Jan. 19, 1943. L. M. PRINCE, JR 2,308,778

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 11, 1939 3 Sheets-Sheet 1

FIG. 1.

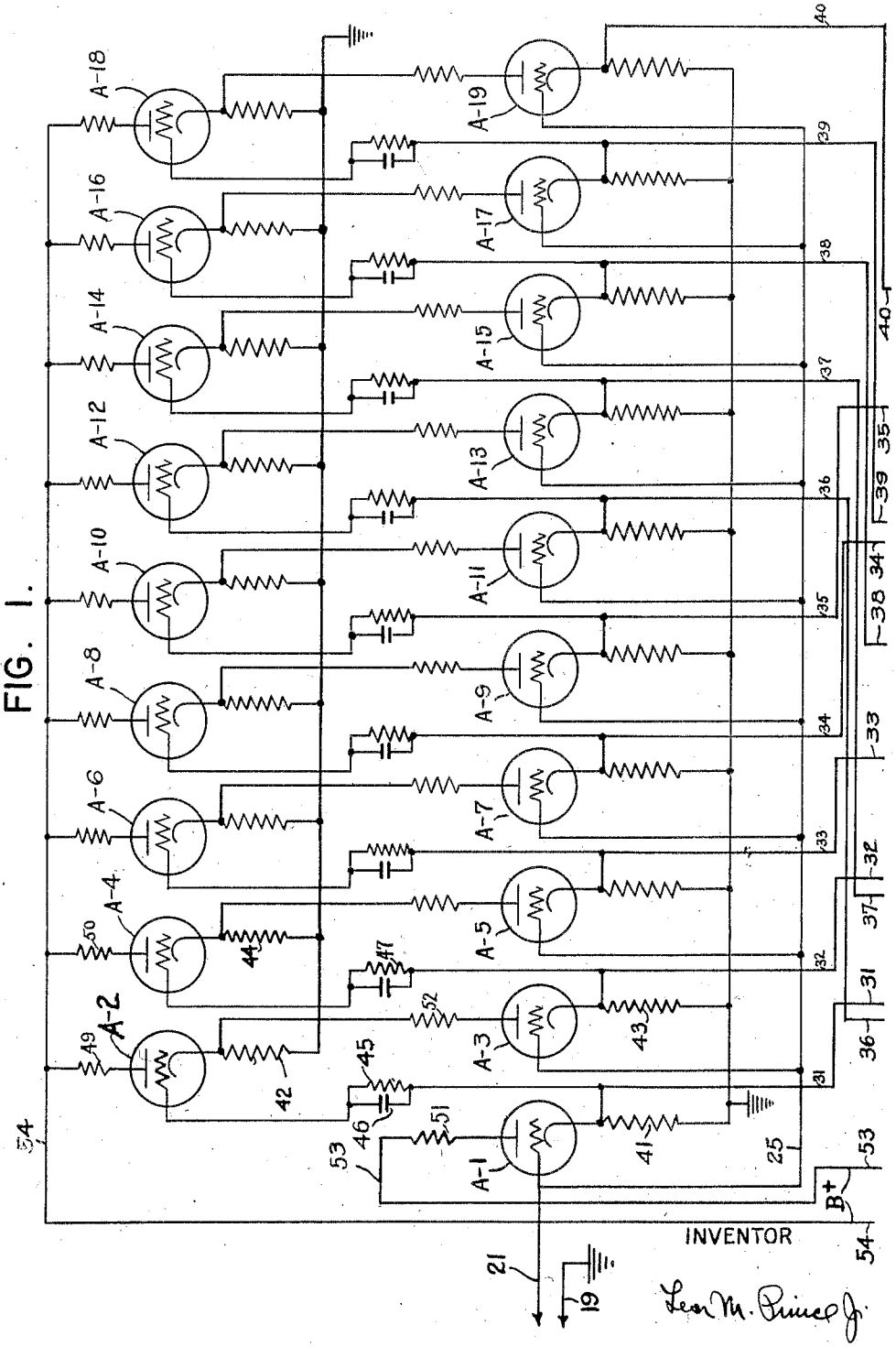

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FIG. 2.

