

Oct. 12, 1937.

J. I. BELLAMY

2,095,730

STOCK QUOTATION SYSTEM

Filed Dec. 11, 1929

16 Sheets-Sheet 1

STOCK-LETTER KEYS

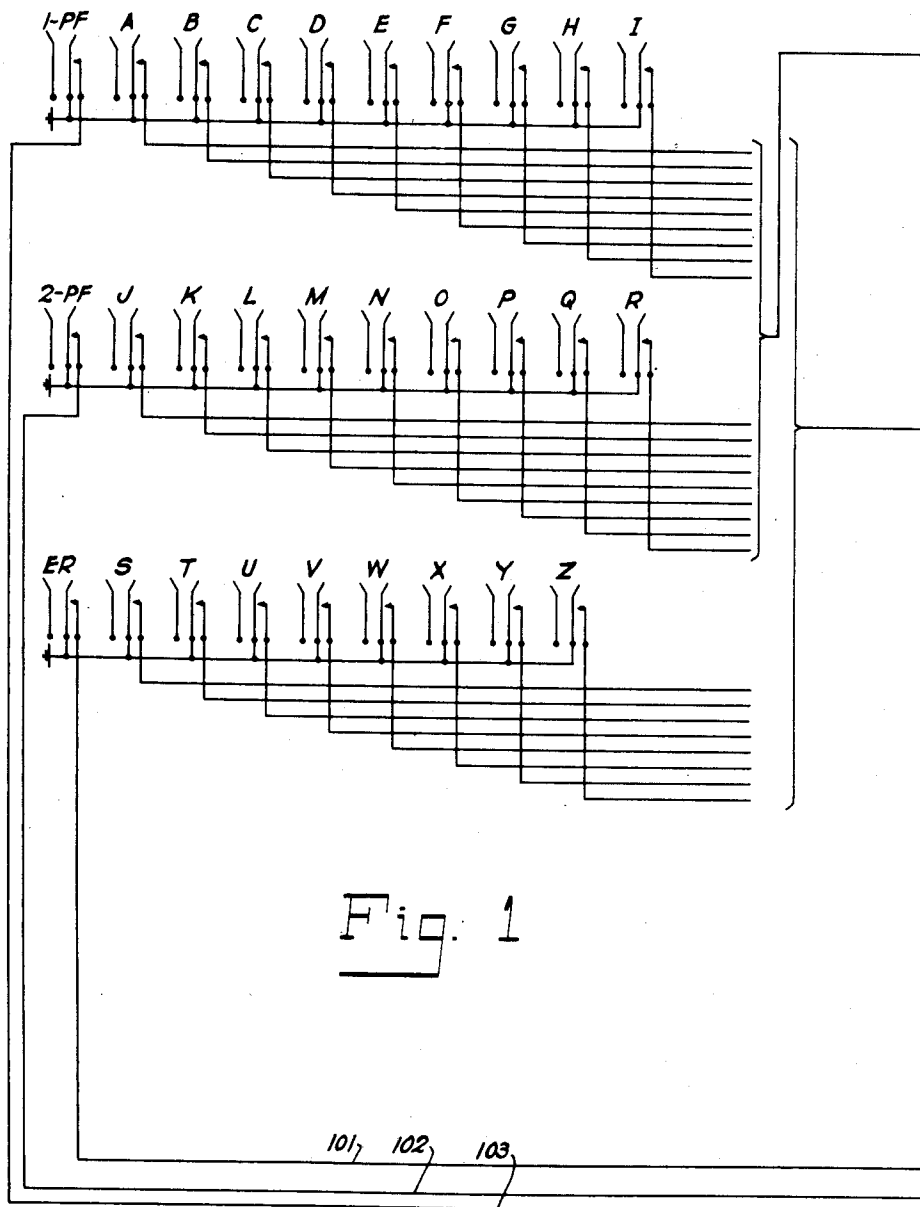


Fig. 1

101, 102, 103

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Oct. 12, 1937.

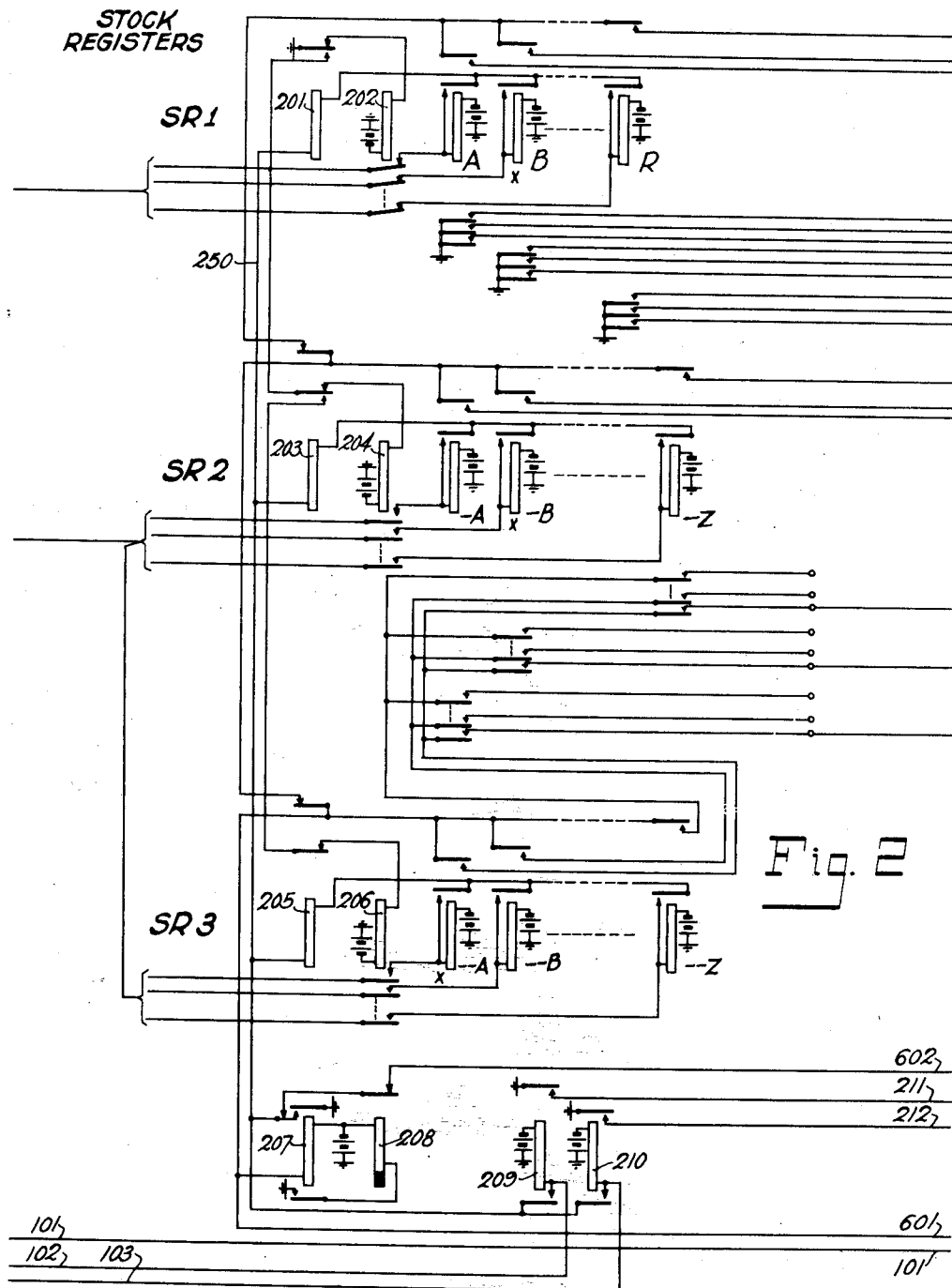
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STOCK QUOTATION SYSTEM

Filed Dec. 11, 1929

16 Sheets-Sheet 2



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2,095,730

STOCK QUOTATION SYSTEM

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16 Sheets-Sheet 3

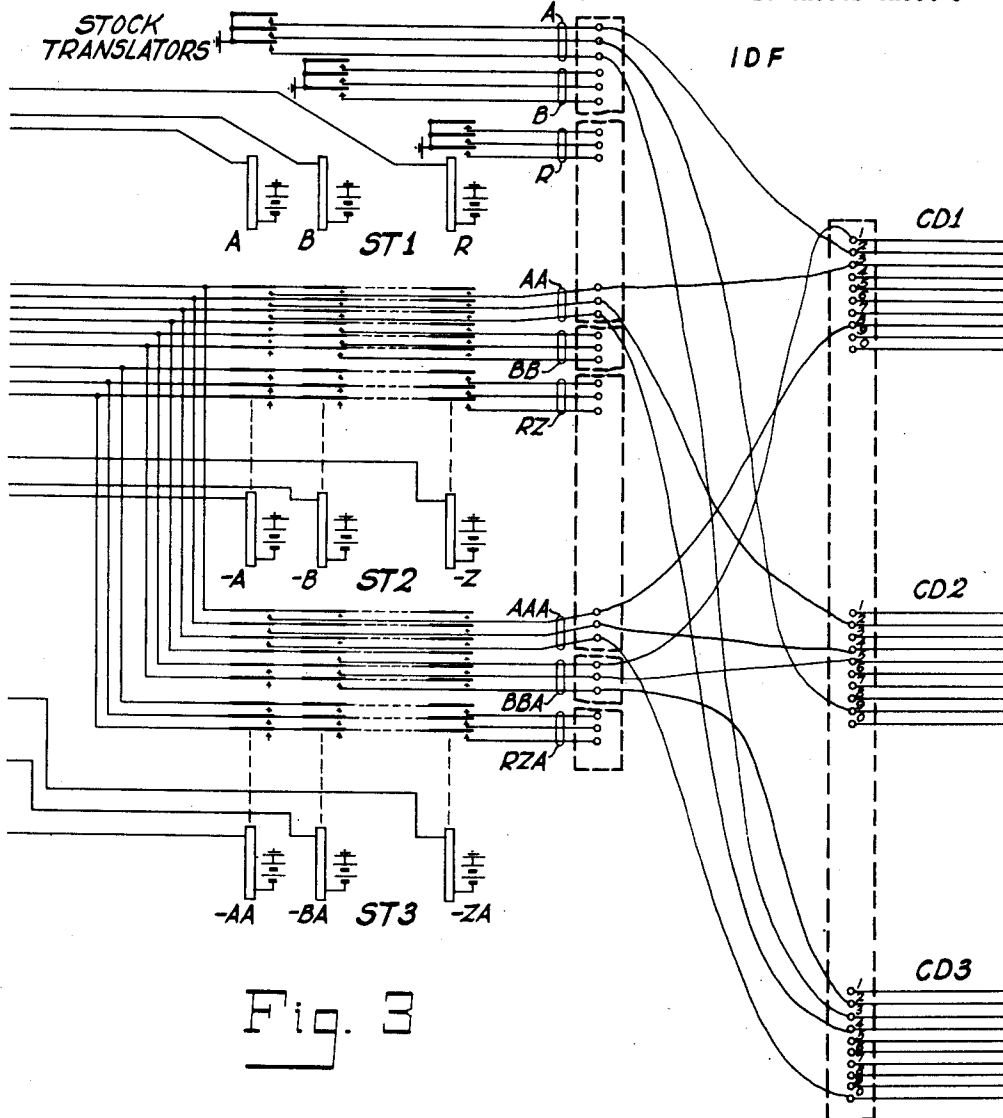


Fig. 3

602

211

212

601

101

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STOCK-CODE
REGISTERS

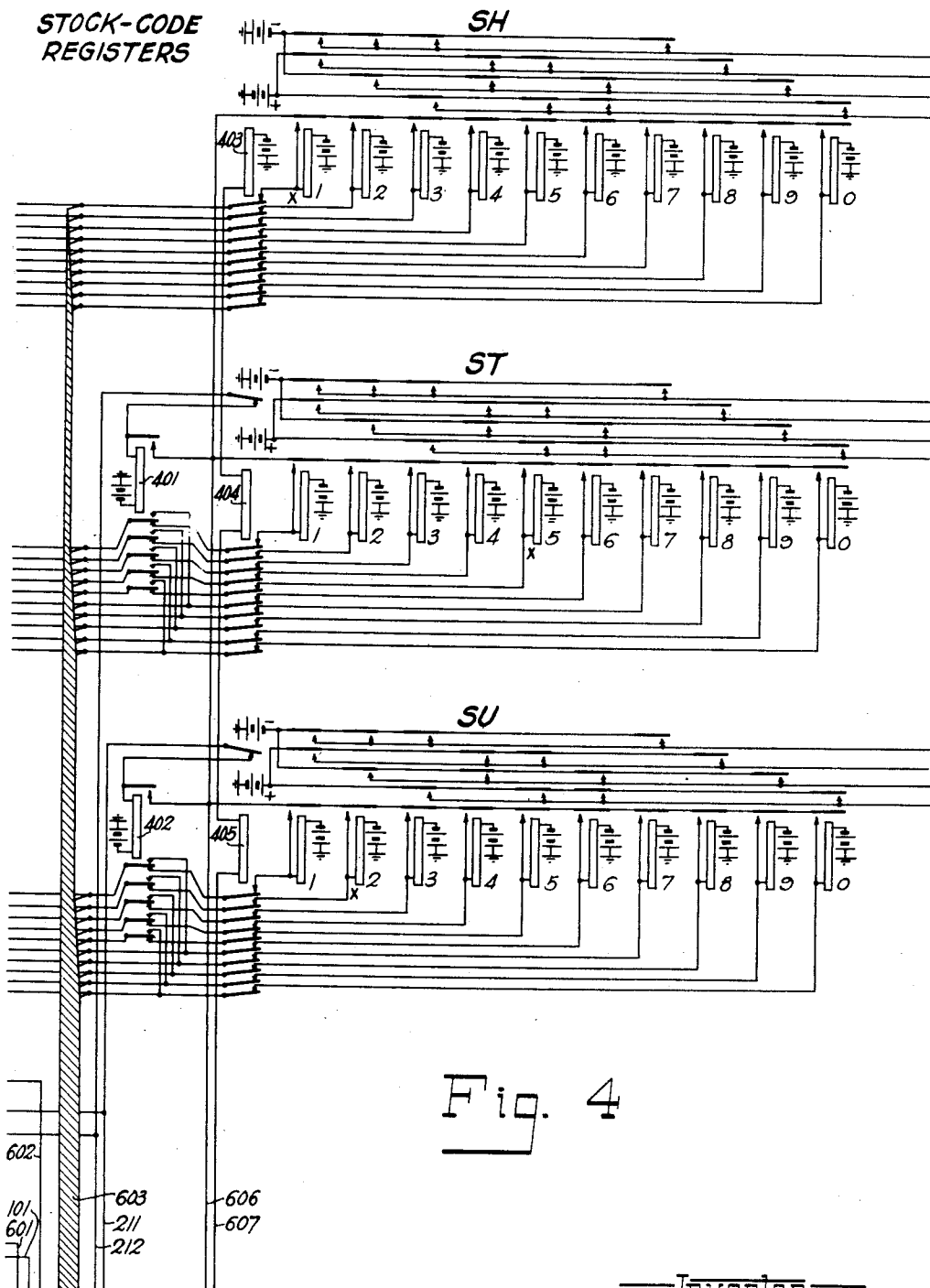


Fig. 4

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STOCK QUOTATION SYSTEM

2,095,730

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Fig. 5

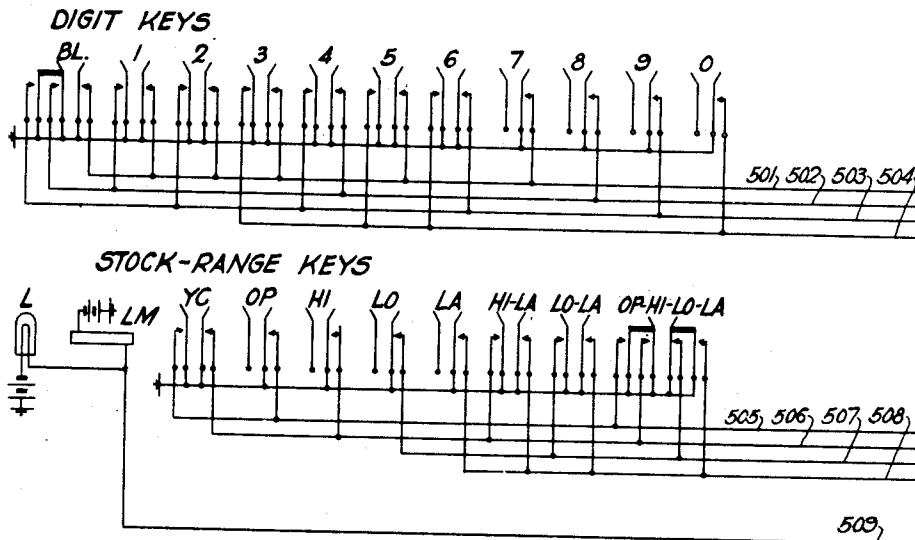
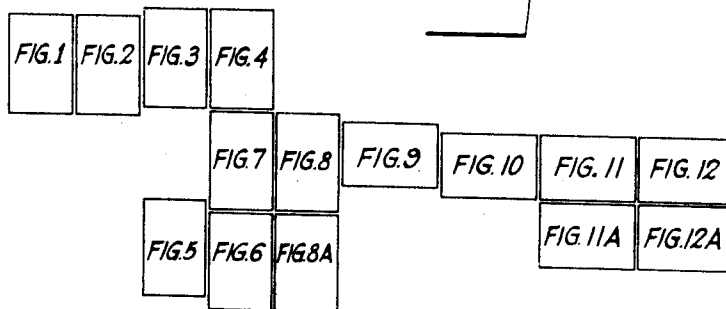


