June 9, 1942. R. C. DAVIS ET AL 2,285,908

SENDER CONTROL SYSTEM

Filed Sept. 7, 1940 3 Sheets-Sheet 1

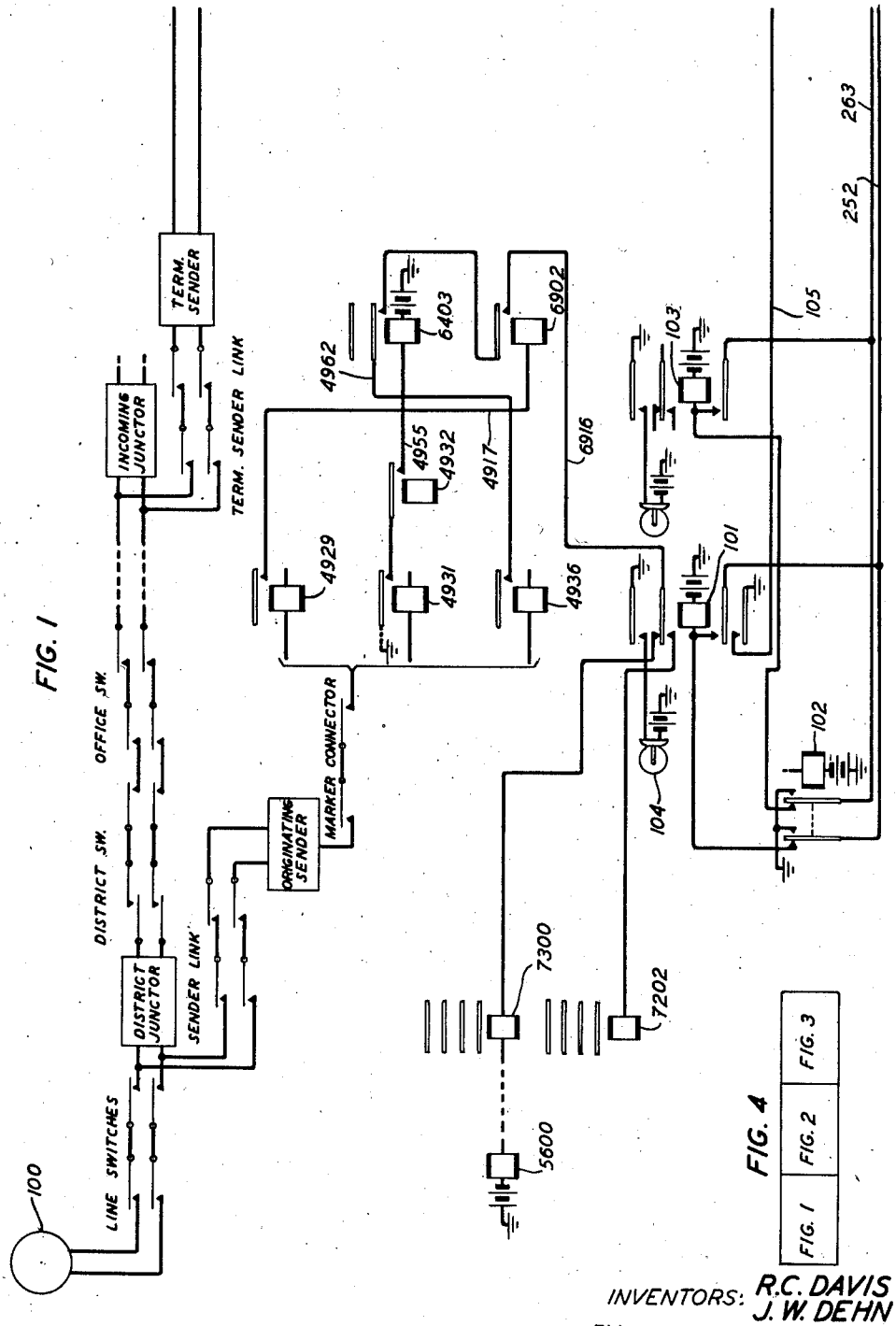

FIG. 1

FIG. 4

FIG. 1	FIG. 2	FIG. 3

INVENTORS: R.C. DAVIS
J. W. DEHN

BY P. C. Smith

ATTORNEY

June 9, 1942. R. C. DAVIS ET AL 2,285,908

SENDER CONTROL SYSTEM

Filed Sept. 7, 1940 3 Sheets-Sheet 2

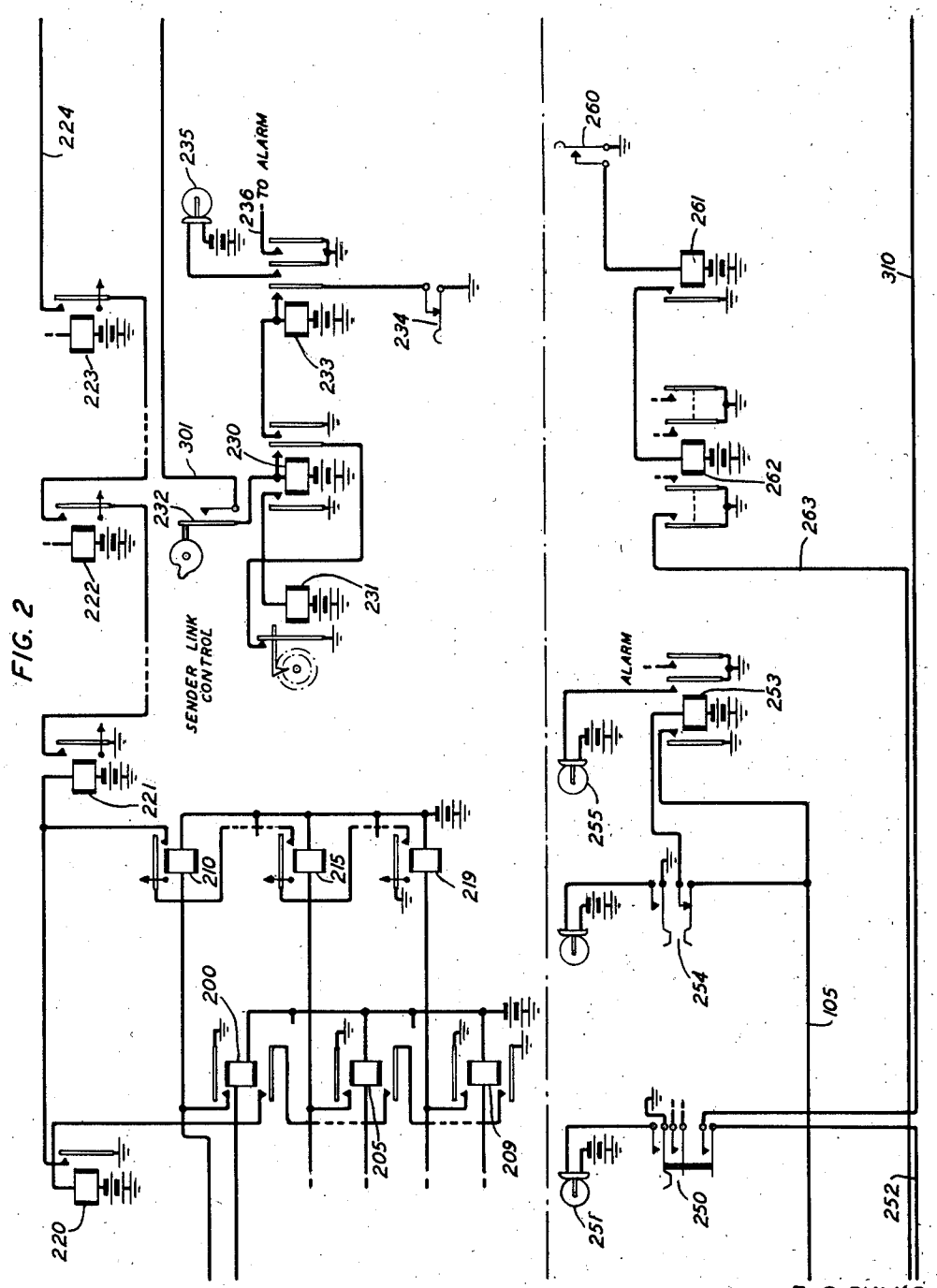

FIG. 2

INVENTORS: R. C. DAVIS
J. W. DEHN

BY R. C. Smith

ATTORNEY

June 9, 1942. R. C. DAVIS ET AL 2,285,908

SENDER CONTROL SYSTEM

Filed Sept. 7, 1940 3 Sheets-Sheet 3

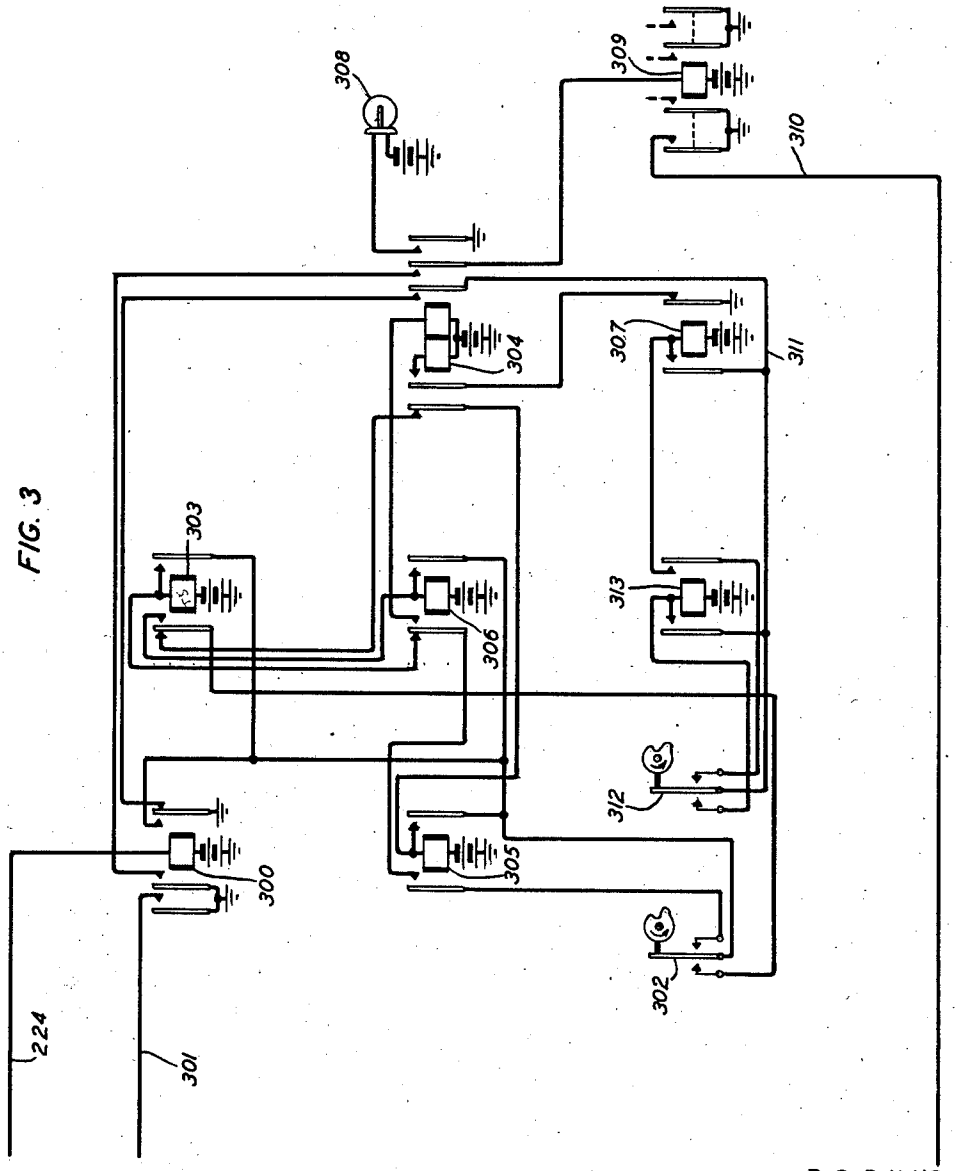

FIG. 3

INVENTORS: R. C. DAVIS
J. W. DEHN

BY P. C. Smith

ATTORNEY

Patented June 9, 1942

2,285,908

UNITED STATES PATENT OFFICE

2,285,908

SENDER CONTROL SYSTEM

Richard C. Davis and Joseph W. Dehn, Great Neck, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application September 7, 1940, Serial No. 355,760

10 Claims. (Cl. 179—18)

This invention relates to telephone systems and has for its object to reduce the ill effects of peak load conditions.

In the cross-bar system, the switches are directed in their action by control devices known as senders and markers. These control devices are of two kinds, originating and terminating, the former receiving