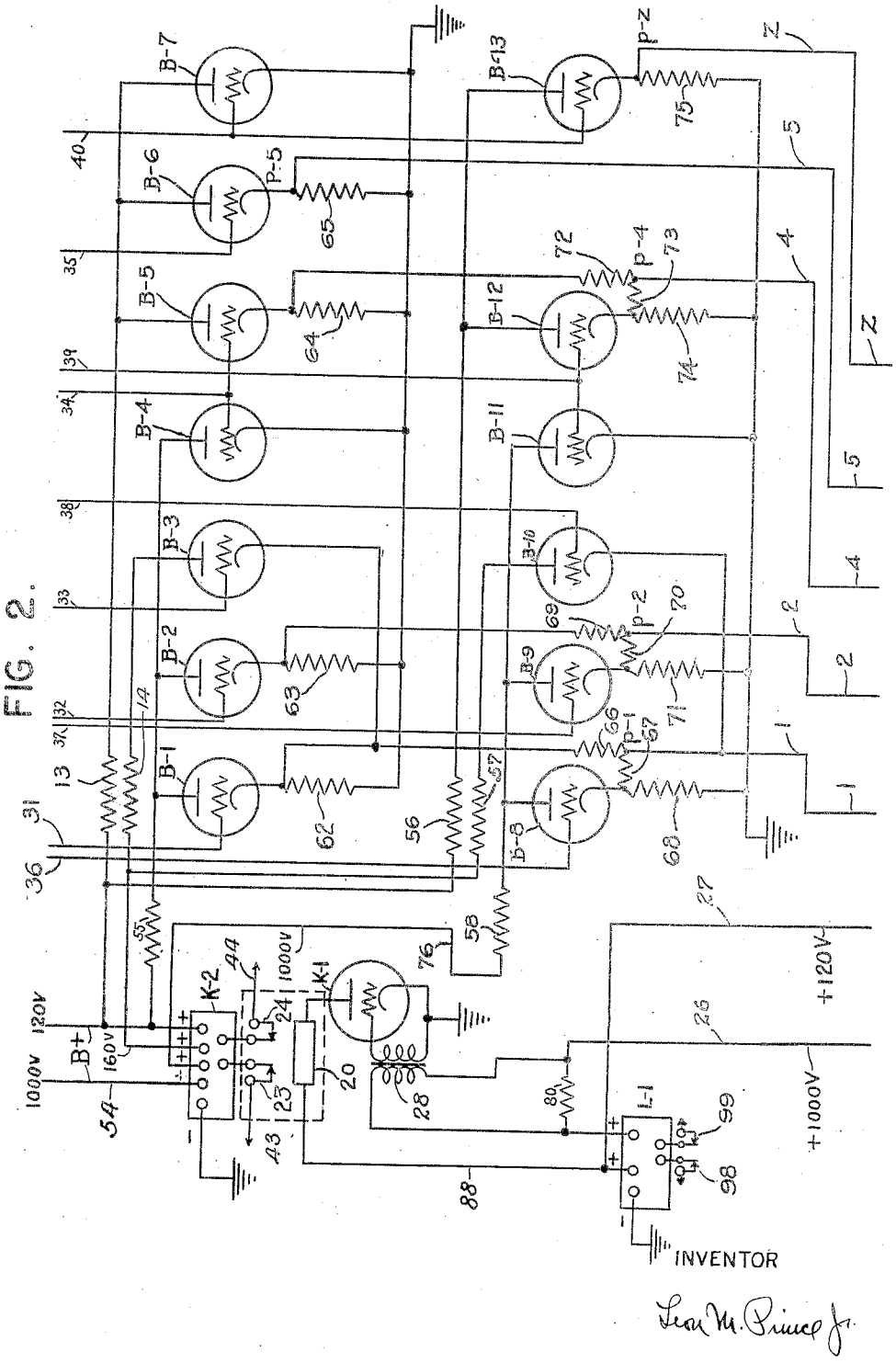

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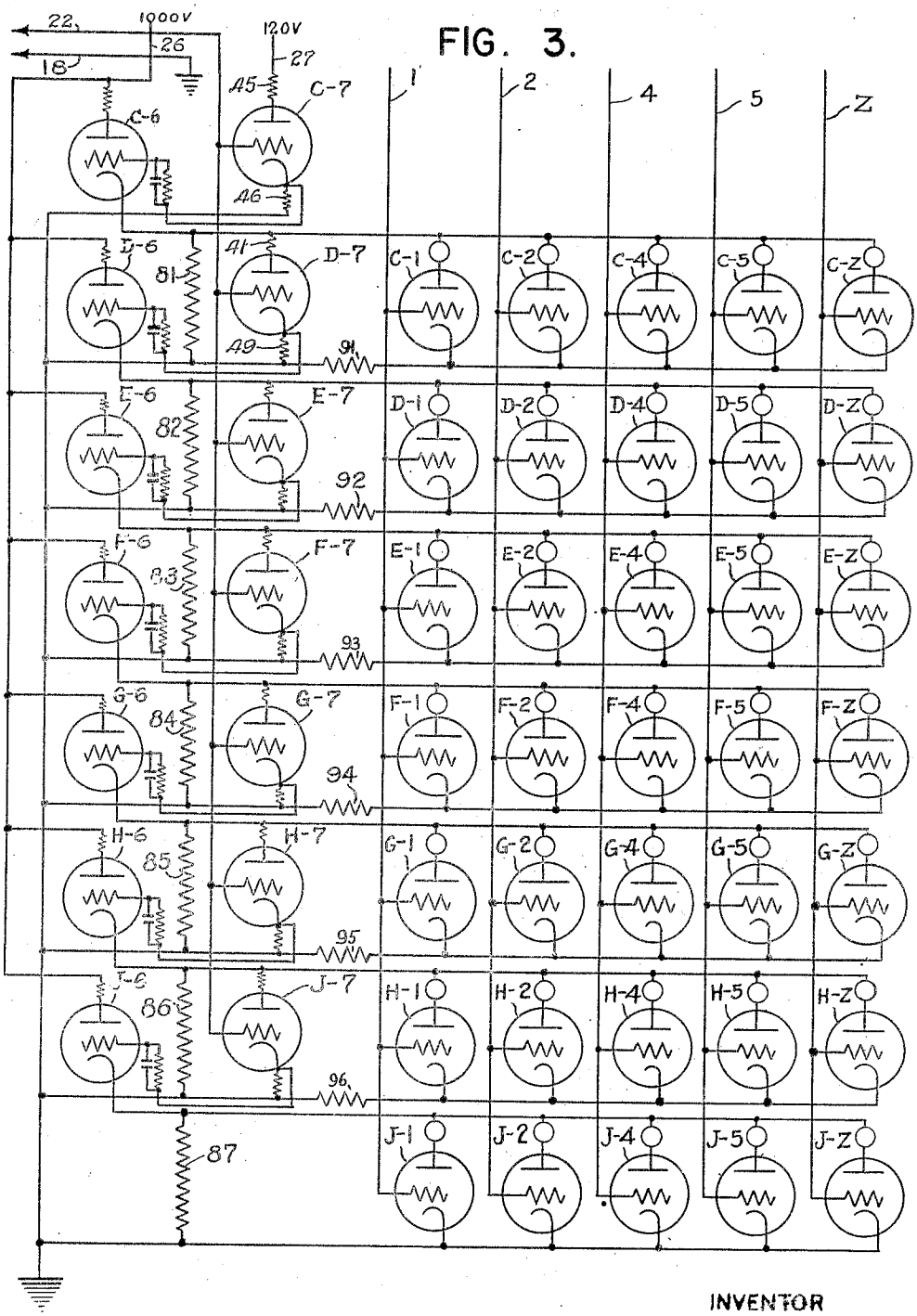
FIG. 3.



INVENTOR

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UNITED STATES PATENT OFFICE

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AUTOMATIC TELEPHONE SYSTEM

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Application September 11, 1939, Serial No. 294,230

14 Claims. (Cl. 179—18)

This invention relates to electronic control circuits and more specifically to application of such circuits to automatic telephone systems.

The accompanying Figures 1, 2 and 3 represent an all-electronic register circuit for a panel sender of a dial telephone system. It is designed for use with telephone numbers comprised of seven units, e. g., the numbers used in New York city. The circuit is subdivided into three main circuits and two auxiliary control circuits. The first main circuit, Figure 1, is called the "counting circuit" and is comprised of tubes A—1 to A—13. The second main circuit, Figure 2, is called the "differentiating circuit" and consists of tubes B—1 to B—13. The third main circuit, Figure 3, is called the "register circuit" and is comprised of tubes C—6, C—7, C—1, C—2, C—4, C—5, and C—Z . . . . . J—6, J—7, J—1, J—2, J—4, J—5, and J—Z. Auxiliary reset circuits are comprised of apparatus K—1, K—2, and L—1, shown in Fig. 2.

For the purpose of illustrating the cooperation of the three circuits a brief description of a typical automatic telephone dialing system is included. When a telephone subscriber wishes to dial a number, e. g. Endicott 2-7769, he places his finger in the opening of the dial showing the letter E and pulls the dial around to the stop bracket. When the dial is released the dial clicks off three signals. Next, he places his finger in the opening showing N and again pulls the dial around to the stop bracket. Upon releasing it, the dial clicks off six signals. Then he dials the number 2 and the dial clicks off two signals. This is repeated for the numbers 7, 7, 6, and 9 in order, and each time the dial clicks off signals corresponding to the number dialed.