Fig. 17



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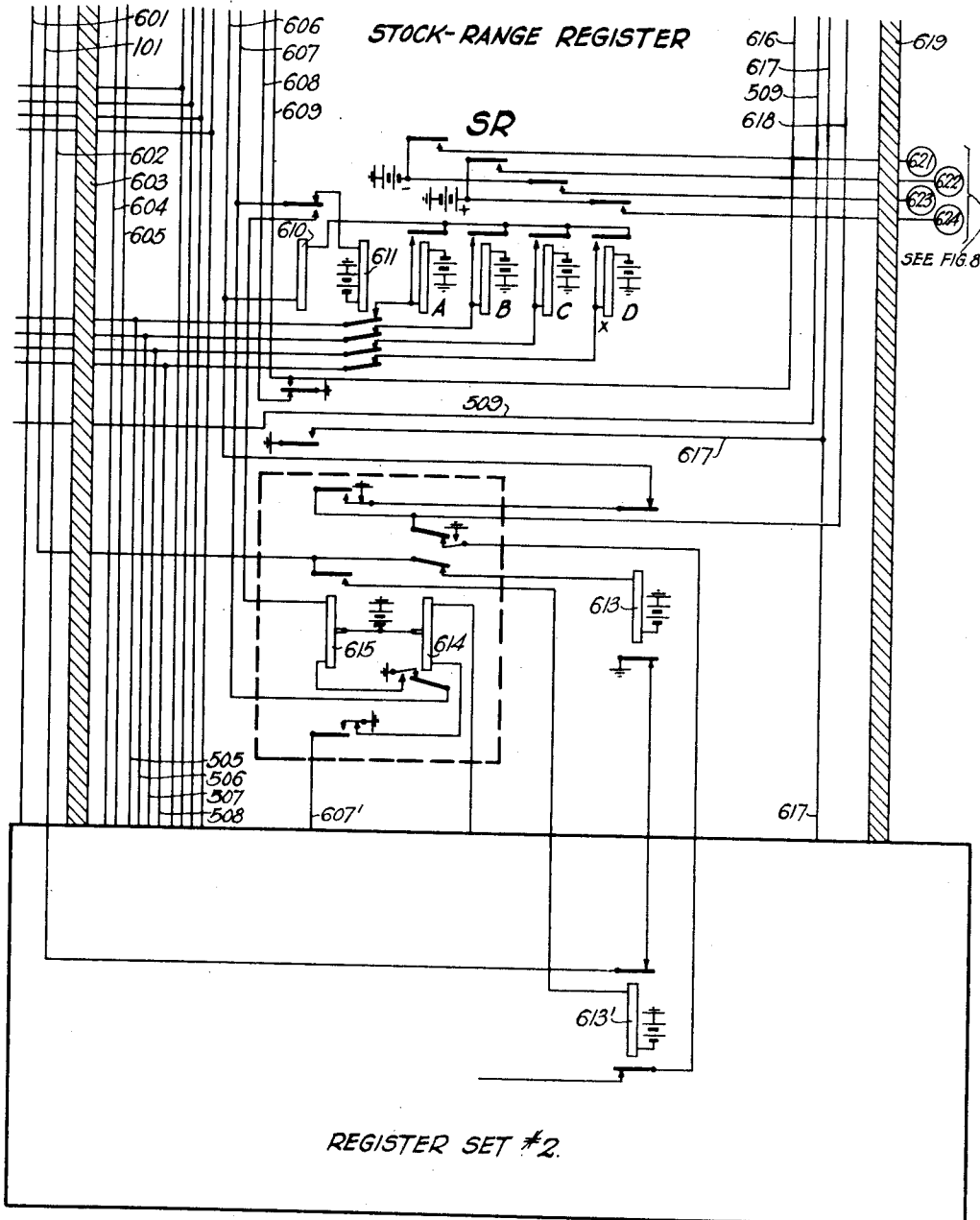


Fig. 6

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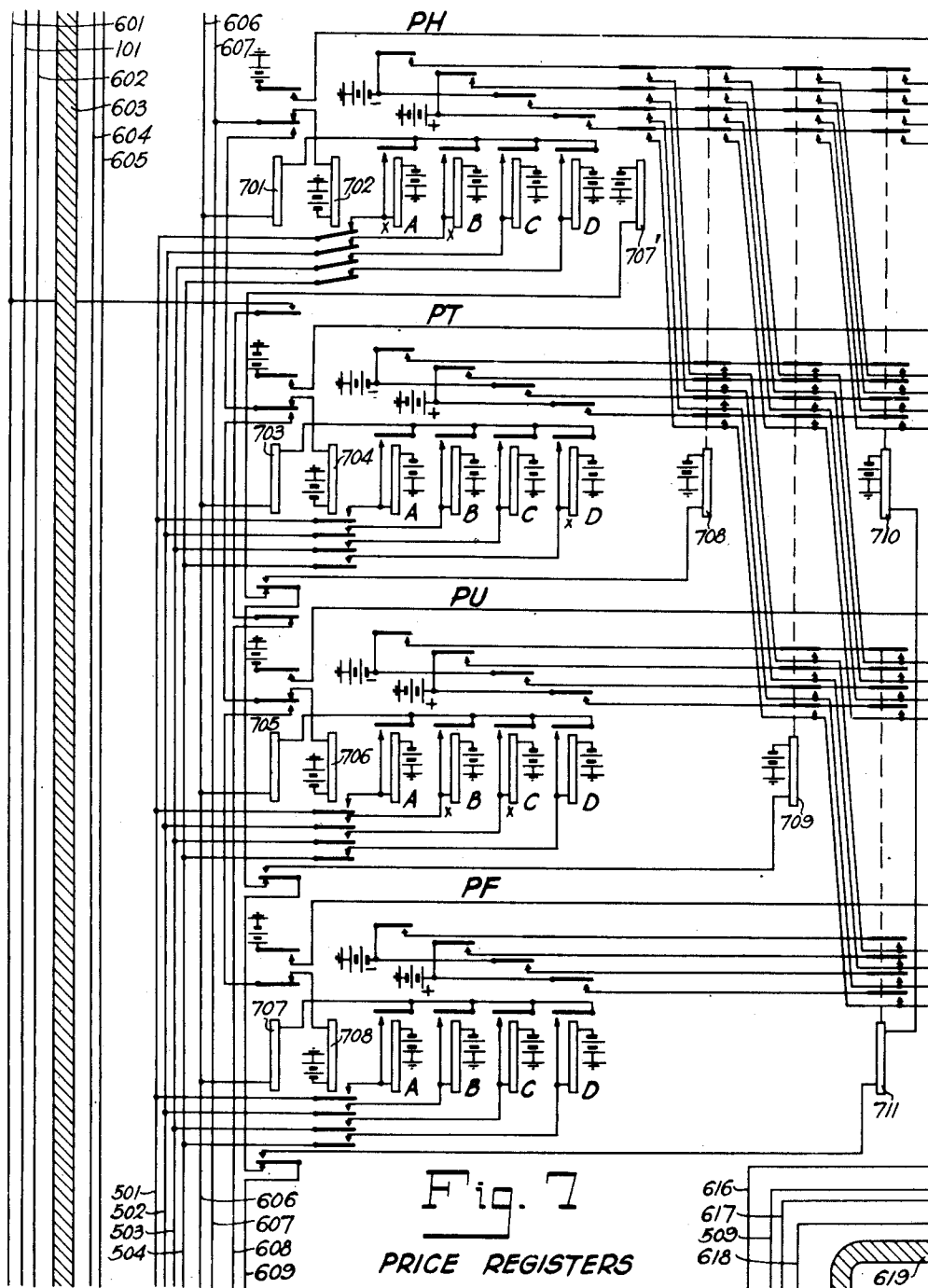
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STOCK QUOTATION SYSTEM

Filed Dec. 11, 1929

16 Sheets-Sheet 7



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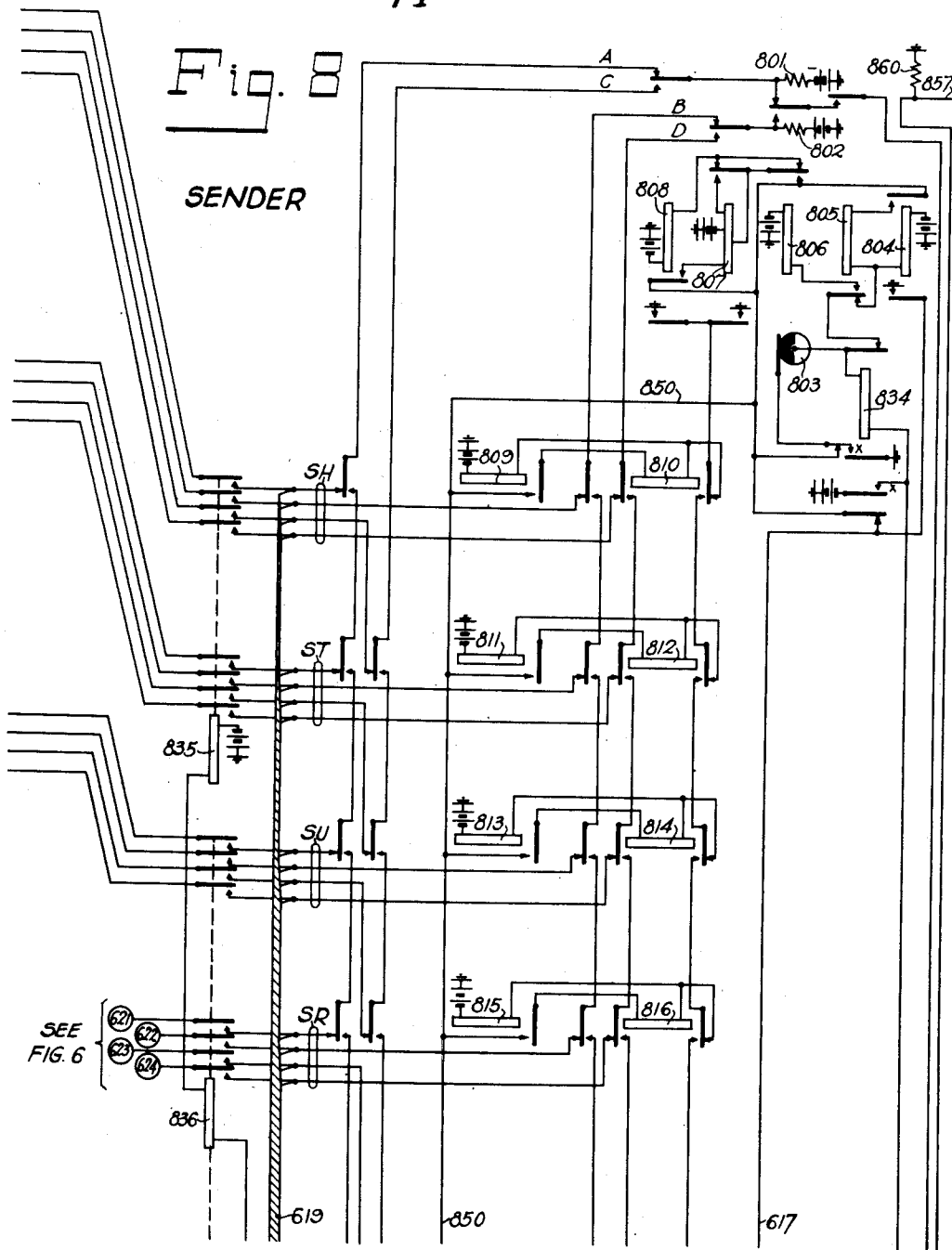
2,095,730

STOCK QUOTATION SYSTEM

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T1



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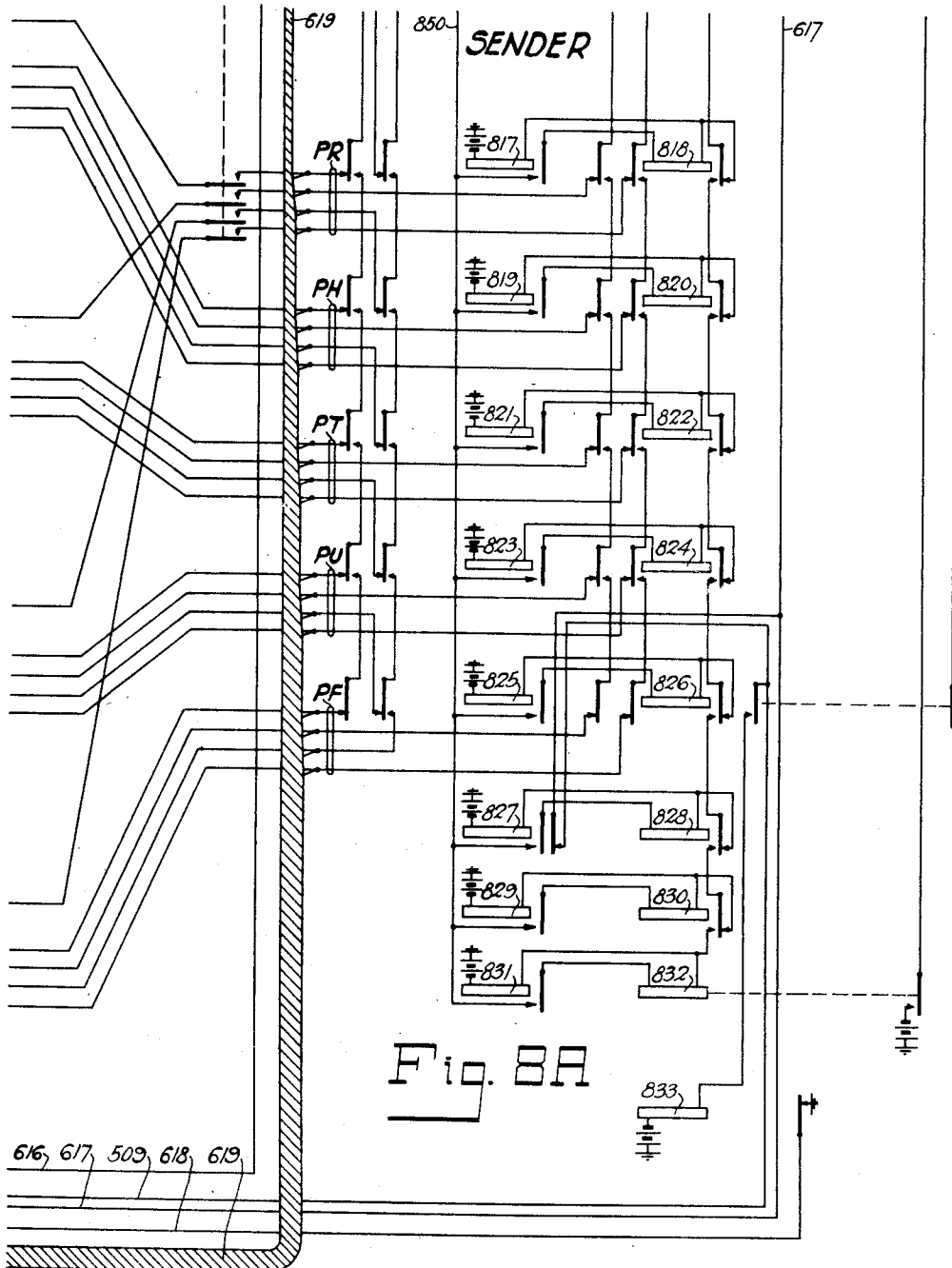
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STOCK QUOTATION SYSTEM