the complete designation of wanted lines and connecting the calling line to a trunk incoming to the office at which the wanted line is located. The terminating sender receives the numerical designation from the originating office and with the help of the terminating marker controls the connection of the incoming trunk to the wanted line, thereby completing the connection between the calling and called lines.

Telephone exchanges are designed to complete all calls during heavy load periods with a certain minimum delay. Throughout the greater part of the time, therefore, there will be no delay. Occasionally, however, some event of exceptional interest will produce such a congestion of calls that the control equipment will all be busy and calls will experience long delays.

In accordance with the present invention, when all terminating senders in a cross-bar office are busy, a signal is transmitted to originating offices to prevent the extension of calls to the busy office.

Means is also provided for giving an overflow signal to subscribers dialing the code of an office in which all terminating senders are busy.

In addition, means is provided for delaying the transmission and the removal of the senders busy signal to obviate brief overloads or relief of such overloads.

The invention will be more clearly understood from a consideration of the following description in connection with the accompanying drawings in which:

Fig. 1 shows diagrammatically a connection between a calling line, an originating sender and an incoming junctor, together with a part of a marker;

Fig. 2 shows parts of a terminating sender link control circuit above the broken line and, below the line, certain keys and lamps locating at the originating office of Fig. 1;

Fig. 3 shows the overload timing and control circuit; and

Fig. 4 shows the arrangement of Figs. 1 to 3, inclusive.

A complete disclosure of the originating circuits of a cross-bar office may be found in U. S. Patent 2,235,803 granted March 18, 1941, to W. W. Carpenter, while the terminating circuits are disclosed in U. S. Patent 2,089,921, granted to W. W. Carpenter on August 10, 1937. For convenience in consulting the complete circuits, the marker relays of Fig. 1 have been given the same reference numerals as they bear in the Carpenter Patent 2,235,803

When the subscriber at substation 100 initiates a call, the substation is connected over line switches to an idle district junctor and over the line switches and sender link to an idle originating sender. He then dials the designation of the wanted line. Having received the designation of the wanted office the sender connects by means of a marker connector with a marker.

In the marker, three registers, represented by relays 4929, 4931 and 4932, 4936, receive the three office digits. Relays 4931 and 4932 together operate relay 6403, while relay 4929 operates relay 6902, whereupon a circuit is completed over contacts of relays 4936, 6403 and 6902, conductor 6916, upper back contact of relay 101 through the windings of route relay 7300 and relay 5500 to battery. Relay 7300 controls the operation of the district and office switches to extend the calling line to an incoming junctor at the wanted office.

At the wanted office, a terminating sender is connected by means of a terminating sender link to the incoming junctor and the originating sender transfers the numerical line designation to the terminating sender which controls the further extension of the connection.

When the terminating sender is seized it operates a sender busy relay 200 in the sender link control circuit. The sender busy relay, at its upper contact, returns ground to the sender for controlling certain functions thereat and also closes a circuit for relay 210 which is slow to release.