Each of these clicks is transformed into an electrical impulse and it is the purpose of my counting circuit, Fig. 1, to count each one of these impulses. Thus, on the first series of impulses corresponding to the letter E, the counting circuit will record 3. It is there reset, as it is after each successive series of impulses. Upon the second series of impulses corresponding to the letter N it will record 6. Upon the third series of impulses, corresponding to 2, it will record 2. This will be continued until all the numbers are counted. After counting each series of impulses, the counting circuit sends its count to the differentiating circuit, Fig. 2, which actuates circuits corresponding to the count which in turn actuate the register circuit, Fig. 3, to record the result and cause the number to be connected. The counting circuit and the differentiating circuits are then cleared and are ready to receive the next series of impulses. The register circuit is not reset until the whole series of numbers have been recorded and retransmitted to an automatic switching apparatus (not shown) which, as is well known in the automatic telephone art, is suitably operated to connect the proper subscriber circuit to the trunk line.

In order to save duplication of equipment in the register circuit, Fig. 3, the telephone company uses only a few of the numbers from 1 to 0. Just five units are used in this code but these five units are made to do the work of ten. These units are 1, 2, 4, 5, and z, the latter representing the character 0. The dialing of the number 1 or a letter corresponding to it is represented by 1; the dialing of the number 2 or a letter corresponding to it is represented by 2; the dialing of the number 3 is represented by 2 and 1 in combination; the dialing of 4, by 4; the dialing of 5, by 5; the dialing of 6, by 5 and 1; the dialing of 7, by 5 and 2; the dialing of 8, by 5, 2 and 1; the dialing of 9, by 5 and 4; and finally the dialing of 0, by z alone.

The counting circuit, Fig. 1, counts out the total number of impulses in each series of clicks as the dial sends them out. The function of the differentiating circuit, Fig. 2, however, is to take these dialed impulses and codify them so that the output circuit of the differentiating apparatus actuates the proper lines of the five lines corresponding to the numbers 1, 2, 4, 5, and z of the code. These lines in turn will supply operating potential for the grids of each set of tubes in the register groups, Fig. 3. For example, on the second dialing operation corresponding to the letter N, six impulses will be received by the counting circuit shown in Fig. 1. This will operate six odd-numbered tubes in the counting circuit which in turn will operate corresponding tubes in the differentiating circuit shown in Fig. 2 so as to put operating potential on lines 5 and 1 of its output circuit.

As a result, tubes D1 and D5 in the second group of tubes in the register circuit shown in Fig. 3, will be operative, indicating that the second unit of the telephone number dialed is N (or 6). In the same way, the operation of tubes C1 and C2 in the first register group indicates that the letter E (or 3) is the first letter of the number dialed. The operation of tube E2 in the third register group indicates that the number 2 is the third number dialed. This continues down the line until tubes 15 and 14 in the bottom group of tubes operate to indicate that 9 was the final number dialed. How these results are accomplished by my circuit is described in greater detail hereafter.

D. C. potential is suplied to the plates of all tubes. In the present arrangement gas-filled tubes are used having operating characteristics such that a plus bias of 20 volts on the grids is required to render them operative. Any tubes with similarly suitable characteristics may, of course, be substituted.

Referring to Figure 1, it is the purpose of the counting circuit to count the impulses of the dial and to transmit the results of this counting to the differentiating circuit. This circuit is composed of a series of pairs of tubes A—1 and A—2, A—3 and A—4, through A—17 and A—18, and the single tube A—19. Each pair is comprised of a primary and secondary tube, the secondary tube in each instance acting to prepare the following primary tube for operation. The single tube A—19 does not require a secondary tube because it is the last tube in the line and therefore has no corresponding secondary tube to prepare for operation. All the odd numbered tubes in group A are primary tubes and the even numbered are secondary tubes. The grids of all the primary tubes are in parallel and connected with input line 21, 19. This input line 19, 21 is arranged to respond to the dialed number by temporarily raising the potential of the common primary grid line 25 from ground potential to some higher value, i. e., 20 volts, for each dial click received over line 19, 21. This grid potential impulse is timed by a suitable time constant circuit to die out in a predetermined time interval before the next dial click is received. Thus the grid line 25 will receive a series of sharp transient impulses, i. e., a series of 20-volt pulses, spaced in a predetermined manner, the number of which impulses will correspond to the number of dial clicks received, i. e., to the digit dialed.