Filed Dec. 11, 1929

16 Sheets-Sheet 9



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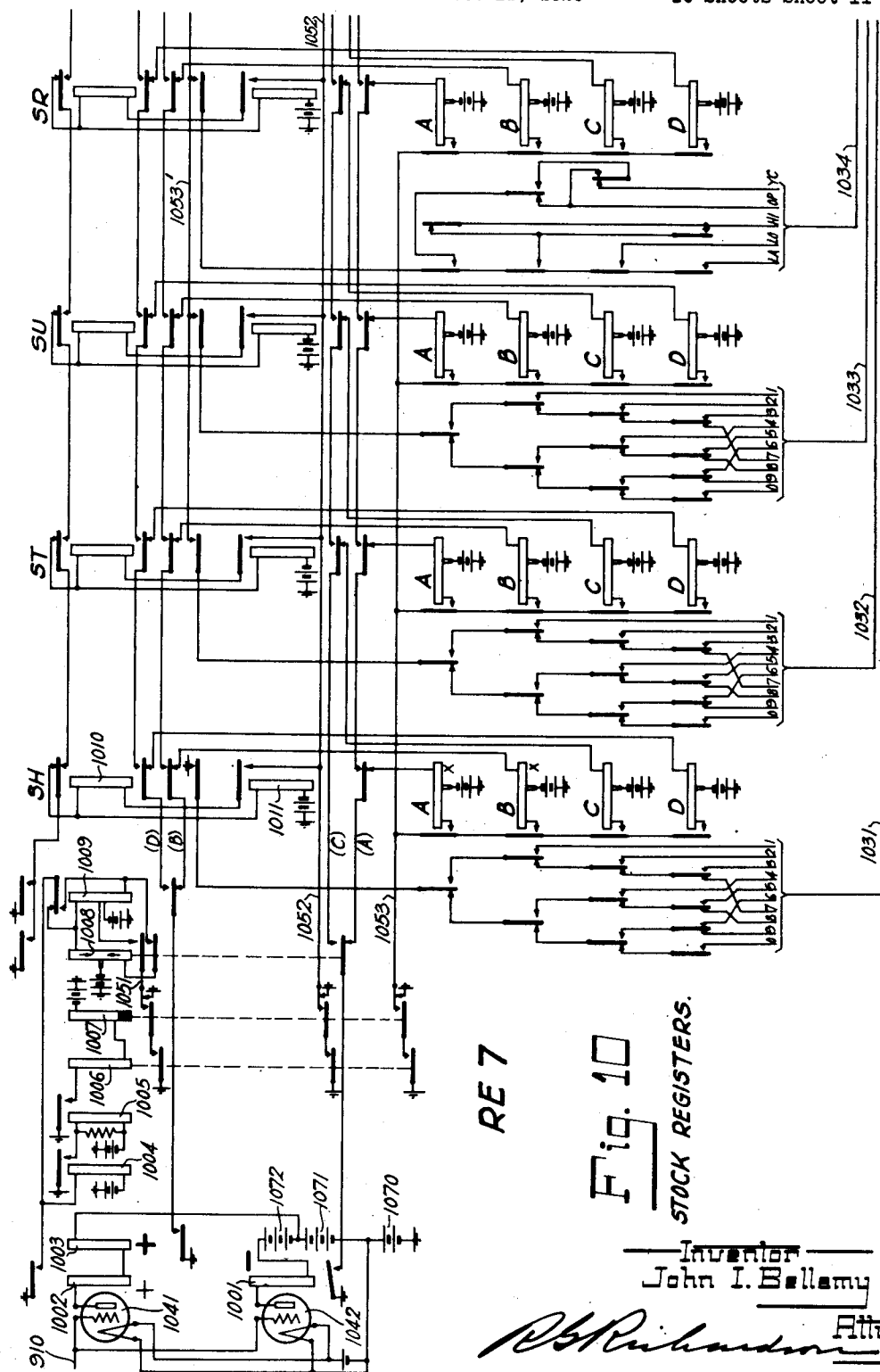
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Oct. 12, 1937.

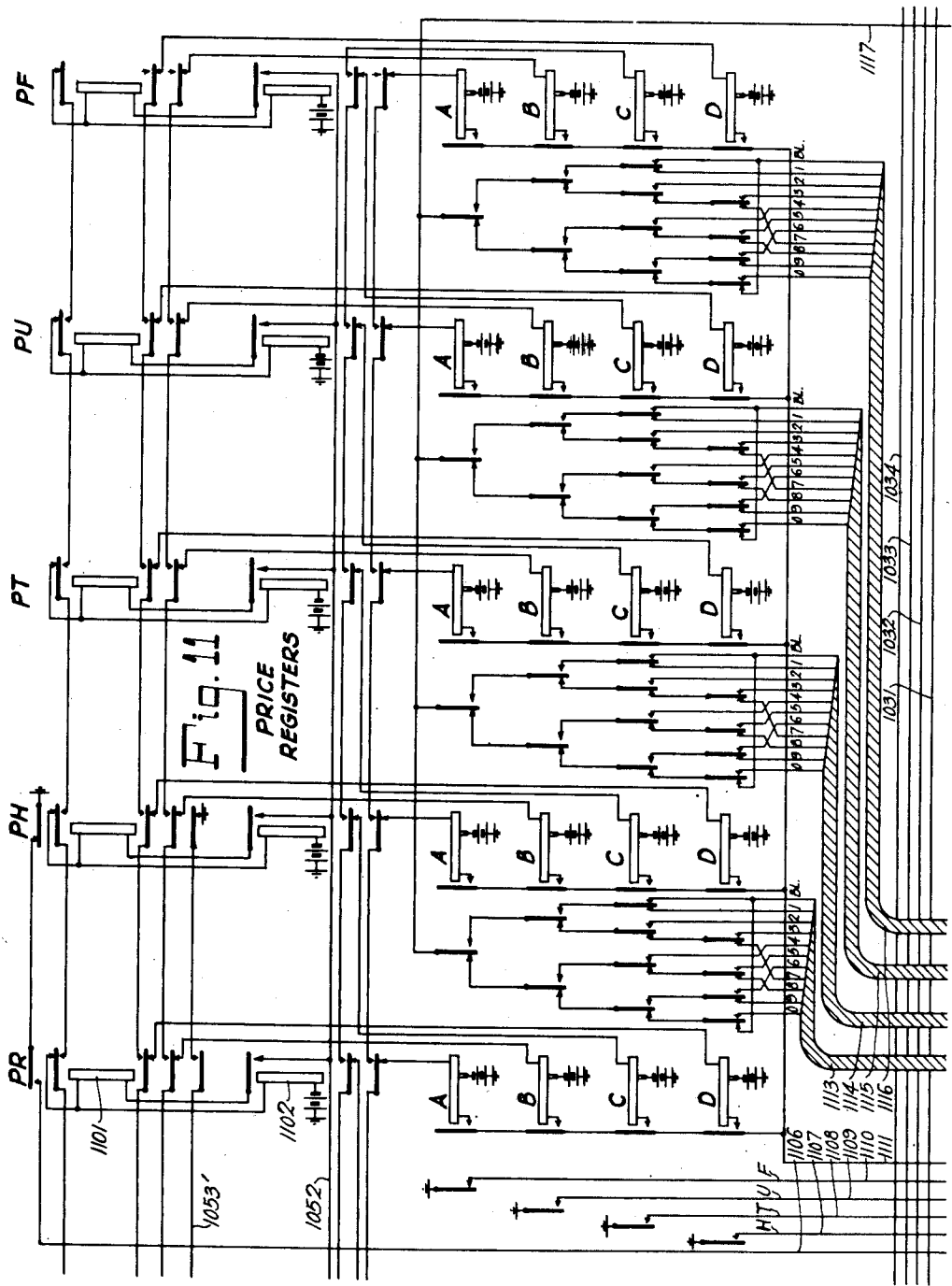
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STOCK QUOTATION SYSTEM

Filed Dec. 11, 1929

16 Sheets-Sheet 12



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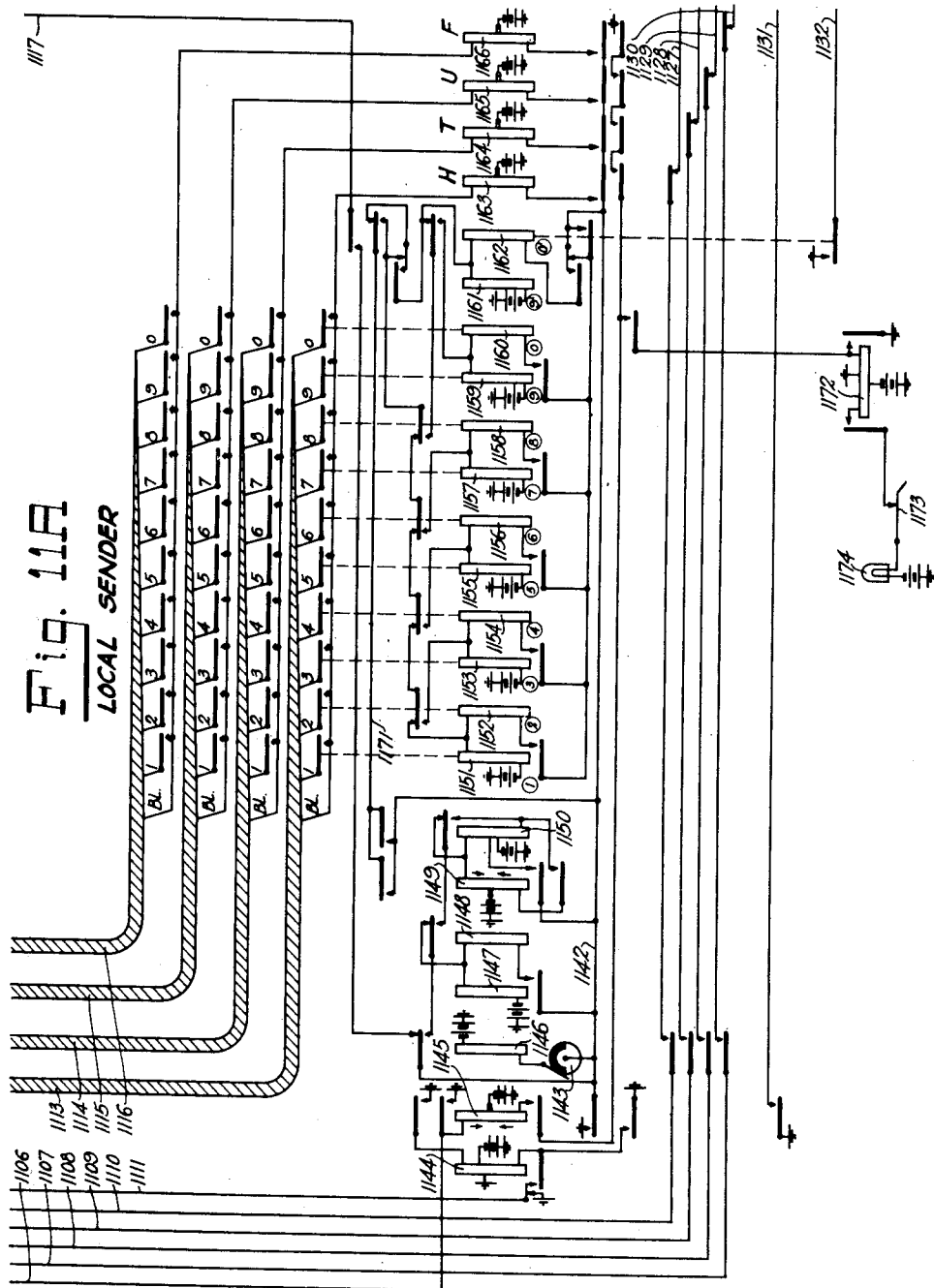
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STOCK QUOTATION SYSTEM

Filed Dec. 11, 1929

16 Sheets-Sheet 13



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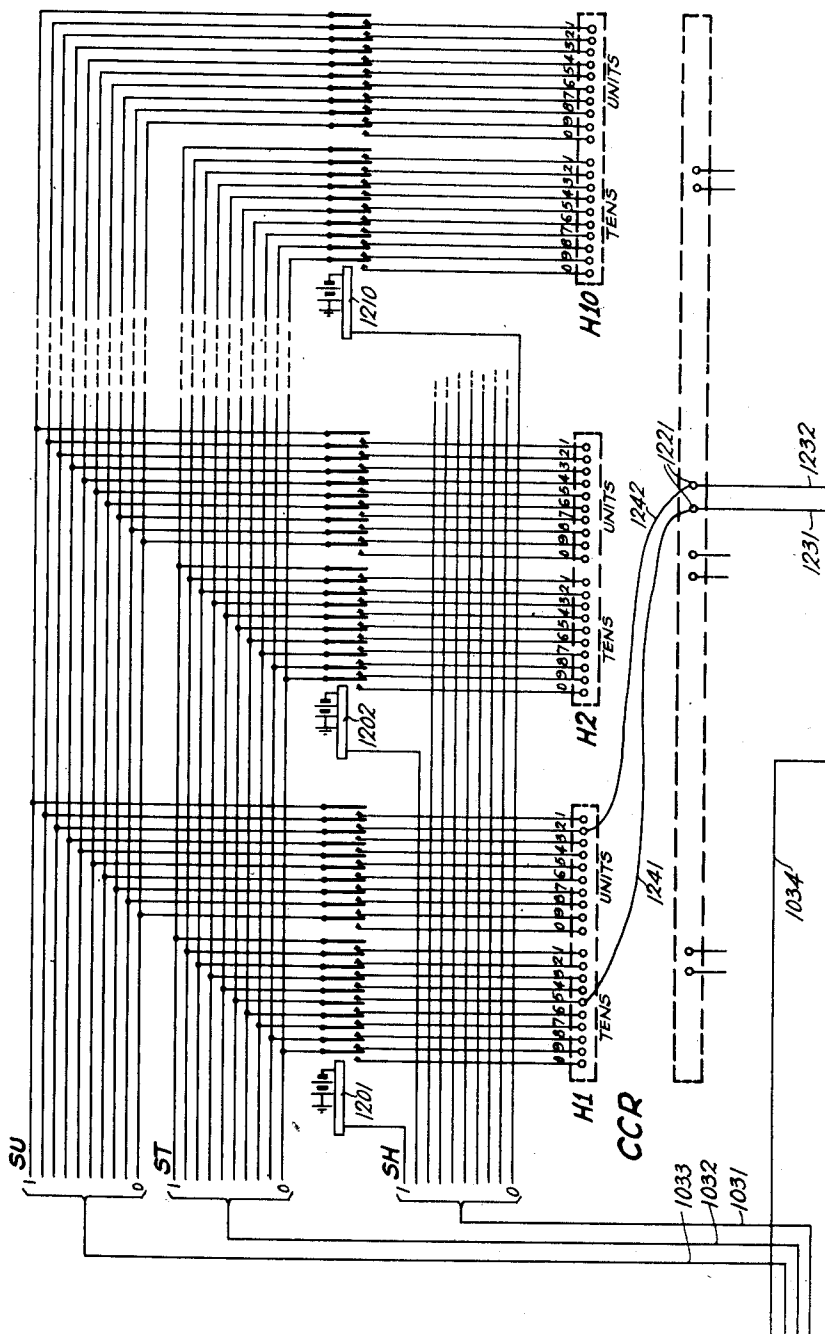
2,095,730