Relays 205 and 209 are sender busy relays belonging to other senders of the same group and when operated, in turn operate slow-to-release relays 215 and 219. When all the senders of the group are busy, a chain circuit is closed over the lower contacts of relays 209, 205, 209 and the intermediate relays of the group through the winding of relay 220 and battery. Relay 220 in turn operates relay 221 which is slow to release. When the group of slow relays 210 to 219 are all operated they close a supplementary circuit for relay 221.

Similar groups of busy and slow relays are provided for the other sender groups which, when operated to indicate a group busy condition, in

turn operate relays 222, 223, etc. With all of the sender groups busy a chain circuit over the contacts of relays 221, 222, 223, etc. is closed, connecting ground to conductor 224. The purpose of the supplementary slow-to-release relays is to prevent the removal of ground from conductor 224 during the brief intervals which occur between the release of a sender by one call and its seizure on the next call. The individual slow relays tend to bridge this momentary idle period and the group relay adds an additional interval.

When ground is connected to conductor 224, a circuit is completed for relay 300 which controls the timing circuit. When relay 300 operates, it connects ground over its outer left contact to conductor 301, completing a circuit over interrupter 232 for relay 230. Relay 230 operates at each closure of interrupter 232, locks to the back contact of meter 231 and operates that meter, thereby obtaining an indication of the duration of the all-senders-busy condition. At its outer right contact relay 230 closes a circuit for relay 233 which locks to ground over key 234, lights lamp 235 and connects ground to conductor 236 to sound an alarm.

At its right contact relay 300 connects ground to the armature of interrupter 302. When the interrupter closes its left contact it connects this ground over the back contacts of relays 303 and 304 to the winding of relay 305 and battery. Relay 305 locks under the control of relay 300. When interrupter 302 next closes its right contact, ground is extended over the left contact of relay 305, back contact of relay 306, to the winding of relay 303 and battery. Relay 303 also locks under the control of relay 300 and connects the left contact of interrupter 302 to the winding of relay 306, which relay operates when that interrupter contact is closed and locks to relay 300. With relay 306 operated, interrupter 302 next closes a circuit from ground over its right contact, left front contacts of relays 305 and 306 to battery through the right winding of relay 304. Relay 304 locks in a circuit from battery through its left winding and left front contact to ground at the back contact of relay 307. Interrupter 302 has a complete cycle of seven seconds, with a five-second interval between the closure of its left contact and the closure of its right contact. Therefore the time between the grounding of conductor 224 and the operation of relay 304 will vary between twelve and nineteen seconds. If desired, the time may be shortened by omitting relays 303 and 306, thereby omitting one cycle of operations by the interrupter.

With relay 304 operated, lamp 308 is lighted and a circuit is closed from ground at the inner left contact of relay 300, middle right contact of relay 304 to the winding of relay 309 and battery. Relay 309 grounds conductor 310 and a plurality of other conductors leading to originating markers of the same office. Conductor 310 leads to key 250 individual to the marker shown, which, when operated, lights lamp 251 and extends ground from conductor 310 over the contact of key 250, conductor 252, to the outer back contact of relay 102, winding of relay 101 and battery. Relay 102 is operated as soon as a marker is seized, therefore relay 101 can only operate while the marker is idle. Relay 101 operated, locks to conductor 252, lights lamp 104 and grounds conductor 105, operating relay 253 which locks under the control of key 254, lights lamp 255 and sounds an alarm. Relay 101 also transfers the route relay circuit, previously traced to conductor 6916, from route relay 7300 to the overflow route relay 7202, thereby causing all calls for the busy terminating office to be routed to an overflow trunk which gives an overflow signal to the calling subscriber, as described in the above-identified Carpenter Patent 2,235,803.

