401 operated as before described. Relays 320 and 321 continue to function, and after a 0.15 second closed period plus a 1.15 seconds open period equal to 1.3 seconds, relay 321 is released and relay 320 is operated, closing a circuit for operating relay 411, which circuit may be traced from battery through the winding of relay 411, upper make contacts of relay 401, break contacts of relays 402 and 403, over conductor 317, upper make contacts of relay 320, upper break contacts of relay 321 to ground on conductor 302. Relay 411 locks through its lower contacts to ground on conductor 312. The total elapsed time from the grounding of conductor 302 until the operation of relay 411 is accordingly 1.15 seconds plus 1.30 seconds plus 1.30 seconds equal to 3.75 seconds.

For the operation of relay 411, relay 321 was released and relay 320 operated as before described. These relays continue to function and after a closed period of 0.15 second plus an open period of 1.15 seconds equal to 1.30 seconds, relay 321 is again operated and relay 320 released, closing a circuit for the operation of relay 402. This circuit may be traced from battery through the winding of relay 402, upper make contacts of relay 411, upper break contacts of relay 400, over conductor 318, upper inner break contacts of relay 320 and upper make contacts of relay 321 to ground on conductor 302. Relay 402 accordingly operates and locks through its lower contacts to conductor 312 to 1.30 seconds after relay 411, that is, 3.75 seconds plus 1.30 seconds equal

to 5.05 seconds after the grounding of conductor 302.

For the operation of relay 402 relay 321 was operated and relay 320 released as before described. After an additional closed period of 0.15 second plus an open period of 1.15 seconds, then relay 321 is released and relay 320 operated and a circuit is closed for operating relay 400 which may be traced from battery through the winding of relay 400, upper make contacts of relay 402, break contacts of relay 403, over conductor 317, through upper make contacts of relay 320, and upper break contacts of relay 321 to ground on conductor 302. Relay 400 in operating locks through its lower make contacts to conductor 312. The total elapsed time from the grounding of conductor 302 is accordingly 5.05 seconds plus 1.30 seconds equal to 6.35 seconds.

For the operation of relay 400 relay 321 was released and relay 320 was operated as before described. After an additional closed period of 0.15 second, plus an open period of 1.15 seconds then relay 321 is again operated and relay 320 released and a circuit is closed for operating relay 403. This circuit is traced from battery through the winding of relay 403, upper make contacts of relay 400, over conductor 318, through upper break contacts of relay 320, and upper make contacts of relay 321 to ground on conductor 302. Relay 403 locks through its lower inner contacts to ground on conductor 312. The total elapsed time from the grounding of conductor 302 to the operation of relay 403 is accordingly 6.35 seconds plus 1.30 seconds equal to 7.65 seconds.

When relay 403 operates it operates with its lower outer make contacts relay 404 which functions as before described to call in trouble indicator 406, so that a record may be made of the trouble. After the trouble is recorded relay 407 operates and causes the closure of the trouble release circuit as above traced over conductor 119 and connector 117 to the sender 114. Sender 114 disconnects itself from the marker, and the latter restores to normal, releasing all relays including those relays which were operated and locked as hereinbefore described.

In the before-given description it was assumed that some abnormal condition prevented the connection of the district and office frame circuits to the marker, which condition was indicated by the continued non-operation of relay 305, until finally after a period of 7.65 seconds minimum the marker was timed out and restored to normal. Let it be assumed, however, before relay 403 finally operated, causing the aforesaid marker release, that relay 305 did operate indicating that the connection of the marker to the aforementioned frame circuits had been effected. The system will now be discussed for this third phase of operation.

When connector relay 221 operates from marker ground 415, through a circuit indicated by the broken line 223, a plurality of conductors 224 extending from the marker are connected to corresponding conductors 222 of district link and connector circuit 200. When this connection is established one of the conductors is grounded to indicate the establishment of the connection, and this causes relay 305 to operate over conductor 311, through upper next to innermost contacts of relay 403 to ground, through a circuit not shown but indicated by the broken line 413. Relay 305 in operating locks to control conductor 331 and opens the locking cir-