STOCK QUOTATION SYSTEM

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Fig. 12
HUNDREDS SELECTOR



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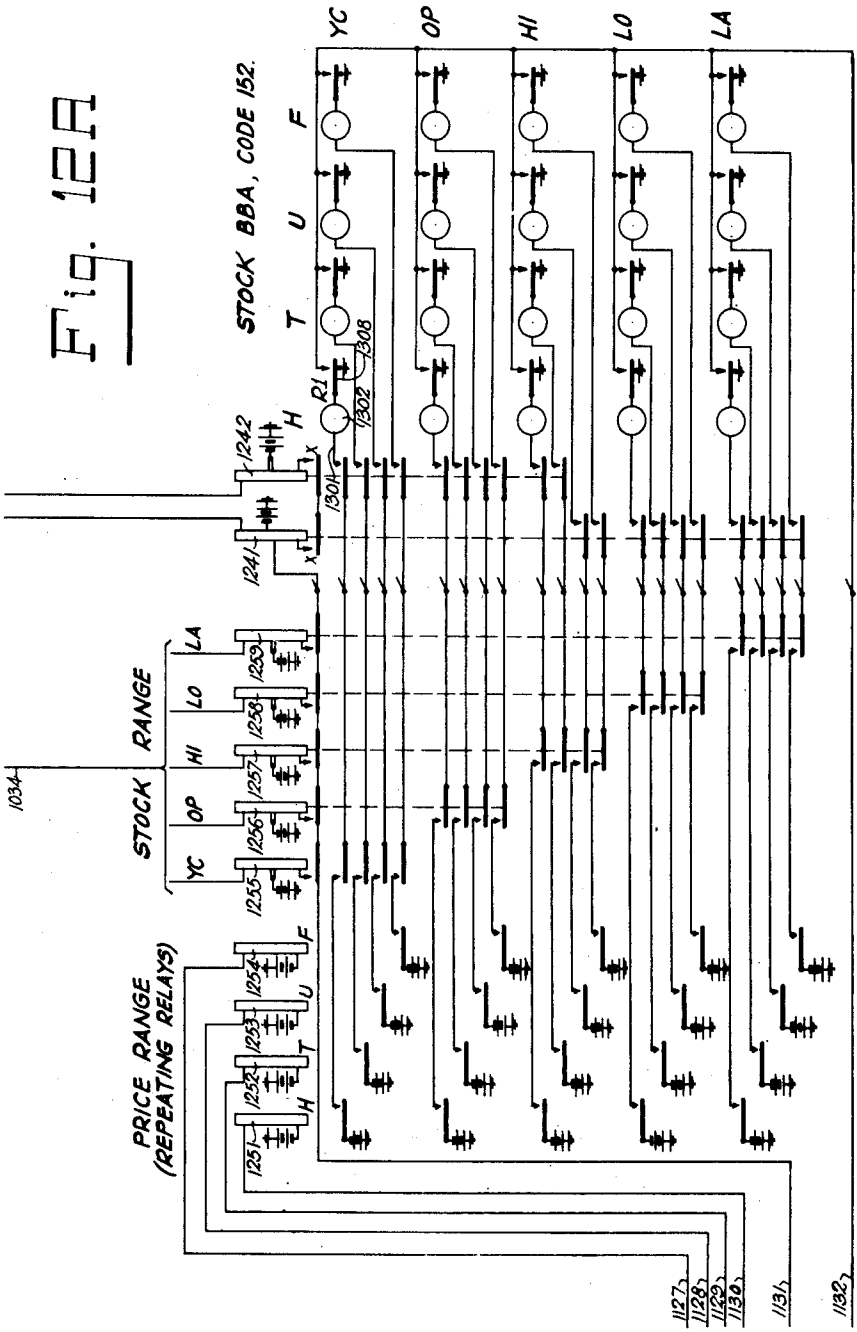
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Fig. 12R



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UNITED STATES PATENT OFFICE

2,095,730

STOCK QUOTATION SYSTEM

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Delaware

Application December 11, 1929, Serial No. 413,205

4 Claims. (Cl. 177—353)

The present system relates to transmitting and receiving systems, but is concerned more particularly with systems of this kind wherein the transmitter comprises a register sender and wherein the receiver comprises an indicating device responsive to impulses received from the transmitter.

The main object, broadly stated, is the production of a new and improved transmitting and receiving system suitable for transmitting information regarding the selling price of stocks so that such prices may be received and set up on indicators at a plurality of points.

The system herein disclosed is an improvement on the system disclosed in the application of Bellamy et al., Serial Number 378,208, filed July 15, 1929 corresponding to British Patent 358,889. As pointed out in this prior application, it is customary for a stock broker to have a so-called stock ticker in his office from which a tape slowly unwinds, giving the selling prices of the active stocks. The broker has an attendant who reads the tape and marks down the prices on a blackboard so that the waiting customers may see the trend of the market. In addition to showing the last selling price in a space provided under the name of a given stock, the blackboard shows yesterday's closing price, today's opening price, the high price of the day, and the low price of the day. Certain of the features described in this application are being claimed in the divisional application Serial No. 527,905, filed April 6, 1931, and also in the divisional application Serial No. 540,993, filed May 29, 1931.

General description

One outstanding disadvantage of the method of procedure above outlined is that the person writing down the prices and making continuous changes is as often as not in such a position as to obscure the board from the view of the customers. In addition, the total amount of labor required, considering the brokers' offices as a whole, is quite enormous, and it is to the interest of efficiency to reduce this labor to a minimum. For this purpose, it is proposed in the above-mentioned prior application, to provide a single point at which the desired information can be recorded and to provide an automatically operated indicator in each broker's office controlled from a separate transmitter at the single recording point.

It is proposed further in the said prior application, to make use of the usual ticker tape at the central point, and to provide two operators for

setting up the quotations. The stocks are listed by means of the letters of the alphabet, some stocks being represented by a single letter, some by two, and others by three. In order to make a division of stocks between the two operators, all stocks represented by the letters A to K may be assigned to one operator, as well as all stocks of two or three letters of which the first letter is A to K. The second operator takes care of the sales involving the stocks L to Z and the plural letter stocks whose designations begin with any one of the letters L to Z.

Certain outstanding features that distinguish the present systems from the system disclosed in the above-mentioned prior application are as follows:

1. In the transmitter, instead of depending upon a slow-acting relay to provide the timing between successive transmissions, additional counting relays are provided auxiliary to the sender which count a predetermined number of operations of the controlling interrupter before permitting the sender to start a new quotation.

2. In order to obviate the use of repeaters between the transmitter and the plurality of receivers to be operated thereby, and in order to secure faster operation in the receiver, a novel arrangement has been devised employing vacuum tubes in the receivers which respond to the impulses from the transmitter and repeat current impulses to the receiving apparatus. The advantage of this arrangement is that the current flow over the connecting line between the transmitter and the multiply-connected receivers is practically zero, and that relatively small potential changes of the interconnecting conductor, cause any desired current change in the receivers through the medium of the receiving vacuum tubes.

3. In the receiver, a local sender is provided to set the stock registers under the control of the registering apparatus which responds to the received impulses. By this means, the registers themselves may be made simple responding devices without a testing function, as in one modification of the said prior application and without elaborate mechanical interconnections as in the other modification of the said prior application.

4. By means of novel circuits within the receiver, a portion of the register can be released so that a second quotation may be partly received while the local sending apparatus is setting the stock registers in accordance with a first quotation.

In the local sender employed in the receiver to set the stock registers, new circuit arrangements have been devised which may be applicable to senders in general. One new arrangement involves using an impulse-transforming device, preceding the counting-relay chain of the sender, arranged to send only half as many impulses to the said counting relays as are sent to the stock registers being operated, so as to enable a reliable counting-relay arrangement to be used, employing two relays per impulse delivered to the counting relays, but only one relay per impulse delivered to the stock registers. The transmitter is arranged to transmit the so-called price range digit as part of each quotation, in this manner information is made available in the receiver of the number of price digits contained in each quotation before the price digits are received. This arrangement permits the local sender to be started earlier to thereby increase the permissible overlapping of successive quotations as will be hereinafter described.

Description of drawings

Referring now to the drawings comprising Figs. 1-17, they show by means of the usual circuit diagrams and mechanical drawings a transmitting and receiving system embodying the features of the invention. More in particular, Figs. 1-8 and 8A show a transmitter which may be designated as the transmitter T1; Fig. 9 indicates the transmitters T2, T3, and T4, together with a few of the plurality of receivers; Figs. 10, 11, 11A, 12, and 12A show circuit drawings of one of the receivers RE1; Figs. 13 and 14 indicate mechanical details of a stock register used in the receiver; Fig. 15 is a table showing the code according to which the impulses are transmitted by the transmitter and are received and recorded in the receiver; Fig. 16 shows a modified form of the receiver RE1 to be used whenever differences in ground potential are sufficient to interfere with the operation of the receiving arrangement of Fig. 10; and Fig. 17, appearing on the lower part of the same sheet with Fig. 5, is a layout of Figs. 1 to 12A.

The transmitter

In the transmitter, Figs. 1 to 8A, the apparatus for registering the stock-designating letters, set up on the stock letter keys of Fig. 1, comprises the stock registers SR1, SR2, and SR3 of Fig. 2; and the apparatus for translating the registration of stock letters into a three-digit code to be sent to the receiving stations comprises the stock translators ST1, ST2, and ST3, as well as the intermediate distributing frame IDF, Fig. 3. The price registers for registering the price (at which a current stock transaction took place) under the control of the digit keys of Fig. 5 comprises the price registers shown in Fig. 7. The price register PH registers the price-hundreds digit; the register PT registers the price-tens digit; the register PU registers the price-units; and the register PF registers the price-fractions digit. These designations hold true in case a full price quotation is sent, but the arrangement varies somewhat in case a lesser number of price digits is sent as will be hereinafter explained.

The stock code registers, shown in Fig. 4, are set from the translating apparatus of Fig. 3, through the intermediate distributing frame IDF, and comprise the stock-hundreds register SH, the stock-tens register ST, and the stock-units reg-

ister SU. It may be further pointed out that a so-called range indication (to be later explained) is registered on the stock-range register SR of Fig. 6 under control of the range keys of Fig. 5, and that a price-range registration is set up automatically by the action of the transfer relays, 701, 703, 705, and 707, associated with the price registers of Fig. 7.

It will be noted that the lower portion of Fig. 6 includes a rectangle labeled "register set #2". This register set #2 contains a duplicate of the equipment shown in Figs. 4 and 7, of the range register R of Fig. 6, and of the relays 835 and 836, Fig. 8. The two register sets are arranged to be used alternately so that a second registration may be set up immediately following the first and while the first is held stored on the first register set and is being transmitted. The relays 614 and 615 are common to the two registers and are arranged to switch from one register to another automatically at the end of a registration so as to automatically switch the next register into service.

The apparatus shown in Figs. 8 and 8A is the sending apparatus and it sends digit impulses under the control of the two register sets shown in Figs. 4, 6, and 7. The impulses transmitted by the sender of Fig. 8 go out over the conductor 857 to the several receiving stations, as will be hereinafter explained.

The receiver

In the receiver, Figs. 10, 11, 11A, 12, and 12A, the vacuum tubes 1041 and 1042 have their grid elements connected to the incoming line conductor 910, and they have the responding relays 1001, 1002, and 1003 connected in their plate circuits. These responding relays, with the cooperation of relays 1004-1009 send impulses to set the stock registers of Fig. 10 and to set the price registers of Fig. 11. The stock registers of Fig. 10 are labeled SH, ST, SU, and SR. They are the hundreds, tens, units, and range registers, respectively. The price registers of Fig. 11 are labeled PR, PH, PT, PU, and PF. They are the range, hundreds, tens, units, and fraction registers, respectively.

Fig. 12 shows the stock-relay hundreds selector comprising relays 1201-1210, of which the relays 1201, 1202, and 1210 only are shown; together with the associated terminals provided below the relays for the interconnection between the relay contacts and the stock-relay pairs, such as the stock-relay pair comprising 1241 and 1242. The stock-relay pairs are divided into ten groups of not more than one hundred relay-pairs per group, and the relays of Fig. 12 are operated in accordance with the stock-hundreds digit to select the hundreds group in which a stock relay is to be operated.

Each stock on the receiving board is represented by twenty registers, such as the register R-1, Figs. 13 and 14, Fig. 14 being a front view. These registers are arranged in five horizontal rows, four registers to a row. The top row (YC) indicates yesterday's closing price; the next row (OP) indicates today's opening price; the next row (HI) indicates today's high price; the next row (LO) indicates today's low price; and the bottom row (LA) shows the last price received for the stock in question. The stock-range relays 1255 and 1259, operated under the control of the stock-range register SR, Fig. 10, correspond, respectively, to the rows of stock registers above named. If the relay 1255 alone is operated, the

incoming price digits are transmitted to the top row only of the registers, the other relays controlling the other rows, respectively.

Fig. 11A shows the local sender which operates under the control of the price registers of Fig. 11 to send impulses to the stock registers through the medium of the receiving relays 1251—1254, Fig. 12A.

Detailed description

The system having been described generally, a detailed description of the operation of the apparatus shown will now be given. For this purpose, a description will be given of the operations involved when the operator at the transmitter T¹, shown in Figs. 1 to 8 and 8A sets up a quotation on her key set of which the stock-letter keys are shown in Fig. 1, and the digit keys and range keys in Fig. 5.

It will be assumed that the register set #1, comprising the registering apparatus of Figs. 4 and 7, the upper portion of Fig. 6, and relays 835 and 837, Fig. 8, is in service at this time, this being true because the relay 614 is energized, as shown, and because the relay 615 is deenergized, as shown. It will be assumed further that the letters representing the stock whose quotation is to be transmitted are the letters B, B, and A and that the price to be transmitted is 104 and $\frac{1}{8}$ dollars (104 $\frac{1}{8}$). The numerator only of the fractions of dollars is transmitted; the denominator 8, being the same in all cases, is not transmitted.

It will be assumed further that this is neither the high price nor the low price of the day and that it is accordingly set up as merely the last price, abbreviated, L.A. The full indication to be set up may be represented by BBA—104 $\frac{1}{8}$ —L.A. The first portion is set up by operating the stock-letter keys of Fig. 1. The second portion is set up by operating the digit keys of Fig. 5; and the final portion (the range indication) is set up by operating a range key of Fig. 5.

Stock registration

To set up this "number" the operator first operates the letter key B of Fig. 1. These keys, it will be understood, are non-locking keys of the push-button type, being arranged so that, when the operator depresses a key to close the contacts thereof, and then releases the key, the plunger returns to normal, and the contacts of the key open.

When the key B is pushed, a circuit is closed from ground through the contacts of the key and through contacts of the normally-energized connecting relay 202 for the register relay B of the stock register SR¹. Relay B energizes and at its inner upper armature closes a locking circuit for itself through the transfer relay 201 from the grounded conductor 250, which is grounded through contacts of relays 207 and 208 from the grounded conductor 602, which latter conductor is grounded in Fig. 6 through contacts of the error relays, 613' of the register set #2, and 613 of the register set #1. The locking circuit for relay B does not become effective immediately, and relay 201 remains short circuited and deenergized as long as the key B of Fig. 1 is held depressed, but, when the key B is released, the short circuit is removed from around relay 201 and it energizes in series with relay B and opens the circuit of relay 202 and closes a circuit for connecting relay 204 through the inner armature of relay 203. Relay 204 pulls up, and relay 202 falls back and disconnects the conductors of the keys

A to R from the storage relays A to R of the stock register SR¹. It will be noted, of course, that only the relays A, B, and R of this set are shown and that only the corresponding contacts of relay 202 are shown. It will be understood that the intervening relays are connected up in the same manner as those shown. A similar curtailment occurs in the case of the registers SR² and SR³, and in each case, it has been for the purpose of simplifying the drawings.

When the operator depresses the stock-letter key B to register the second stock letter B, a circuit is closed through contacts of relay 204 of the stock register SR² for the B relay in this stock register. It will be noted that this relay is designated —B. This indicates that the registration of this relay is the second letter of a stock, and that the first letter may be any one of several. When the relay —B operates, it closes at its inner upper armature a locking circuit for itself to the said grounded conductor 250 by way of the transfer relay 203. Relay 203 is accordingly operated when the key B of Fig. 1 is allowed to restore, and it transfers the operating ground from relay 204 to relay 206 by way of contacts of the transfer relay 203. Accordingly relay 204 falls back and disconnects the stock-letter keys A to Z from the second-letter storage relays —A to —Z, and relay 206 energizes through contacts of relays 201, 203, and 205, and connects the stock-letter keys A to Z to the third-letter relays —A to —Z of the stock register SR³. The relays of the register SR³ are designated in this manner to indicate that they are the third-letter relays and that the first two letters are variable letters; that is, either one of the first two letters may be any one of a plurality.

When the operator depresses the key A of Fig. 1 a circuit is closed through contacts of relay 206 for the relay —A, which operates and at its inner upper armature closes a locking circuit for itself through relay 205 to the grounded conductor 250. Accordingly, transfer relay 205 operates in series with relay —A when the A key is released, and at its inner armature it disconnects relay 206 and allows it to fall back and disconnect the stock-letter keys from the associated relays —A to —Z.

The stock concerning which the quotation is about to be transmitted has now been identified on the registering apparatus by the above-described energization of relay B of the stock register SR¹, of relay —B of the stock register SR², and of the relay —A of the stock register SR³. This three-letter registration is to be subsequently translated by the translating apparatus of Fig. 3 into a pre-assigned three-digit code in a manner to be hereinafter pointed out.