When the busy condition is relieved for long enough to permit one of the slow group busy relays to release, relay 300 releases, permitting relays 303, 305, 306 and 309 to release. In idle markers, with relay 102 released, the release of relay 309 also releases relay 101, but relay 101 is held operated by ground over the front contact of relay 102 if relay 309 releases while a connection is in progress.

Since relay 304 is locked under the control of relay 307, that relay remains operated, and the release of relay 300 closes a circuit from ground at the back contact of relay 300, inner right contact of relay 304, conductor 311 to the armature of interrupter 312. Interrupter 312 in closing its left contact operates relay 313 which locks to conductor 311. With relay 313 operated the next closure of the right contact of interrupter 312 operates relay 307 which also locks to conductor 311. Relay 307 in operating opens the locking circuit of relay 304 which releases, restoring the load control circuit to normal.

Interrupter 312 has a thirty-second cycle, so that restoration of the load control circuit will be delayed from thirty to sixty seconds in order to hold relay 309 ready for immediate reoperation, should the relief of the congestion be only temporary. After relay 304 releases, the all-senders-busy condition must continue long enough to reoperate relays 305, 303, 306 and 304 in order to operate relay 309 and signal the originating markers. While relay 304 is held operated, the temporary relief of the load will permit relay 309 to release and restore the markers, but the recurrence of the overload will immediately reoperate relay 309. It also removes ground from conductor 311 so that a complete release timing cycle will occur after each cessation of the overload.

While the drawings, show the load control relay 309 acting directly on the originating markers of the local office by way of keys such as key 250, it is clear that relay 309 may operate relays in distant offices which control the markers thereat and that keys may be provided to select the offices at which the routing is to be changed in accordance with the cause of the overload.

Another use of rerouting in the marker is shown in the wiring of relay 103. It is well known that calls to special operators, business offices, etc. are made by the use of a three-digit code, similar to an office code. These codes are translated by the marker which operates corresponding route relays. Some offices which are busy enough during the day to warrant the services of local operators and clerks may profitably share the services of a centralized personnel in the evening or night. Such an office will have a key 260 which, when closed, operates relay 261, in turn operating relay 262. Relay 262 grounds a conductor such as conductor 263, leading to each marker where it operates a relay such as relay 103 which, in the manner shown for relay 101 transfers the route relay operating circuits from a route relay adapted to complete the call locally to one wired to control the extension of the call to another office. While only one transfer armature is shown, as many would be provided as required by the codes being rerouted.

What is claimed is:

1. In a telephone system, telephone lines, automatic switching equipment, originating control equipments to control said automatic switching equipment, terminating control equipment common to other of said switching equipment, means under the control of a subscriber on one of said lines for successively operating said control equipments to control said automatic switching equipment to establish a conversational connection between said line and a called line over said automatic switching equipment, and means effective if all of said terminating control equipment is busy to prevent said originating control equipment from directing a connection to the control of said terminating control equipment.

2. In a telephone system, telephone lines, automatic switching equipment, originating control equipment common to certain of said switching equipment, terminating control equipment common to other of said switching equipment, means under the control of a subscriber on one of said lines for successively operating said control equipment to control said automatic switching equipment to establish a conversational connection between said line and a called line over said automatic switching equipment, and means effective if all of said terminating control equipment is busy to transmit a signal to said originating control equipment to prevent said originating control equipment from directing a connection to the control of said terminating control equipment.

3. In a telephone system, telephone lines, automatic switching equipment, originating control equipment common to certain of said switching equipment, terminating control equipment common to other of said switching equipment, means under the control of a subscriber on one of said lines for successively operating said control equipments to control said automatic switching equipment to establish a conversational connection between said line and a called line over said automatic switching equipment, and means effective if all of said terminating control equipment is busy to measure a time interval and at the end of said interval to transmit a signal to said originating control equipment to prevent said originating control equipment from directing a connection to the control of said terminating control equipment.