cuit of relay 304, which releases and in turn releases relay 307. Relay 307 in releasing removes ground from conductor 312, thereby causing the release of relays 401, 411, 402, 400 and 403, whichever of these relays should be operated. Relays 320 and 321, if these should be operated, also release due to the opening of the upper outer and lower inner contacts of relay 304. When all of the aforementioned relays have released, a circuit is closed for operating relay 306, starting the aforementioned third phase of operation. This circuit may be traced from battery through the winding of relay 306, lower operated make contacts of relay 305, break contacts of relays 304 and 307 over conductor 308, through lower break contacts of relay 400, over conductor 316, through upper break contacts of relays 320 and 321 to ground on conductor 302 to which relay 306 locks through its lower middle make contacts. Relay 306 in operating operates relay 402 over conductor 309 from ground on its upper make contacts and with its lower innermost make contacts connects ground from conductor 302 to interrupter 322. Relay 400 now operates due to cyclic functioning of relays 321 and 320, after a minimum interval of 1.15 seconds as did relay 307 before relay 305 operated, as hereinbefore discussed. Relay 403 then operates, as before, 1.30 seconds after relay 400, that is, 2.45 seconds after the operation of relay 305, and causes the timing out of the circuit as before discussed unless the marker is successful in completing the connection and effects a regular release before the expiration of this period. The total time required to time out the circuit for this phase of operation is reduced from 7.65 seconds to 2.45 seconds by causing relay 402 to operate initially instead of relay 307. Relay 403 operates relay 404, and the trouble indicator 406 is called in to record the trouble. As before, it causes relay 407 to operate, and ground is connected to release lead 119.

Shortly after the marker connects to the office link frame 205, as above described, a test is made of the trunk group to determine an idle trunk 209. When an idle trunk is found, the marker is released from the sender 114 by the release of the marker connector 117. The marker proceeds to control the district and office switches to complete the connection through to the selected idle trunk 209, and during this time the timing mechanism counts the interval for the third stage of operation as just described. When the connector 117 releases, the conductor 123 is reclosed to reoperate the relay 301. This removes ground from the timing lead 302, but relay 329 continues to hold ground connection on this lead to insure the continued operation of the timing mechanism throughout the third stage of operation. When the marker completes its functions and the connection is established, it restores to normal, and at this time relay 330 operates, releasing relay 329, and ground is removed from the timing conductor 302.

While the marker is in its third stage of operation in connection with a particular call, and after the relay 301 has been reenergized, a second sender 122 may seize the marker by reoperating the marker connector 117. Should this occur, the conductor 123 is opened and relay 301 is released to connect ground to the timing lead 302 for the new call. Since, however, the previous call is still being timed, relay 329 is energized and ground is being maintained on the conductor 302 by relay 329. Relay 306 is also

energized at this time. The timing for the new call, therefore, does not start immediately, but it will begin as soon as the marker has completed its functions in connection with the first call.

5 The marker having completed these functions, the relay 305 is released, releasing in turn relay 306. Relay 306 releases any timing relays that have been operated prior to this time. With relays 304, 306, 305 released and the other timing

10 relays in their normal condition, the mechanism is now in condition to begin timing the second call, since relay 301 is released in response to the arrival of the second call and ground exists on the timing conductor 302. At the time the

15 marker completes its functions in connection with the previous call, the released relay 330 is also operated. This releases relay 329 which disconnects its grounded contact from the lead 302. However, as has just been explained, lead 302 is

20 already grounded again in response to the arrival of the new call, and the measurement of the first-stage interval proceeds in connection with the new call.

During periods of heavy office loads conductor

25 302 may remain continuously grounded for the reason that the marker is seized by a sender for each successive call before it has completed its functions on the preceding call. However, the timing of each call is started at the beginning of the relay cycle to avoid any irregularity in the

30 operation of the equipment. If the marker is wholly free when seized by a sender, the timing of the call begins at the time of seizure. But if the marker is still working on a previous call

35 when it is seized on a second call, the timing of the second call does not begin until the first call is disposed of and the relays restored as above described.

Following the operation of relay 403, if the

40 trouble indicator 406 cannot be called in, because it is busy or for some other reason, relays 320 and 321 continue to function and then 1.3 seconds after relay 403 operated, relay 408 operates, through the upper make contacts of relay

45 403, over conductor 317 and through contacts of relays 320 and 321. Relay 408 locks, over conductor 319, to ground on conductor 302, and connects ground with its upper innermost contacts to the major alarm circuit 412, thereby

50 sounding an alarm; with its lowermost contacts it effects the lighting of lamp 417, which identifies the marker in trouble. Relay 408 also in operating, with its upper, next to innermost contacts opens a circuit releasing relay 305; with

55 its upper, next to outermost contacts it opens the start lead 414 to the office connector relay 225 releasing thereby relays 225 and 220 and opening the established connection, over the plurality of conductors 416 and 219, between the

60 marker and the office frame. The district frame connection is also released at this time. Relay 408 in operating also connects ground with its upper, outermost make contacts, to trouble release conductor 119. Since the connector 117

65 has already opened the sender-to-marker connection, ground will be connected over conductor 119 through contacts of relay 221, over a corresponding one of the conductors 222, through the district link frame, over one of the conductors

70 120, through district junctor 106, over one of the conductors 112, through contacts of connector 118 to the subscriber sender 114 which thereby receives trouble release signal. Relay 408 also connects ground with its lower middle make

75 contacts to the winding of relay 409, which in

turn operates relay 410. This effects the release of all marker relays which may be operated at this time, and the marker is now restored to normal, in the same manner as when relay 409 operated, following the operation of relays 405 and 407 as hereinbefore discussed.