Price registration

Referring now to Figs. 5, 6, and 7, when the operator depresses the digit key 1, Fig. 5, to register the price-hundreds digit 1, a circuit is closed from ground through the right and left contacts of the digit key 1 over conductors 501 and 502 for the storage relays A and B of the price-hundreds register PH, Fig. 7, through contacts of connecting relay 702, which latter relay is energized through contacts of transfer relay 701 from the grounded conductor 607, conductor 607 being supplied with ground potential through the lower armature of the energized relay 614 of Fig. 6. When relays A and B of PH operate, they close locking circuits for themselves at their inner armatures through trans-

fer relay 701 to the grounded conductor 606, conductor 606 being grounded at this time through the upper contacts of relay 613 and the normally closed contacts controlled by the upper armature of relay 615. As a result, when the digit key 1 of Fig. 5 is allowed to restore, the locking circuit for relays A and B becomes effective, and relay 701 energizes therein and transfers the grounded conductor 607 from relay 702 to the connecting relay 704, through contacts of the transfer relay 703. Accordingly, relay 702 falls back and disconnects the key conductors 501—504 from the relays A to D of the price-hundreds register PH, and relay 704 operates and connects these conductors to the corresponding relays of the price-tens register PT.

When the operator depresses the digit key 0 to set up the price-tens digit, a circuit is closed from ground over conductor 504 and through contacts of connecting relay 704 for relay D of the price-tens register PT. Relay D operates and locks itself at its inner armature to the grounded conductor 606 by way of the transfer relay 703. Relay 703, accordingly, energizes when the digit key 0 is restored, and it transfers the operating conductor 607 from connecting relay 704 to the connecting relay 706 by way of contacts of the transfer relay 705. Relay 704 accordingly falls back and relay 706 operates, and conductors 501—504 are disconnected from the relays of the register PT and are connected to the relays A to D of the register PU.

When the operator depresses the digit key 4 to set up the price-units digit 4, a circuit is closed from ground through the contacts of the digit key 4 over conductors 502 and 503 for the relays B and C of the price-units register PU. These relays operate and close locking circuits for themselves at their inner armatures through the transfer relay 705 to the grounded conductor 606. As a result, when the key 4 of Fig. 5 is released, relay 705 operates and transfers the operating ground from relay 706 of the price-units register to the relay 708 of the price-fractions register PF. Conductors 501—504 are accordingly disconnected from the relays of the price-units register by the deenergization of relay 706 and are connected to the relays A to D of the register PG by the energization of relay 708.

When the fractions digit 1 (indicating $\frac{1}{8}$) is recorded by depressing the digit key 1, relays A and B of the price-fractions register PF operate over conductors 501 and 502 and close locking circuits for themselves to conductor 606 by way of transfer relay 707. As a result, relay 707 operates when the digit key 1 is released, and it opens the circuit of relay 708, whereupon relay 708 falls back and disconnects the conductors 501—504 from the relays A to D of the price-fractions register PF.

Stock-range registration

Having recorded the stock and the price quotation, the operator indicates the stock range by depressing the stock-range key LA to cause the price quotation to be recorded as the last price. When this key is depressed, a circuit is closed from ground through the contacts of the key and over conductor 508 and through contacts of relay 611 for relay D of the range register, relay 611 being energized from the grounded conductor 607 through contacts of relay 610. Upon operating, relay D of the range register SR closes

a self-locking circuit at its inner contacts through relay 610 to the grounded conductor 606. As a result, relay 610 energizes when the range key LA is released, with results to be explained hereinafter.

The registration is now complete and the result of the registration will be taken up in detail.

Stock transfer and translation

Since a stock may be identified by one letter, by two letters, or by three letters, arrangements are provided for delaying the transfer of a registration to the translating apparatus of Fig. 3 until a price digit is recorded, in order to avoid the premature transfer of a two-letter indication as a single-letter indication or the transfer of a three-letter indication as a two-letter indication. The way the transfer takes place will now be pointed out.

When the transfer relay 701, associated with the price-hundreds register PH, energizes, as hereinbefore pointed out, upon the release of a digit key following its depression for the first price digit 1, it closes a circuit at its lower armature which starts at ground through the inner lower armature, normal, of transfer relay 610 of the stock-range register SR, Fig. 6, and continues by way of conductor 609, lower contacts of relay 703, lower contacts of relay 701 (now energized), stock-transfer conductor 601, to the upper armatures of relays —A to —Z of the register SR3, Fig. 2. This conductor is extended to the corresponding armatures of the relays —A to —Z of the stock register SR2 in case only a two-letter designation is recorded on account of the fact that relay 205 is not energized in such case, and it is extended through contacts of relay 203 to the corresponding armatures of relays A to R of the stock register SR1 in case only a one-letter designation is recorded, as in this case the transfer relay 203 is not operated. However, in the present case, a full three-letter designation is recorded and the further extension of the conductor 601 is prevented due to the operated condition of the upper armature of relay 205. With relay —A energized as before explained, the circuit continues from conductor 601 through the upper contacts of the relay —A, contacts of the energized relay —B, to the relay —BA of the stock translator ST3. Relay —BA energizes.

The relay —BA, it will be noted, has a plurality of sets of contacts, three contact pairs a set. Each of these contact sets is associated with a different one of the groups of conductors, three conductors a group, grounded under the control of the relays A to R of the stock register SR1. Relay —BA closes all of these conductors through to the left-hand side of the intermediate distributing frame IDF, but only the set labeled BBA at the frame IDF is grounded on account of the fact that only the relay B of the stock register SR1 is energized.

On the right-hand side of the intermediate distributing frame IDF there are three sets of terminals, one terminal set is connected with a group of conductors labeled CD1, indicating that this group of conductors corresponds to the first code digit; the next set of contacts on the right-hand side of the IDF terminates the conductors labeled CD2, having to do with the second code digit; while the third set of contacts terminates the group of conductors CD3, having to do with the third code digit. The contacts of each of these sets are labeled 1 to 0, and they correspond respectively to the digits 1 to 0. The conductor

groups CD1, CD2, and CD3 extend at this time through the contacts of the energized relays 403, 404, and 405 to the relays 1 to 9 of the stock code registers SH, ST, and SU, corresponding to the hundreds, tens, and units code digits, by means of which the stocks are identified at the receiving station.

There is a separate code assigned to each stock and the three contacts corresponding to a stock in each case are cross-connected in accordance with the code. For example, the code assigned to the stock BBA, now under consideration, is the code number 152. Accordingly, the upper terminal of the set of three terminating the BBA conductors on the left-hand side of the frame IDF is cross-connected to the first contact of the upper set on the right-hand side of the frame IDF; the second terminal is cross-connected to the fifth terminal of the second set on the right-hand side of the frame; while the third terminal of the set BBA is cross-connected, as shown, to the second terminal of the third set on the right-hand side of the frame. As a result, a circuit is closed over the first of the group of conductors labeled CD1 for the first register relay 1 of the stock-hundreds register SH; a circuit is closed over the fifth one of the conductors CD2 and through contacts of relays 401 and relay 404 for the fifth register relay 5 of the stock-tens register ST; and a circuit is closed through the second one of the conductors CD3, and through contacts of relays 402 and 405, for the second relay 2 in the stock-units register SU. These relays operate and at their inner upper armatures close locking circuits for themselves to the register locking conductor 606.

A moment after the above stock transfer and translation occurs, the transfer relay 703 associated with the price-tens register PT, Fig. 6, energizes upon the setting up of the tens digit by the operator, as before explained, and at its lower armature opens the initial energizing circuit for the above-mentioned relay —BA of Fig. 3 by removing ground at its lower armature from the stock transfer conductor 601. Relay —BA falls back, but the operated relays of Fig. 4 remain operated over the locking conductor 606, as they are locked at their inner-upper armatures, as above mentioned.

It may be pointed out at this time that in case only a single digit is set up on the price register it is, of course, set up on the register PH and the next digit to be set up is the stock-range digit. In this case the operation of the transfer relay 610 of the range register SR opens the above-mentioned circuit over conductor 601 at its lower armature, so that, in any case, the circuit of the energized stock translating relay of Fig. 3 is closed for only the time elapsing between the registration of two digits. By this means, these relays, which carry heavy spring loads, can be provided with heavy windings with no danger of overheating.

Transfer to register set #2

When the transfer relay 610 of the range register SR of Fig. 6 operates as hereinbefore pointed out, it places ground at its inner-lower armature on conductor 616 and on conductor 609, closing a circuit over conductor 609 through the lower armature of the operated transfer relay 707 of the price-fractions register PF, for the relays 711 and 710 in series. These two relays energize and connect the control conductors of the registers PH, PT, PU, and PF to the cor-

responding conductors of the sending apparatus of Fig. 8. Relays 835 and 836, Fig. 8, operate over conductor 616 and complete the connecting of control conductors to the sender of Figs. 8 and 8A.

As a further result of the operation of relay 610, it opens the circuit of relay 611 at its upper armature, as hereinbefore pointed out, and extends the ground potential to the upper winding of the relay 615. Relay 615 operates, and at the normally closed contacts controlled by its lower armature opens the circuit of the lower winding of relay 614. When this occurs, relay 614 falls back and at the normally closed contacts controlled by its lower armature closes a holding circuit for relay 615 through its lower winding, and at about the same time opens the initial energizing circuit for the upper winding of relay 615, by removing the ground potential from conductor 607. When conductor 607 is thus ungrounded, relays 403, 404, and 405 of Fig. 4 fall back and disconnect the conductors CD1, CD2, and CD3 from the associated register relays of the registers SH, ST, and SU.

As a further result of the deenergization of relay 614 and the energization of relay 615, the error relay 613 of the register set #1 is disconnected and the corresponding relay 613' of register set #2 is connected up.

As a still further result of the deenergization of relay 614 and the energization of relay 615, conductor 618, which is grounded at the outer contacts of relay 833 of the sender, Fig. 8A, is connected at the upper armature of relay 615 to locking conductor 606 through contacts of relay 613 in place of the local ground connection at the normally closed contacts controlled by the upper armature of relay 615. Accordingly, the locking conductor 606 is maintained grounded and the locked-up register relays of Figs. 4, 7 and 6 remain operated until such time as the ground potential is removed from conductor 618 by the sending apparatus, as will be hereinafter described.

Stock-range keys locked

Relay 610 also grounds the sender-start conductor 617, closing a circuit through the left-hand contacts of relay 827, Fig. 8A and over conductor 809 for the locking magnet LM associated with the stock-range keys in Fig. 5. Magnet LM energizes, and by means of a mechanical interlocking arrangement (not shown) prevents any of the stock-range keys from being depressed. This arrangement is employed to insure that the operator will not get two full numbers set up before the sender has finished sending out the first.

Operation of the sender

As a further result of the grounding of the sender-start conductor 617 by relay 610, conductor 850 is grounded through the lower contacts of relay 834, preparing operating and locking circuits for the relays of the sender. When conductor 850 is grounded, a circuit is closed through contacts of relay 834, and through the constantly operating interrupter 803, as soon as the interrupter closes, for relay 804, through contacts of relays 834 and 805. Relay 804 operates and at its lower armature makes a local ground connection to conductor 617 to insure that the sender will go through a complete cycle of operations. Relay 804 also closes a locking circuit for itself in series with 805. This locking circuit does

not take effect as long as the interrupter 803 remains closed, owing to the fact that relay 805 is short-circuited, but, when the interrupter 803 opens, and the short circuit is removed from around relay 805, relay 805 operates from grounded conductor 850 in series with relay 804, and disconnects the right-hand terminal of the interrupter from the junction of relays 804 and 805 and extends it to the sending relay 806. As a result, relay 806 responds to the interrupter 803 each time it closes following the operation of relay 805, and sends alternate, negative and positive impulses over the conductor 857 by way of the upper contacts of relay 805, and through the left-hand contacts of relay 826, to the receivers.

Upon referring to the table shown in Fig. 15, it will be noted that each digit 1 to 0, as well as the blank digit BL, is represented by four impulses, a negative, a positive, a second negative, and a second positive. The distinction between the digits is made in accordance with whether an impulse is light or heavy. The heavy impulses are represented by bolder characters than the light ones. For example, the blank digit is represented by a heavy negative, a heavy positive, a heavy second negative, and a light second positive; the digit 1 is represented by a heavy negative, a heavy positive, a light negative, and a light positive; etc. The sending apparatus in the upper right-hand corner of Fig. 8 is arranged to send out a succession of negative and positive pulses through the resistances 801 and 802 and these pulses are light, unless made heavy by the connections made to the conductors A, B, C, and D, connected to the contacts of relays 807 and 808, by the registers of Figs. 4, 7, and 6.

The first negative pulse is sent when relay 805 pulls up upon the opening of the interrupter 803 following the operation of relay 804. This negative impulse is sent over conductor 857 through the upper contacts of relay 805 and the upper armature and back contact of relay 806 by way of the resistance 801. Because of the relative values of resistances 801 and 860, this impulse is light unless resistance 801 is shunted by a direct connection to negative battery over the upper contacts of relay 808 and conductor A. When relay 806 operates, when the interrupter 803 again closes, a positive impulse is sent through resistance 802 and the upper contacts of relays 806 and 805, and is a light impulse, because of resistance 860, unless it is changed to a heavy one by a direct connection made from positive battery by one of the registers to conductor B. In this way the operations of relay 806 result in a train of negative and positive, light and heavy, impulses being sent over conductor 857.

Keeping in mind that connecting relays 710 and 711 are energized over conductor 609 as hereinbefore pointed out, and that the relays 835 and 836 are energized over conductor 616, it will be noted that conductor A of the sender is connected through the left-hand armature of relay 809 and through contacts of relay 835 to the contacts of relays 1—3, and 7 of the stock-hundreds register SH, Fig. 4. Relay 1 of SH, it will be recalled, is locked energized, with the result that the first negative impulse transmitted is a heavy impulse due to the direct connection of negative battery through the contacts of relay 1 of SH and back through the contacts just mentioned to conductor A and thence to conductor 857 by way of the upper contacts of relays 806 and 805. Now, when relay 806 energizes to terminate the first negative impulse and trans-

mit the first positive impulse, a heavy positive impulse is transmitted through the contacts of relay 1 of the stock-hundreds register SH, Fig. 4, through contacts of relay 835, left-hand contacts of relay 810, conductor B, upper contacts of relay 807, and the upper armatures of relays 806 and 805.

As a further result of the first energization of relay 806, a circuit is closed at the lower armature thereof through the lower armature, normal, of relay 807 for relay 808. This happens at the termination of the first negative impulse and after the A conductor has been effective in influencing the first negative impulse and making it heavy, as above pointed out. Consequently, the resting contact of the upper armature of relay 806 may now be shifted from the A conductor to the C conductor, and this is done at the upper armature of relay 808. As a result, when relay 806 falls back to send the second negative impulse, this impulse is transmitted as a light impulse through resistance 801 unless a negative potential is encountered over conductor C. This conductor C is now connected through the inner left-hand armature of relay 811 to the contacts of relays 2, 4, 6, and 9 of the stock-hundreds register SH, but the impulse is not altered by this connection on account of the fact that only the relay 1 of the stock-hundreds register is at this time energized. As a result, the second negative impulse in this digit is a light impulse, and this is in accordance with the table shown in Fig. 1 where impulses for the digit 1, now being transmitted, are indicated.

As a further result of the operation of relay 808 it closes a locking circuit for itself in series with relay 807, but this locking circuit is not effective at this time due to the fact that the initial circuit of relay 806 is still closed.

When relay 806 falls back to send the second negative impulse, it opens the initial circuit of relay 808 whereupon relay 807 energizes in series with relay 808 from the grounded conductor 850 through the inner-lower contacts of relay 808, lower winding of relay 807, inner armature and normal contact of relay 806, and relay 808 to battery. Upon energizing, relay 807 connects its upper winding in multiple with the winding of relay 808.

When relay 806 operates to transmit the second positive impulse, the last impulse of the first digit, it closes at its lower armature a circuit for the upper winding of relay 807 through the inner armature, operated, of relay 807, and opens the circuit of relay 808. Relay 808 now falls back but leaves relay 807 operated until relay 806 falls back at the end of the negative impulse, whereupon relay 807 falls back; and the relays 807 and 808, having passed through a complete cycle during the two positive impulses of the first digit, are in their original condition ready to operate in the same way coincident with the two positive impulses of the second digit.

It will be recalled that relay 808, upon operating, shifts the resting contact of the upper armature of relay 806 from the A conductor to the C conductor, and that this operation occurs between the first and second negative impulses and while the first positive impulse is being delivered. As a further result of the energization of relay 808, it closes a circuit at its lower armature and through the right-hand contacts of relay 810 for relay 809. Relay 809 operates and at its left-hand armature transfers the A conductor from the stock-hundreds conductor group SH to the stock-tens

conductor group ST through contacts of relay 811. This transfer may be made conveniently at this time, as the A conductor has already been used and is now disconnected at the upper armature of relay 808. As a further result of its energization, relay 809 at its right-hand armature closes a locking circuit for itself from the grounded conductor 850 through relay 810. Relay 810, of course, does not energize as long as the initial circuit of relay 809 remains closed.