Thus, upon the first impulse of a given series corresponding to a given number from 1 to 0 which is dialed, the grid of tube A—1 will lose control. Current will then flow from source of potential of 120 volts at power supply K—2 of Figure 2 through line 53, through current limiting resistor 51, tube A—1, and cathode resistor 41 to ground. As a result line 31 will assume a potential of 20 volts instead of its original potential of zero. One of the results of this change in potential is to charge the condenser 46 through resistor 45 which, after a time delay commensurate with values of said condenser and resistor, will cause the grid of tube A—2 to lose control. Operation of tube A—2 permits current from source of potential of 1000 volts at power supply K—2 in Figure 2 to flow through line 54, current limiting resistor 49, tube A—2, and cathode potentiometer 42 to ground. The IR drop across potentiometer 42 raises the cathode-anode potential of tube A—3 from zero to approximately 120 volts. But by this time the first impulse on line 25 has died out since the time delay in condenser 46 and resistor 45 is so adjusted that tube A—2 will operate some time after the first impulse occurs but before the second one. Therefore, A—3 cannot operate on the first impulse. Before the second impulse occurs, howevers, the IR drop across resistor 42 is sufficient to supply A—3 with a plate potential of 120 volts and therefore A—3 is ready to operate if and when the second impulse occurs. When the grid of tube A—3 loses control as a result of a second impulse on line 25, current flows from the 120 volt source of potential across the cathode potentiometer 42 of tube A—2 through a current limiting resistor 52, tube A—3, and cathode resistor 43 to ground. As before, tube A—4 does not operate until after the second impulse has subsided and before the third one begins. Thus, the potentiometer 44 in the cathode circuit of tube A—4 does not supply tube A—5 with plate voltage until just after the second impulse dies out. Thus tube A—5 cannot operate on the second impulse but is ready to respond to a third impulse.

In this fashion each successive pair of tubes will operate as long as the dial sends out impulses. The value of resistor 51 in the plate circuit of tube A—1 controls the current in resistor 41 so that the IR drop is 20 volts, or more. Resistor 52 in the plate circuit of tube A—3 performs the same function for resistor 43, as do all the other resistors in the plate circuits for the resistors in the cathode circuits of the primary tubes. The value of resistor 49 in the plate circuit of tube A—2 controls the current in cathode potentiometer 42 so that the IR drop equals approximately 120 volts. Similarly, resistor 50 in the plate circuit of tube A—4 performs the same function for cathode potentiometer 44 as do all the resistors in the plate circuits for the cathode potentiometers of the secondary tubes.

After each series of impulses corresponding to a single number of the telephone number to be dialed, the currents in the plate circuits of the A tubes are temporarily interrupted by means of relay contacts 22 and 24 in Figure 2, and they are all reset and immediately ready to operate again. The sequence of events resulting is this operation will be hereinafter described in connection with the circuits shown in Figure 3. In addition to supplying grid control potential for their corresponding secondary tubes, these potentiometers, i. e., the resistors in the cathode circuit of the primary tubes, also control the grid circuits of tubes B—1 through B—13, shown in Figure 2, to which they are connected by lines 31 through 43.

As an example of the actual operations of the circuits just described in connection with Figure 1 let us dial the telephone number Endicott 2–7769. Translating this telephone number into figures it becomes 3—6—2—7769. In accordance with this sequence of numbers, the counting circuit will first operate so that a potential of 20 volts will be on lines 31, 32, and 33. After the dial returns to rest, relay contacts 23 and 24 will operate interrupting the plate circuits and resetting all tubes in the counting circuit (and in the differentiating circuit, Fig. 2, as will hereinafter be explained). The next series of impulses is 6, so lines 31 to 36, inclusive, will have operating potential on them. After the next interruption, lines 31 and 32 will possess operating potential. After the next two interruptions lines 31 to 37, inclusive, will possess operating potential. After the next interruption, lines 31 to 36, inclusive, will possess operating potential. Finally, after the next interruption, lines 31 to 39, inclusive, will possess operating potential. Upon the dial's return to rest after this final signal, the plate circuits will be interrupted once more, clearing the group A tubes for a new incoming call.

The function of the differentiating circuit shown in Figure 2 is to record the results of the counting circuit shown in Fig. 1 in such a way as to make these signals available for use in the register circuit lines 1, 2, 4, 5, and z connecting the differentiating circuit of Figure 2 with the register circuit of Figure 3. The tubes in this differentiating circuit are, in a sense, arranged into six groups. They are (1) tubes B—1, B—2, and B—4, whose plates are connected together to a single series resistor 55 and thence to a 120 volt source of potential; (2) tube B—3, the cathode of which is connected to the cathode of tube B—1 but through its own plate resistor 14 to approximately 160 volts at source K—2; (3) tubes B—5,

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