What is claimed is:

1. In a telephone system, automatic switches, a common marker for controlling their selective operation to extend telephone connections, means for seizing said marker for use, means for measuring a predetermined interval of time beginning with the seizure of the marker, means effective if the marker proceeds normally with its functions for connecting it to said automatic switches before the expiration of said interval, means for measuring a second predetermined interval beginning with the connection of the marker to said switches, and means effective if the marker proceeds normally with the control of said switches to release it from said switches before the expiration of said second interval.

2. In a telephone system, automatic switches, a common marker for controlling their selective operation to extend telephone connections, means for seizing said marker for use, means for measuring a predetermined interval of time beginning with the seizure of the marker, means effective if the marker proceeds normally with its functions for connecting it to said automatic switches before the expiration of said interval, means for measuring a second predetermined interval beginning with the connection of the marker to said switches, means effective if the marker proceeds normally with the control of said switches to release it from said switches before the expiration of said second interval, and means effective if the marker fails to complete its functions within said second interval for forcing it to release from said automatic switches.

3. In a telephone system, automatic switches, a plurality of markers for controlling the selective operation of said switches to extend telephone connections, means for seizing an idle one of said markers for use, means for rendering said switches busy to prevent other markers from making connections therewith while a first marker is connected to said switches, means for measuring a predetermined interval of time beginning with the seizure of a marker, means effective if the seized marker proceeds normally with its functions for connecting it to said automatic switches before the expiration of said interval, means for measuring a predetermined interval beginning with the connection of the marker to said switches, and means effective if the marker proceeds normally with the control of said switches to release it from said switches before the expiration of said second interval.

4. In a telephone system, automatic switches, a plurality of markers, means for connecting said markers to said switches, means for seizing any particular one of said markers for use, means controlled by the seized marker for operating said connecting means to connect said marker to said switches, means for preventing the operation of said connecting means to connect another marker to said switches while said first marker is connected thereto, means for seizing a second marker for use, means for measuring a relatively long interval of time beginning with the seizure of the second marker, during which interval the second marker waits for said first marker to release from said switches, means for measuring a

shorter interval of time which begins when said first marker is connected to said switches and ends prior to the expiration of said long interval, and means effective if said first marker does not operate normally and release from said switches before the short interval expires for forcing said first marker to release at the end of the short interval.

5. In a telephone system, a frame of automatic switches for extending connections, a plurality of markers connectable to said frame for controlling the selective operation of said switches, means effective during the time one marker is connected to the frame for preventing the connection of another marker thereto, means for measuring a predetermined interval beginning when a marker is connected to the frame, means for automatically releasing the marker at the end of said interval if the marker has not already completed its functions and released itself from said frame, means for measuring a longer predetermined interval including the time a marker is waiting access to the frame when busy, and means for automatically releasing the marker at the end of said longer interval if it fails to progress normally.

6. The combination in a telephone system of automatic switches, a switch controlling marker, means for seizing said marker in response to a call to control the selective operation of said switches, a timing mechanism, means responsive to the seizure of the marker for starting said timing mechanism to measure a predetermined interval of time, means effective if the marker performs its functions normally to cause the release of the marker before the expiration of said predetermined interval, means responsive to a second call for seizing said marker for use before it has completed its functions on the first-mentioned call, and means effective when the marker completes its functions on the first-mentioned call for starting said timing mechanism in operation to measure the predetermined interval of time for the second call.

7. The combination in a telephone system of automatic switches, a marker controlling the operation of said switches to extend telephone connections, means responsive to a call for seizing

the marker for use, means for rendering the marker busy until it has progressed through certain stages of its operation, means for seizing the marker again in response to a second call before it has completed its functions in connection with the first call, a timing mechanism for measuring a predetermined interval for each call served by the marker, means effective to start said timing mechanism immediately the marker is seized for a call provided the marker is idle at the time, means for restoring said timing mechanism to its initial condition when the marker has completed its functions in connection with a call, and means effective as soon as the timing mechanism is restored to restart the same for the measurement of the predetermined interval in the event the marker has been seized for a second call before it has completed with the first call.

8. In a telephone system, automatic switches for extending telephone connections, a marker having two stages of operation for controlling said switches, means for seizing the marker in response to a call, means for rendering the marker busy while it is in its first stage of operation, means for seizing the marker in response to a second call after it has advanced into its second stage in connection with the first call, a timing mechanism, means effective when the marker is seized for the first call for starting the timing mechanism in operation to measure a predetermined interval for the first marker stage, means effective when the marker enters the second stage to cause said mechanism to commence the measurement of a second predetermined interval, means effective when the marker completes its second stage in connection with the first call for restoring the timing mechanism and for causing it to commence the measurement of the first predetermined interval of time in connection with a second call, and means operated by said timing mechanism if it completes the measurement of the predetermined interval corresponding to the second stage of operation before the marker completes all of its functions for said second stage.

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