It will be noted that relay 807 closes a multiple point in the initial energizing circuit of relay 809 at its lower armature when it energizes following the termination of the impulse for energizing relay 808. Accordingly, relay 809 remains energized directly, and relay 810 remains short-circuited until relay 808 has fallen back, and until relay 807 has fallen back at the end of the second negative impulse. If it is kept in mind that relay 807, upon energizing at the end of the first positive impulse and while the second negative impulse is being delivered, shifts the working contact of the upper armature of relay 806 from the B conductor to the C conductor preparatory to sending out the second positive impulse, it will be seen that it is permissible following the sending of the second positive impulse to switch the B and D conductors out of engagement with the stock-hundreds conductor set SH and into connection with the conductors of the stock-tens set ST extending to the stock-tens register ST of Fig. 4 by way of contacts of relay 835. This is done at the left-hand armatures of relay 810 when relay 810 energizes in series with relay 809 upon the falling back of relay 807 at the end of the second negative impulse.

The first digit 1 consisting of four impulses, alternating negative and positive, with the first two heavy, has been transmitted, and the control conductors A, C, B, and D have been transferred from the stock-hundreds group SH to the stock-tens group ST. The result is that the next four impulses transmitted are under the control of the stock-tens register ST, Fig. 4. Since relay 8 of the stock-tens register ST, Fig. 4, has been energized as before explained, the negative impulses of the second series go out as light impulses, while the positive impulses are changed to heavy impulses. The relays 811 and 812 are operated by the relays 807 and 808 in the same manner as described in connection with relays 809 and 810. The result is that the conductors A, C, B, and D are transferred to the stock-units register SU by the time the stock-tens digit is transmitted.

In a similar manner the stock-units digit 2, set up on the registers SU, Fig. 4, is transmitted in accordance with the table shown in Fig. 15, relays 813 and 814 being energized by the end of the stock-units transmission.

With the relays 813 and 814 energized at the end of the stock-units transmission, the conductors A to D, connected to the upper contacts of relays 807 and 808, are now extended through the energized relays 809—814 and through the contacts of relays 815 and 816 to the stock-range conductor group SR, which conductors are connected through contacts of relay 836 to conductors 621—624. The circles 621—624 indicate that the conductors to which these circles are attached connect to the similarly indicated conductors of the stock-range register SR, Fig. 6, the connecting conductors having been omitted in the drawings so as to avoid undue complication. Accordingly, stock-range digit registered on the

register SR by the placing of positive potential on conductor 624 by the relay D of SR is transmitted in the same manner as the preceding digits, and transfer relays 815 and 816, Fig. 8, are operated to transfer the conductors A, C, B, and D of the upper portion of Fig. 8 to the price-range conductor group PR, Fig. 8A. The price-range digit, it may be pointed out, is transmitted prior to the transmission of the regular price digits to indicate to the receiving apparatus how many price digits are to follow so that the required number of registers of the selected stock and stock range may be restored during the receipt of the price digits, and thus be ready to be reset by the price digits by about the time the last of the price digits has been received. The price-range registration is made automatically by the transfer relays 701, 703, 705, and 707, Fig. 7, and the number of heavy impulses in the digit is directly proportioned to the number of these transfer relays which are operated, which, in turn corresponds to the number (1 to 4) of price digits set up. In the instant example, the full number (4) of price digits has been set up, with the result that all four impulses in the price-range digit are heavy, because of a direct connection to each conductor of the group PR, Fig. 8A made through contacts of relay 836 by the transfer relays 701, 703, 705, and 707.

The transfer relays 817 and 818 of Fig. 8A are operated during the price-range transmission to extend the control conductors to the price-hundreds conductor group PH.

In the same way, relays 819 and 820 energize during the transmission of the price-hundreds digit and transfer the control conductors to the price-tens group PT and this operation continues until the price-tens, price-units, and price-fractions digits, have been sent out, by which time relays 821—825 have been operated.

Following the transmission of the price-fractions digit PF, the relays 806—808 continue to operate in the same manner as before, and the relays 827—832 of Fig. 8A are operated during the same length of time that would be required to transmit three additional digits. These relays are provided to operate from the relays 806—808 in order to introduce a fixed, minimum time interval between successive quotations in order to allow the receiving apparatus to reach a predetermined point in its operation before a further transmission of a quotation is started. This precaution is taken to prevent interference that would be inevitable if a second quotation should start immediately upon the termination of a first.

Clearing out the transmitter

The operation of the sender following the transmission of the last of the impulses in the price-fractions digit, together with the clearing out of the transmitter as a whole, will now be explained. If special arrangements were not made, the relay 806 would continue sending light negative and positive impulses through the resistances 801 and 802 after the last impulse of the price-fractions digit is transmitted, and while relays 827—832 are being operated, the light negative impulses would prevent the clearing-out operation in the receiver, to be subsequently explained. The sending of additional impulses over conductor 857, however, is prevented by the right-hand armature of relay 826, which opens conductor 857.

In order to clear out the registering apparatus

of Figs. 4, 7, and 6, so as to prepare this registering apparatus to receive a further registration, as soon as the register set No. 2 (in which the registration may have proceeded to a point where all of the digits have been registered except the stock-range digit, the keys of which are locked by the locking magnet LM, Fig. 5), has been set, relay 833 is operated through the middle-right armature of relay 826, and contacts of relay 827 when relay 826 operates at the end of the last impulse in the price fractions digit. This circuit extends from ground on the grounded conductor 617 through the contacts just named to battery by way of relay 833, operating relay 833 to remove the ground potential momentarily from conductor 618. When conductor 618 is thus ungrounded, conductor 606, to which conductor 618 is now connected through the upper armature of the now-operated relay 615 and contacts of relay 613, becomes ungrounded, releasing all operated relays of the registers SH, ST, and SU of Fig. 4, the registers PH, PT, PU, and PF of Fig. 7, and the register SR of Fig. 6.

The release of the relays above mentioned, results in the ground potential being removed from the conductor 617 at the lower armature of the relay 610. This does not stop the operation of the relays of the sender of Figs. 8 and 8A at this time, however, on account of the fact that conductor 617 is maintained grounded at the lower armature of the now-operated relay 804.

When relay 827 operates, a moment after the operation of relay 826, it removes ground potential from the locking conductor 509, thereby allowing relay 833 to fall back and again ground conductor 618, and opening the circuit of the locking magnet LM and the associated signal lamp L of the stock-range keys, Fig. 5. The operator may now depress any one of the range keys, and when the depressed key is released and the range register in register set No. 2 corresponding to the stock-range register SR operates, the registration in the register set No. 2 is complete, and the transfer back to the register set No. 1 takes place, as will be pointed out herein-after. When this transfer takes place, relay 614 pulls up again, and the maintenance of the locked condition of the register relays in register set No. 2 is dependent upon the maintenance of ground potential on conductor 618 by the now-deenergized relay 833.

The operation of the relays 828-832 takes place under the control of relays 807 and 808, and continues until relay 832 operates. Relay 832 operates just as the interrupter 803 opens and drops back relay 806 to open the circuit of relay 807, relay 807 falling back to open the initial circuit of relay 831 to allow a relay 832 to operate. Relay 832 places a battery potential on the lower terminal of relay 834, with the result that relay 834 operates in parallel with relay 806 upon the next closure of interrupter 803. The inner-lower and middle-lower armatures of relay 834 are adjusted to make contact first, as is indicated by the "x" mark placed adjacent to each armature. The inner-lower armature of relay 834 applies a ground potential directly to the left-hand terminal of interrupter 803, and disconnects this left-hand terminal of 803 from conductor 850. The middle-lower armature of relay 834 locks a battery potential on the lower terminal of the relay so as to maintain it operated after relay 832 falls back. At its lower armature, relay 834 disconnects the operating and locking conductor 850 from the grounded con-

ductor 617, now grounded at lower armature of relay 804, whereupon all of the operated relays of Figs. 8 and 8A, with the exception of relay 834, fall back. At its upper armature, relay 834 disconnects the interrupter from the lower armature of relay 805, so as to prevent a false reoperation of relay 804 when relay 805 falls back.

When relay 834 falls back responsive to interrupter 803 opening, it breaks its locking circuit at its middle-lower armature so that it does not again reoperate, and it restores the associated circuit connections to the position shown in the drawings, so that the sending apparatus may begin to function again immediately, in case the sender-start conductor 617 has become grounded in register set No. 2, by the operation of the relay therein corresponding to relay 610 of the stock-range register SR.

Setting the register set #2

When the operator depresses her keys for the next quotation, relays in the stock registers of Fig. 2 are operated as before, and a transfer of the stock indication to the stock translator and intermediate distributing frame IDF of Fig. 3 takes place as described. In this case, since relay 615 is energized and relay 614 deenergized, the stock code is transferred to register set #2, by way of the conductors in the cable 603, through relays in register set #2 corresponding to relays 403, 404, and 405 of Fig. 4, and the price and range indications are registered directly on the register set #2, as the conductor in register set #2 corresponding to conductor 607 is now grounded through the lower armature of relay 615.

When the stock-range register in register set No. 2 is operated by the depression of a stock-range key of Fig. 5 after the stock-range keys have been unlocked as before described, a circuit is closed for the upper winding of relay 614 through contacts of the relay corresponding to relay 610, and relay 614 becomes energized again and relay 615 falls back.

It will be noted that the several branches of the conductors A, B, C, and D of Fig. 8 are multiplied by means of cable 619 to the register set #2 so as to enable the sending apparatus of Fig. 8 to operate from the register set #2. Upon the operation of the stock-range register in register set #2, a starting ground potential is placed on conductor 617 to start the sending apparatus of Figs. 8 and 8A to operate again (as soon as it has cleared out as before described, if it has not already done so), and the previously-traced branch circuit extends over conductor 509 to lock the range keys to prevent the operation of any one of them until the sender of Figs. 8 and 8A has finished transmitting what is set up on the register set No. 2.

General arrangement of the system

Referring now particularly to Fig. 9, the general arrangement of the system will now be explained. Since, as will be recalled, the transmitting apparatus is in two parts, each of the two operators having her own transmitter, the receiving apparatus is provided in two parts, a separate section of the receiver being arranged to receive stock quotations as transmitted by each of the operators. The transmitter T1, shown in Figs. 1 to 8 and 8A is used, as before mentioned, to handle quotations of stocks A to K and of stock designated by more than one letter of which the first letter is any one from A to K.

In Fig. 9 there is shown a transmitter T2 which may be substituted for the transmitter T1 by the operation of the key 901. This spare transmitter is provided so that in case something goes wrong with the one in use, the operator may immediately operate the key 901 and proceed with the spare transmitter.

The transmitter T3 is the one used by the second operator and is the same as the transmitter T1 except that the stock register in the transmitter T3 corresponding to the stock register SR1, Fig. 2, is arranged to take care of the letters J to Z instead of the letters A to R, the letters J to R being common first letters to both operators so that sufficient flexibility is secured in shifting the line of stock division from one operator to another from time to time as changes may occur in the relative activity of the stocks.

Impulses are sent over line conductor 903 by either of the transmitters T1 or T2, depending upon the position of the key 901, and impulses are sent over conductor 911 by either the transmitters T3 or T4, of the second operator, depending upon the position of the associated transfer key 902. There is a connection from conductor 903 to one receiver of each pair, and a connection from conductor 911 to the other receiver of each pair. Since the placing of a ground potential on conductor 903 would prevent the sending of effective impulses to the receivers, the receivers, such as RE1, RE3, RE5, and RE7 (RE7 being shown in Figs. 10 to 12A), are divided into groups and a resistance, such as resistance 904, separates each group from the main conductor 903, each group being served by a branch conductor such as 905. Because of the resistances, such as 904, connected between the main conductor and each of the branch conductors, the grounding of a branch conductor such as 905, although disabling all the receivers connected to such branch conductor, does not disable the other receivers owing to the fact that the ground potential is unable to alter the impulses on the main conductor 903 to any noticeable extent. A resistance, such as 906—909, is connected between each receiver and the associated branch conductor so as to prevent a disabling ground on a line conductor at a receiver, such as on conductor 910, from disabling all receivers connected to the same branch conductor. In order that this method of progressive isolation be properly effective, the resistances such as 904 should be made relatively high with respect to the resistances in the transmitters, such as the resistances 801, 802, and 860, Fig. 8. Furthermore, the resistances such as 906—909 should each be high with respect to the resistances such as 904. It will be noted that the same method of progressive isolation is carried out by means of branch conductors and resistances with respect to the line conductor 911 and the receivers, such as RE2, RE4, RE6, and RE8, served thereby.

Operation of the receiver

Referring now to Figs. 10 to 12, and 11A and 12A, the operation of the receiver RE7 shown therein, will now be described. In Fig. 10, the incoming branch line conductor 910 connects to the grid elements of the vacuum tubes 1041 and 1042. The battery 1070 maintains the filament of tubes 1041 and 1042 sufficiently positive with respect to ground potential so that, with conductor 857 and all its branches, such as conductor 910, maintained at ground potential by the connection to ground in Fig. 8 through resistance 860,

the grid elements of the tubes 1041 and 1042 are sufficiently negative with respect to their filaments that very little plate current flows in the plate-filament circuit of tube 1041 and only a relatively-small plate current flows in the plate-filament circuit of tube 1042. It will be noted that only the battery 1071 is included in circuit with the plate relays 1002 and 1003 of tube 1041. Accordingly, the positive potential placed on the plate of tube 1041 is insufficient to maintain more than a very small plate current due to the relatively negative potential normally maintained on the grid elements by way of conductor 910 and through resistance 860, Fig. 8. On the other hand, the batteries 1071 and 1072 are both included in the plate circuit of tube 1042, and the normal current-flow through the tube 1042 is correspondingly larger than through the tube 1041. The result is that while relays 1002 and 1003 are normally in the retracted state shown in the drawings, relay 1001 is normally operated, as shown.

It is a well known characteristic of vacuum-tube operation that rendering the grid element more negative with respect to the filament of the tube causes the plate current to decrease and that rendering the grid element more positive with respect to the filament causes the plate current to increase. The relative values of the controlling resistances, such as 801, 802, and 860 of Fig. 8 and of the batteries 1070, 1071, and 1072 of Fig. 10, together with the controlling negative and positive batteries used in the transmitter, together with the number of winding turns on the relays 1001—1003 and the adjustments of the relays, are so proportioned that relay 1001 does not respond to a light negative impulse, although the plate current in both tubes is decreased; that relay 1001 does fall back responsive to a heavy negative impulse because the plate current in both tubes is down to about zero; that only relay 1002 responds to a light positive impulse on the grid elements of the tubes; and that both relays 1002 and 1003 respond to a heavy positive impulse on the grid elements of the tubes. The impulses to which the relays 1001—1003 respond are indicated by the signs placed adjacent these relays. It will be noted that a heavy negative sign is placed next to relay 1001, indicating that this relay responds to heavy negative impulses only; that a light positive sign is placed adjacent relay 1002, indicating that this relay responds to light positive impulses (responding therefore to heavy positive impulses as well); and that a heavy positive symbol is placed adjacent relay 1003, indicating that this relay responds to heavy positive impulses only.

To continue with the description of the reception of the quotation transmitted as hereinbefore described, it will be recalled that the first digit transmitted is the stock-hundreds digit 1, being represented, according to the table in Fig. 15, by a heavy negative, a heavy positive, a light negative, and a light positive. When the heavy negative impulse, the first impulse of the first digit, is received, relay 1001 falls back and closes a circuit for the A relay of the stock-hundreds register SH by way of contacts of relays 1009 and 1011. When relay A operates, it locks itself at its inner contacts to ground by way of the grounded locking conductor 1053, grounded through the normally closed contacts controlled by the lower armature of relay 1007.

When the second impulse of the digit, a heavy positive impulse, is received, relays 1002 and 1003 pull up. Relay 1001, having reoperated at

the end of the negative impulse, remains operated. Relay 1003 closes a circuit for relay B of the stock-hundreds register SH, by way of contacts of relays 1008 and 1010. When relay B operates, it locks itself at its inner contacts to ground by way of the grounded locking conductor 1053.

Relay 1002 closes a circuit for relay 1008, which operates and closes a circuit for its upper winding through the upper winding of relay 1009 at its lower armature from ground on the grounded locking conductor 1051, so that, when the initial circuit of relay 1008 is opened upon the falling back of relay 1002 at the end of the first positive impulse, relay 1009 operates.

When the heavy positive impulse is over, and the second negative impulse is received, relays 1002 and 1003 fall back but relay 1001 remains operated because the impulse is light.