4. In a telephone system, telephone lines, automatic switching equipment, originating control equipment, terminating control equipment, means under the control of a subscriber on one of said lines for operating said control equipments to establish a conversational connection between said line and a called line over said automatic switching equipment, a relay operated if all of said terminating control equipment is busy, means under the control of said relay to measure a time interval and at the end of said interval to transmit a signal to said originating control equipment to prevent said originating control equipment from directing a connection to the control of said terminating control equipment, means responsive to the release of said relay, due to terminating control equipment becoming idle, to terminate said signal and to measure a further time interval, and means for rendering said signal transmitting means directly responsive to the operation of said relay during said further time interval.

5. In a telephone system, telephone lines, automatic switching equipment, originating control equipment, terminating control equipment, means under the control of a subscriber on one of said lines for operating said control equipments to establish a conversational connection between said line and a called line over said automatic switching equipment, a relay operated if all of said terminating control equipment is busy, means under the control of said relay to measure a time interval and at the end of said interval to transmit a signal to said originating control equipment to prevent said originating control equipment from directing a connection to the control of said terminating control equipment, means responsive to the release of said relay, due to terminating control equipment becoming idle, to terminate said signal and to measure a further time interval, and means for making said first time measuring means ineffective and for rendering said signal transmitting means directly responsive to the operation of said relay during said further time interval.

6. In a telephone system, telephone lines, automatic switching equipment, originating control equipment, terminating control equipment, means under the control of a subscriber on one of said lines for operating said control equipments to establish a conversational connection between said line and a called line over said automatic switching equipment, a relay operated if all of said terminating control equipment is busy, means under the control of said relay to measure a time interval and at the end of said interval to transmit a signal to said originating control equipment to prevent said originating control equipment from directing a connection to the control of said terminating control equipment, means responsive to the release of said relay, due to terminating control equipment becoming idle, to terminate said signal and to measure a further time interval, means for rendering said signal transmitting means directly responsive to the operation of said relay during said further time interval, and means for restarting said further time measuring means each time that said signal transmitting means is operated and released.

7. In a telephone system, telephone lines, automatic switching equipment, originating control equipment common to certain of said switching equipment, terminating control equipment common to other of said switching equipment, means under the control of a subscriber on one of said lines for successively operating said control equipments to control said automatic switching equipment to establish a conversational connection between said line and a called line over said automatic switching equipment, and means effective if all of said terminating control equipment is busy to cause said originating control equipment to transmit a busy signal to subscribers attempting a connection with the terminating office at which said terminating control equipment is located.

8. In a telephone system, telephone lines, automatic switching equipment, originating control equipment common to certain of said switching equipment, terminating control equipment common to other of said switching equipment, means under the control of a subscriber on one of said lines for successively operating said control equipments to control said automatic switching equipment to establish a conversational connection between said line and a called line over said automatic switching equipment, means ef-

fective if all of said terminating control equipment is busy to transmit a signal to said originating control equipment, and means in said originating control equipment responsive to said signal to route calls for the terminating office at which said terminating control equipment is located to an overflow trunk to give an overflow signal to the calling subscriber.

9. In a telephone system, telephone lines, automatic switching equipment, originating control equipment, terminating control equipment, means under the control of a subscriber on one of said lines for operating said control equipments to establish a conversational connection between said line and a called line over said automatic switching equipment, means effective if all of said terminating control equipment is busy to measure a time interval and at the end of said interval to transmit a signal to said originating control equipment and means responsive to said signal to modify said originating control equipment to prevent said originating control equipment from directing subsequent connections to the control of said terminating control equipment.

10. In a telephone system, telephone lines, automatic switching equipment, originating control equipment, terminating control equipment, routing means in said originating control equipment, means under the control of a subscriber on one of said lines for operating said routing means, means under the control of said routing means for connecting said originating control equipment with the office at which said terminating control equipments are located, said control equipments operating to establish a conversational connection between said line and a called line over said automatic switching equipment, means effective if all of said terminating control equipment is busy to transmit a signal to said originating control equipment, and means in said originating control equipment responsive to said signal to render said routing means ineffective to direct subsequent calls to said terminating office.

RICHARD C. DAVIS.
JOSEPH W. DEHN.