When relay 1008 operates, it closes a circuit at its upper armature for the transfer relay 1011 through contacts of relay 1010, and relay 1011 operates and locks itself energized through relay 1010, which latter relay does not operate for the time being owing to the fact that it is short-circuited. Relay 1008 also transfers the impulsing conductor associated with the negative relay 1001 from conductor (A) to conductor (C), and relay 1011 transfers the (A) conductor from the A relay of the stock-hundreds register SH to the corresponding relay of the stock-tens register ST. When relay 1009 operates in series with relay 1008 at the end of the first positive impulse, it transfers the impulse conductor associated with the contacts of the heavy positive relay 1002 from the (B) conductor to the (D) conductor.

When relay 1002 energizes again, at the beginning of the second positive impulse (which impulse does not operate relay 1003 because it is light), it closes a holding circuit for the lower winding of relay 1009 through the inner-upper armature, operated, of relay 1009, and a branch circuit for the lower winding of relay 1008 through the middle lower armature of relay 1008. Relay 1008 falls back now, because it is differentially wound, and opens the previously established locking circuit for the two relays in series, so that when relay 1002 falls back at the cessation of the second positive impulse and opens the circuit of the lower winding of relay 1009, relay 1009 falls back also, and both relays are again in normal position at the end of the second positive impulse, which is the last impulse of the first digit. When relay 1009 falls back, the short circuit is removed from around the winding of relay 1010 at the upper contacts of relay 1009, and relay 1010 energizes in series with relay 1011 and transfers the (D) and (B) conductors to the relays of the stock-tens register ST.

As the impulses of the succeeding digits come in, the relays 1001—1003, 1008, and 1009 operate in the manner hereinbefore described, and the transfer relays associated with the succeeding registers operate to transfer the conductors (A), (B), (C), and (D), along as the impulses are received. As a result, the stock-tens digit 5 is stored by an energization of the register relays B and D in the stock-tens register ST; the stock-units digit 2 is stored by the energization of the relays A and C of the register SU; the stock-range digit LA (last price) is stored by the energization of relay D of the register SR; the price-range digit indicating four price digits (represented by four heavy impulses) is registered on the price-range register PR, Fig. 11, by

the energization of relays A, B, C, and D; the price-hundreds digit 1 is registered on the price-hundreds register PH, by the energization of relays A and B; the price-tens digit 0 is registered by the energization of relay D of the register PT; the price-units digit 4 is registered by the operation of the relays B and C of the register PU; and the price-fractions digit 1 is registered by the energization of relays A and B of the register PF, the transfer relays of the several registers in the receiver operating in the same manner as described in connection with relays 1010 and 1011.

It will be noted that the shunted relay 1005 is operated at the contacts of relay 1004 which latter relay is operated by relay 1002, which responds to all positive impulses. Being slow-acting due to the shunt around its winding, relay 1005, when once operated, remains operated throughout the series of digits.

Relay 1005 closes a circuit for relays 1006 and 1007 in series. Relay 1006 prepares alternate paths to ground for conductors 1051, 1052, and 1053, and relay 1007 shifts the conductors 1051—1053 to the alternate paths to ground through the contacts of relay 1006, so as to permit the said conductors 1051—1053 to become momentarily ungrounded, as will be hereinafter pointed out, when relay 1006 falls back.

Selecting the stock

For the purpose of identifying the stock register group on which the received price quotation is to be recorded, ten hundreds relays 1201, 1202, to 1210, Fig. 12, are provided, three of these relays being shown. From the contact pyramid of the relays A to D of the register SH there extend ten conductors, each corresponding to a different hundreds. Between Figs. 10 and 12, these ten conductors are represented by the single line 1031. Only one of these conductors becomes grounded in the given case. In this case, since it is the A and B relays that are operated, in accordance with the code digit 1, the ground potential is extended, upon the operation of the upper transfer relay 1010 of the stock-hundreds register SH, to the #1 hundreds conductor, operating the first hundreds relay 1201. This relay connects the stock-tens and stock-units groups ST and SU, Fig. 12, through to the upper portion of the cross-connecting rack CCR, shown in Fig. 12.

In order to make a selection as to the stock-tens, there are ten conductors (represented by line 1032) extending from the contact pyramid of the relays A to D of the stock-tens register ST. This conductor group is shown in Fig. 12 and is labeled ST. Since the digit 5 has been stored on the register ST, Fig. 10, by the energization of relays B and D, it is the fifth conductor of the group which is grounded. The ground potential is not placed on the contacts of the relays A to D of registers ST, SU, and SR, however, until the upper transfer relay 1101 of the price-range register PR operates, upon the receipt of the price-range digit. But, when conductor 1053' is grounded in the register PR, Fig. 11, ground potential is accordingly extended through contacts of the upper transfer relay of the register ST, and through the associated contact pyramid, over the fifth conductor of the group ST, and through the jumper 1241, shown in Fig. 12, to the left-hand contact of the contact set 1221, by way of contacts of the #1 hundreds relay 1201. This energizes stock relay 75

1241 over conductor 1231, but only slightly, owing to the fact that the upper winding thereof is an inefficient winding drawing small current. As a result, only the contacts marked "x" are closed by the energization of the upper winding. In a stock quotation receiving board containing many stocks, it is possible and perhaps probable that every conductor closed through by a stock-hundreds relay such as the relay 1201 will have a plurality of jumpers connected to it, each leading to a winding of a separate stock relay, such as the stock relay 1241. When this conductor is grounded, each of the relays to which a jumper is connected pulls up through its first step and closes its "x" contacts, but the relay does not close its remaining contacts except under a condition to be described hereinafter.

In accordance with the setting of the stock-units register SU, Fig. 10, in accordance with the code digit 2, the relays A and C thereof arrange the contact pyramid so that ground from conductor 1053' through the lower contacts of the upper transfer relay of the register SU is extended through contacts of the operated relays A and C, as well as through contacts of the unoperated relay B, over the path of line 1033, to the second conductor in group SU, Fig. 12. When this conductor is grounded, a connection extends through contacts of the stock-hundreds relay 1201 and jumper 1242 on the cross-connecting rack CCR to the right-hand terminal of the set 1221, and from thence to the upper winding of the stock register relay 1242, by way of conductor 1221. Relay 1242, like relay 1241, is able to operate only far enough to close contacts marked "x" when energized through the upper winding alone. As a result, if relay 1242 is energized at a time when relay 1241 is not energized the relay operates only its "x" contacts and does not close the connections through with its remaining contacts. At this time, however, both relay 1241 and relay 1242 are operated, and a circuit exists from the now-grounded conductor 1131 through lower windings of the two relays and their "x" contacts in series. The lower windings of relays 1241 and 1242 are efficient windings drawing sufficient current to operate the relays fully. Accordingly, relays 1241 and 1242 are both completely operated, and circuits are prepared for operating the associated registers of stock BBA, code 152.

Operation of stock-range relays

According to the previous assumption and description, the instant price quotation is to be indicated on the receiving board as merely the last price. It will be recalled that the operator pressed the stock-range key LA, Fig. 5, and that this resulted in the operation of only the stock-range relay D in the stock-range register SR, Fig. 6. As a result of this, the stock-range digit was transmitted by the sending apparatus of Figs. 8 and 8A as three light impulses and one heavy impulse, the heavy impulse being the second positive impulse. This second positive impulse is received at a time when relay D of the stock-range register SR, Fig. 10 is connected to the contacts of relay 1003. Accordingly, relay D is operated and is locked to conductor 1053. That being the case, when ground potential is placed on conductor 1053', as hereinbefore mentioned, a circuit is closed through the lower contacts of the upper transfer relay of the register SR and through the outer armature of relay D of the register SR for the stock-range relay 1259 (LA), Fig. 12A,

the five conductors extending from the contacts of relays A to D of the register SR to the stock-range relays of Fig. 12A being indicated by the single line 1034. When the stock-range relay LA, Fig. 12A operates, it locks itself at its inner armature to the now-grounded locking conductor 1131, and at its lower armatures it prepares restoring and operating circuits for the registers in the bottom row only (LA) of the stocks BBA.

Operation of price-range relays

As described and pointed out hereinbefore, the instant quotation contains the full number of price digits, and all four impulses in the price-range digit are transmitted as heavy impulses, resulting in the operation of all four register relays, A to D, of the price-range register PR, Fig. 11. Accordingly, circuits are prepared at the contacts of relays A to D of the register PR over conductors 1107—1110 for each of the four price-range, repeating relays 1251—1254, Fig. 12A.

Restoring the stock registers

In order that the resetting impulses transmitted to the stock registers shall set the registers in the desired positions, it is necessary to first restore the registers from their instant positions to blank position, used also as a normal or starting position. In order that the series of restoring impulses will advance a stock register only as far as its blank position, each of the stock registers, the stock register R1, for example, Figs. 13 and 14, and Fig. 12A is provided with a cam spring such as 1308 which is in engagement with a permanently grounded spring only as long as the indicator is in any position other than the blank position. As will be seen in Fig. 13, the register R1, the upper left-hand register of the stock group BBA, Fig. 12A, is provided with a cam 1306, arranged to rotate with the indicating drum 1304. This cam 1306 carries a projection 1309 which engages the end of the cam spring 1308 when the drum 1304, Figs. 13 and 14, is standing with its blank position exposed to the window in the front piece 1307. When thus operated by the projection 1309, the spring 1308 is moved out of engagement with the grounded spring and is moved into engagement with the spring connected to conductor 1132, Figs. 13 and 12A. In this way, the left-hand terminal of the operating magnet 1302 is connected to ground in all positions of the register R1 except the blank position, in which position it is connected to the conductor 1132. The same is true of all the other registers, and it is indicated in Fig. 12A by showing a cam such as cam 1308 connected in the circuit of each operating magnet such as 1302.

The local sender of Fig. 11A is arranged to send impulses to restore and reset the stock registers, and this sender is started into operation responsive to the grounding of conductor 1106 at the upper contacts of the upper transfer relay 1101 of the price register PR. When conductor 1106 is grounded, differential start relay 1145 operates and locks itself energized at its inner-upper armature. At its upper armature, start relay 1145 closes a circuit for the upper winding of relay 1144. Relay 1144 operates, and supplies ground potential to locking conductor 1111 through its lower armature and the lower armature of relay 1145, instead of through the normally closed contacts controlled by the lower

armature of relay 1144. The purpose for this substitution of ground supply will become apparent as the description progresses.

As a further result of its operation, start relay 1145 places ground on conductor 1142, preparing locking circuits for the relays 1147 to 1162, and closing a circuit through the interrupter 1143 for the impulse sending relay 1146. Relay 1146 accordingly operates under the control of interrupter 1143, and at its lower armature sends impulses from the now-grounded conductors 1107—1110 by way of the lower contacts of relays 1163—1166 to the price-range repeating relays 1251—1254. These repeating relays are accordingly operated each time impulse relay 1146 operates under the control of interrupter 1143. It is to be understood, of course, that, while all of the repeating relays 1251—1254 operate in this case, that condition results only from the fact that all of the price-range relays A to D of the register PR, Fig. 11 are energized, indicating that the full number of price digits is contained in the present quotation. If a lesser number of price digits were contained, certain of the relays A to D of PR would be unoperated, and the corresponding ones of conductors 1107—1110 would be ungrounded, preventing the operation of the corresponding ones of the repeating relays 1251—1254.

Each time relays 1251—1254 operate, an impulse is delivered at the lower contacts of these relays and through contacts of the stock-range relay 1259 (LA) and contacts of stock relay 1241 to the magnets of the bottom row of stock register assigned to the stock BBA. As will be seen upon reference to Fig. 13, each time a stock-register magnet energizes, the associated drum is advanced one half of a step, and is advanced the remaining one half of a step when the magnet deenergizes, the drum 1304 rotating in a counter-clockwise direction.

As will be understood from explanation already given, the first function of the local sender of Fig. 11A is to send a series of restoring impulses to the selected stock registers. The local sender is normally set to send its set of restoring impulses without influence from the contact pyramids of the register PH, PT, PU, and PF. In order to avoid interference, the conductor 1117 which is the conductor over which ground potential is supplied through the apex of the contact pyramids just named, is maintained disconnected for the time being at the upper contacts of relay 1162.

The first time relay 1146 operates under the control of interrupter 1143, it closes a circuit for relay pick-up 1147 at its upper armature. Relay 1147 operates and locks itself to conductor 1142 through pick-up relay 1148. As a result, relay 1148 operates as soon as relay 1146 falls back, and it transfers the working contact of the upper armature of relay 1146 to relay 1149. As a result of this, relay 1149 energizes upon the second operation of relay 1146 and at its inner armature locks its upper winding energized through the upper winding of relay 1150. Relay 1150 accordingly energizes as soon as relay 1146 falls back and it prepares a holding circuit for itself and a differential knock-down circuit for relay 1149. Upon the third energization of relay 1146, a circuit is closed for the lower windings of relays 1149 and 1150, whereupon relay 1149 falls back due to the differential action of the lower winding, but relay 1150 is maintained operated until the end of the impulse,

whereupon relay 1150 falls back and again transfers the operating circuit to relay 1149. This action of relays 1149 and 1150 continues and the relays operate and restore on alternate impulses. This action it will be noted is similar to action of relays 1008 and 1009 under the control of relay 1002.

It may be pointed out at this time that the impulse used to operate the pick-up relays 1147 and 1148 is not counted by the counting relays 1151—1160 because it may not be a complete impulse. That is, the energization of start relay 1145 may occur at such a time as to transmit an impulse that is already half spent. This half-spent impulse may be sufficient to operate relays 1147 and 1148, but not be sufficient to secure a proper stepping action of the registers. No arrangements are provided for preventing this impulse from being delivered to the registers, as it results in no harm if the registers receive an additional impulse, as will be understood from the description to follow.

When relay 1149 operates the first time, it closes a circuit for counting relay 1151, and this relay operates and locks itself at its lower armature through the normally closed contacts controlled by lower armature of relay 1162 to the grounded locking conductor 1142. The circuit of relay 1151 remains directly closed at the upper contacts of relays 1149 and 1150 until the relay 1150 falls back at the end of the second impulse received by the relays 1149 and 1150.

With relays 1149 and 1150 both de-energized at the end of the second counted impulse, the short circuit is removed from around the winding of relay 1152 at the upper contacts of relays 1149 and 1150, and relay 1152 operates in series with relay 1151 and transfers the operating circuit to the relays 1153 and 1154. Accordingly, relay 1153 responds at the beginning of the third counted impulse, and relay 1154 responds at the end of the fourth counted impulse. In the same way, relays 1155—1160 are successively operated until relay 1158 pulls up at the end of the eighth counted impulse.

Relays 1159 and 1160 are not operated coincident with the transmission of the ninth and tenth impulses, relays 1161 and 1162 being operated instead. When relay 1161 operates, it locks itself at its upper armature to conductor 1171 through contacts of relay 1162, at the same time severing the connection between conductor 1171 and the contact chain including the upper armatures of relays 1158, 1156, etc. At its lower armature, relay 1161 locks itself to conductor 1142 and opens the locking circuit of the preceding counting relays, whereupon relays 1151—1158 fall back, leaving relay 1161 operated, and relay 1162 short-circuited.

When relay 1150 falls back at the end of the tenth counted impulse, conductor 1171 is ungrounded, and relay 1162, being no longer short-circuited pulls up. Relay 1162, at its lower armature, prepares locking circuits for relays 1151—1160; at its middle upper armature it transfers conductor 1171 back to the contact chain including the upper armatures of relays 1158, 1156, etc.; and at its inner upper armature it disconnects the front contact of the inner armature of relay 1158 from relay 1161 and transfers it to relay 1159.

By the time relay 1162 operates, ten counted impulses have been delivered to the repeating relays 1251 and 1254, and these relays have responded to ten counted impulses, and have de-

livered these impulses to the stock registers of the bottom row (LA) of the stock BBA through contacts of the stock-range relay LA and contacts of the stock relay 1241. It will be understood, of course, that in case any one of the other stock-range relays were operated, impulses would be delivered at the same time through the contacts of such stock-range relay to the corresponding row of stock registers. The maximum number of impulses required to advance a stock register to blank position is ten. If a stock register is standing in blank position when the resetting impulses start, no movement at all takes place because conductor 1132 to which the magnets of the stock registers are connected by their respective cam springs (such as 1308) when they are in blank position is ungrounded. Furthermore, as the various stock registers reach their blank positions, they cease to operate because their cams are shifted over from their normal ground connection to the ungrounded conductor 1132. Accordingly, all the stock registers in the bottom row (LA) of the stocks BBA are now standing in blank positions.

Resetting the stock registers

The operating speed of the local sender, relative to the operating speed of the transmitter, is such that the registers PH, PT, PU, and PF, Fig. 11, have been operated by the time the restoring series of impulses has been transmitted by the local sender.

When relay 1162 operates at the end of the tenth counted impulse, which it does just when relay 1146 falls back and allows relay 1150 to fall back to remove the shunt from around it, it grounds conductor 1132 at its lower armature preparatory to an advance of the stock registers in response to the impulses in the resetting group now to be transmitted, and at its upper armature, relay 1162 places ground on conductor 1117 from the grounded conductor 1142 through the armature and back contact of impulse relay 1146, relay 1146 being deenergized at the time that relay 1162 operates. As a result, in case any one of the registers PH, PT, PU, or PF, Fig. 11, is set in accordance with a blank digit, relays A, B, and C of such register are energized and the ground potential on conductor 1117 is extended to the blank conductor BL associated with the contact pyramid of such register. The blank conductors from these registers extend directly to the stop relays 1163—1166 of Fig. 11A, independent of the contacts of counting relays 1151—1160. As a result, corresponding stop relay is immediately operated, under the above assumption, and the circuit of the corresponding one of the repeating relays 1251—1254, Fig. 12A, is opened, and no further impulses are transmitted to the corresponding stock register. By this arrangement, no resetting impulses are delivered to a stock register when the setting of the registering apparatus corresponding to such stock register is in accordance with the digit blank.

In the case of the stock quotation being described at present, the price registers PH, PT, PU, and PF are set in accordance with the digits 1, 0, 4, and 1, respectively. That being the case, none of the registers extends the ground potential on conductor 1117 to the conductor BL associated therewith, and none of the relays 1163—1166 is energized immediately.

Upon the next energization of the impulsing relay 1146, following the termination of the tenth counted impulse in the restoring series, and the

consequent energization of relay 1162, a circuit is again closed through the upper armature of the operated relay 1148 and through the upper armature, normal, of relay 1150 for relay 1149, and relays 1149 and 1150 are started upon another cycle of operation as hereinbefore described. Relay 1149 again places ground on conductor 1171 from the grounded conductor 1142, and relay 1151 operates in the same manner as hereinbefore described. As a further result of the energization of relay 1146, an additional impulse is transmitted through contacts of relays 1163—1166 and over the conductors 1127—1130 to the repeating relays 1251—1254. Since conductor 1132 is now grounded at the lower contacts of relay 1162, all the stock registers in the bottom row (LA) of the group corresponding to stock BBA, Fig. 12A, are operated, notwithstanding the fact that they are all in blank position. When relay 1146 falls back, it again grounds conductor 1117, whereupon a circuit is closed through the contact pyramid of the register PH, wherein the relays A and B are energized in accordance with the digit 1, and over the corresponding number 1 conductor and through contacts of counting relay 1151, Fig. 11A, for stop relay 1163. Relay 1163 operates and locks itself to conductor 1142 at its inner armature, and at its lower armature opens a point in the circuit of the hundreds repeating relay 1251, with the result that relay 1251 does not again respond, and the hundreds register in the bottom row (LA) of the stock BBA, having been advanced one step in response to the first impulse received, stands in position 1 and does not follow the remaining impulses.

Since the digit 1 is set up on the price-fractions register PF, the relays A and B are energized therein also, and a ground potential is extended over the associated number 1 conductor and through the upper contacts of the number 1 counting relay 1151 for the price-fractions stop relay 1166. Relay 1166 energizes and locks. The result is that a point in the circuit of the price-fractions repeating relay 1254, Fig. 12A, is opened at the same time that a point in the circuit of relay 1251 is opened. Therefore, the fractions stock register in the bottom row (LA) also remains in position 1.

The operation of relay 1146 continues until four impulses have been transmitted in the resetting series and relay 1154 has been operated, before any further stop relays are energized. Upon the deenergization of relay 1146 at the end of the fourth impulse in the resetting series, the grounding of conductor 1117 extends a circuit through the contact pyramid of the price-units register PU, (wherein the digit 4 is set up by the energization of relays B and C) and over the associated number 4 conductor, by way of contacts of relay 1154 for the units stop relay 1165. As a result, stop relay 1165 operates and locks itself, and opens a point in the circuit of the units repeating relay 1253 to prevent further impulses from being sent to the units stock register, leaving this register in position 4.

The price-tens register PT, Fig. 11, is set in accordance with the digit 0, relay D alone being energized therein. As a result, the tens stop relay 1164 is not operated to open a point in the circuit of the price-tens repeating relay 1252 until relay 1160 energizes at the end of the tenth impulse in the reset series. The result is that the tens register in the bottom row (LA) of the stock BBA, Fig. 12A, is advanced to the tenth position to expose the digit 0, and the desired

price 1041 (104 and one-eighth dollars) is displayed.

Clearing out the local sender

5 With all of the stop relays 1163—1166 operated, a circuit is completed through the middle-lower armatures of these relays and through the inner-lower armature of differential start relay 1145 for the lower winding of relay 1145. With
10 both windings of the relay energized, the core of the relay is demagnetized due to the differential action of the windings. Relay 1145 thereupon falls back and opens the circuit of its upper winding at its inner-upper armature (conductor 1106 having been ungrounded at the upper contacts of the upper transfer relay of the price-hundreds register PH, Fig. 11) and at its inner-lower armature it opens the circuit of its lower winding, leaving the relay in the deenergized condition shown in the drawings. At its
20 middle-lower armature, relay 1145 removes ground from conductor 1142, whereupon all energized ones of the relays 1147—1166 fall back, and relay 1146 ceases to operate. At its lower
25 armature, relay 1145 removes ground potential from conductor 1131, whereupon the locked-up stock-range relay 1259 and the locked-up stock relays 1241 and 1242 are unlocked and fall back.

At its upper armature, relay 1145 opens the
30 circuit of the upper winding of relay 1144, and at its lower armature relay 1145 removes a shunt from around the high resistance lower winding of relay 1144, whereupon the lower winding of the relay is energized over conductor 1111 in series
35 with the locking windings of the energized register relays A to D, Fig. 11. The resistance of the lower winding of relay 1144 is sufficiently high so that no one of the register relays will remain operated in series with this lower winding, but
40 the current-flow through the lower winding of relay 1144 through even one of the register relays is sufficient to hold the relay 1144 operated. As a result, relay 1144 remains operated until
45 all energized ones of the register relays A to D of the registers PR, PH, PT, PU, and PF have fallen back, which they do immediately, whereupon relay 1144 falls back and replaces the direct ground potential on conductor 1111 at the normally closed contacts controlled by its
50 armature.

Indicating an abnormal condition

It will be noted that relay 1160 at its lower
armature supplies ground potential to the lower
55 winding of relay 1145 upon operating. This ground potential is supplied through the right-hand winding of the alarm relay 1172. The alarm relay is adjusted so as not to operate quickly, and the result is that this relay is
60 ways shunted by the ground potential supplied through the middle-lower contacts of stop relays 1163—1166 as long as the apparatus is working properly, and relay 1172, therefore, does not
65 ordinarily operate. In case, however, something, such as a dirty contact, for example, prevents the operation of one of the relays 1163—1166, the circuit for the right-hand winding of relay 1172 in series with the lower winding of relay 1145 is effective when relay 1160 operates and relay
70 1172, not being shunted in this case, operates. At its left-hand armature, relay 1172 locks itself in series with a lamp 1174, and at its right-hand armature it shunts its own right-hand winding to bring about the complete energization
75 of the lower winding of differential start relay

1145 to neutralize the upper winding of the relay as above pointed out. The lamp 1174 becomes lighted in series with the left-hand winding of relay 1172 to indicate the abnormal condition. The lamp 1174 may be supplemented by a buzzer operated through additional contacts of relay 1172 if so desired, or any other well known or desired alarm circuits may be employed in connection with relay 1172.

When the trouble has been discovered and
1 remedied, relay 1172 is unlocked and the lamp 1174 is extinguished by a momentary operation of the manual key 1173.

Clearing out the receiver

As was mentioned hereinbefore, the speeds of
the interrupters (such as interrupter 803) in the transmitters relative to the speed of the interrupters (such as 1143) in the local senders of
2 the receivers is such that the registers PH, PT, PU, and PF have been set by the time the local sender of Fig. 11A has transmitted the restoring
21 impulses, so that the local sender may immediately proceed to transmit the resetting impulses. That being so, the receiver starts to clear
22 out at about the same time that the local sender starts to send the resetting impulses.

When no further impulses are received, relay
1004, which responds to each operation of the light positive relay 1002, remains deenergized,
30 and the slow-acting shunted relay 1005 falls back and opens the circuit of relays 1006 and 1007. Relay 1007 is slow-acting and does not fall back immediately, while relay 1006 falls back as soon
35 as the circuit is opened. As a result, the conductors 1051, 1052, and 1053 are ungrounded momentarily at the contacts of relay 1006, and the ground potential is then replaced at the contacts of relay 1007 when the latter relay falls
40 back. The removal of the ground potential from conductor 1051 deenergizes relays 1008 and 1009 in case these relays should be operated at this time, which is not ordinarily the case. The ungrounding of conductor 1052 deenergizes all of
45 the transfer relays of Figs. 10 and 11, such as the transfer relays 1010 and 1011; and the ungrounding of conductor 1053 deenergizes the relays A to D of the registers SH, ST, SU, and SR. The unlocking of the relays A to D of the registers shown in Fig. 11, as well as the unlocking
50 of the stock range relays 1255—1259 and the stock relays 1241 and 1242 does not take place until the resetting impulses have all been transmitted, whereupon it takes place responsive to the deenergization of start relay 1145, as has been
55 described hereinbefore.

Since the resetting impulses are being transmitted while the clearing-out process is taking place, and since the space between successive quotation transmissions is only the space that would be required to send three digits from the transmitter to the receivers, the next quotation starts to come
60 in before the resetting impulses have all been transmitted, in case the maximum number of resetting impulses is required, as was the case described hereinbefore. Nevertheless, the resetting impulses are all transmitted and the apparatus required to be held up while the resetting
65 impulses are being transmitted has been cleared out in the hereinbefore described manner, before or by the time the new registration has taken place as far as the stock-range register SR, Fig. 10. In practice, the final clearing out of the receiver should be arranged to be completed by
70 the time the stock-tens register ST, Fig. 10 has

been operated in accordance with the stock-tens digit of the next quotation, leaving the margin of the transmission time of two digits to prevent possible overlapping. In case greater speed becomes necessary, the apparatus can operate on a closer margin by arranging the controlling interrupters in the transmitters and in the senders to operate within closer limits.

Receiving short numbers

It may be well to mention at this point that in case a new price relative to a stock does not contain a price-hundreds digit as set up in the transmitter, the fourth impulse in the price range series is a light impulse, and relay D of the register PR is not operated. As a result, conductor 1107 is not grounded, and the hundreds repeating relay 1251 cannot operate to disturb the setting of the hundreds register of a selected row of stock registers. Also, the price-hundreds digit transmitted consists of light impulses only, and none of the storage relays A to D of the price-hundreds register PH, Fig. 11, is operated. In this case there is a connection through back contacts of relays A to D of register PR, from conductor 1117 to the hundreds stop relay 1163, by way of the blank conductor BL. Therefore, relay 1163 operates at the beginning of the series of resetting impulses and closes a point in the restoring circuit of start relay 1145 at its middle armature. A similar condition exists if the tens digit is omitted, and also if the units digit is omitted.

In some cases a new stock quotation differs from the old one only in that the new stock quotation ends with a different fraction. In this case it is merely necessary to move the fractions stock register. In other cases the new quotation may mean a change in only the units and fractions stock registers, while in still other cases the quotation is the change in only the tens, units, and fractions.

Setting up short numbers

In the transmitter, variations in the number of digits in a transmitted price is automatically taken care of in a manner now to be explained. In case only a single price digit is set up by the operation of only one of the digit keys of Fig. 5, this digit is registered on the price-hundreds register PH, Fig. 7. In case the operator next operates a stock-range key and causes the operation of one of the relays A to D of the stock-range register SR, Fig. 6, a circuit is closed over conductor 609 at the inner-lower armature of transfer relay 610, through the lower armature, normal, of relay 707, inner-lower armature, normal, of relay 705, and the inner-lower armature, normal, of relay 703, for connecting relay 707'. In this case, relay 707 connects the conductors extending from the upper contacts of the relays A to D of the register PH to the conductor group PF extending to the sending apparatus in Fig. 8A. Accordingly, the digit registered on the register PH is transmitted as a fractions digit, and the hundreds, tens, and units digits are transmitted with light impulses only, and none of the register relays in the receiver in the price-hundreds, price-tens, and price-units registers are operated, as hereinbefore mentioned.

Assuming that the operator sets up only two digits, a units digit and a fractions digit. The units digit is recorded on the register PH, Fig. 7, and the fractions digit is recorded on the register PT.

ister SR is operated and ground is placed on conductor 609, a circuit is closed through the contacts of relays 707 and 705, and through the lower armature, operated, of relay 703 for the connecting relay 707'. Relay 707 at its upper set of four contact-pairs connects the conductors of the register PH to the conductor group PU extending to the sending apparatus of Fig. 8A, and at its inner set of four contact-pairs connects the conductors of the register PT to the conductor group PF, extending to the sending apparatus of Fig. 8A. As a result the two digits set up on the registers PH and PT are sent out as the units and fractions digit.

It will be seen that in case tens, units, and fractions digits are recorded on the registers PH, PT, and PU, a circuit is closed (upon the operation of the stock-range register) over conductor 609 and through the lower armature, normal, of relay 707, and the lower armature, operated, of relay 705 for the connecting relay 709. Relay 709 connects the conductors of the register PH to the price-tens group PT, extending to the sending apparatus; it connects the conductors of the register PT to the group PU, and it connects the conductors of the register PU to the conductors PF, causing the digits to be sent out as the tens, units, and fractions digits. It has already been explained how, when four digits are set up on the registers PH, PT, PU and PF, and relay 707 is operated, that when conductor 609 becomes grounded, and the relays 710 and 711 operate to connect the conductors of the four registers straight through to the sending apparatus and send out the four registered digits as the hundreds, tens, units, and fractions digits respectively.

Setting up yesterday's closing price

At the close of the day, when the last stock quotation comes through for a particular stock and is set up and sent through as the last price, this last price is subsequently resent, before the operator leaves the premises, as yesterday's closing price so that it will show on the indicators when business is resumed the next day. To do this, the operator sets up the stock indication in the manner hereinbefore described, followed by the last price as indicated by the last-price registers of that stock (it being usual to provide a receiving board at the transmitting station operated from one of the branch circuits of Fig. 9 so that the operators may check up on what they are sending). Having set up the stock and price indication, the operator depresses the stock-range key YC, Fig. 5, operating relays A and B of the registers R, Fig. 6. The sending apparatus operates in the manner hereinbefore described, and in the receiver of Figs. 10 to 12A, the A and B relays in the stock-range register SR are operated, closing a circuit over conductor YC for the yesterday's-close stock-range relay 1255, Fig. 12A. This causes the price to be set up on the upper row of registers in the stock selected.

Following this, the operator again registers the same stock designation and operates the blank digit key BL of Fig. 5 four times, setting up a blank hundreds digit, a blank tens digit, a blank units digit, and a blank fractions digit. Following this, the operator manipulates the key labeled OP—HI—LO—LA, this key corresponding to the indications, Open, High, Low, and Last. When this occurs, relays A to D of the stock-range register SR are operated, and, when the sending apparatus functions, the relays A to D of the stock-

range register SR in the receiver, Figs. 10 to 12A, are operated, and each of the range relays 1256—1259 is operated. With the open, high, low, and last stock-range relays operated, the corresponding rows of stock are selected, and all the stock registers of the selected stock group with the exception of the ones in the row having to do with yesterday's closing price are returned to their blank positions and left standing there.

10 *First quotation of day*

The sending of the first price in the morning is accomplished in the same way as the wiping out of the open, high, low, and last registration above described, except that the hundreds, tens, units, and fractions digits of the first price of the morning are set up on the digit keys of Fig. 5 instead of the blanks above described.

When a different price is received, on the next sale of the stock, this price will either be higher or lower than the open price, with the result that the operator uses either the high-last key HI—LA of Fig. 5, or the low-last key LO—LA of Fig. 5.

From the foregoing description, it is thought that it can be understood how the operator takes care of the various price quotations.

Handling preferred stock

In addition to the so-called common stock, there is often a so-called first-preferred stock on the market of the same designation as the common stock, second-preferred stock. For example, the stock BBA is a common stock and in addition there may be a stock BBA, first-preferred, and a stock BBA, second-preferred. In setting up a stock indication BBA, first-preferred, the operator sets up the BBA designation and operates the first-preferred key 1—PF, Fig. 1. When the first-preferred key 1—PF is operated, a circuit is closed over conductor 103 for relay 210. Relay 210 locks itself to conductor 250, along with the other register relays of Fig. 2 and at its upper armature closes a circuit over conductor 212 and through contacts of the energized relay 404, Fig. 4, for the first-preferred relay 401, assuming the register set #1 to be connected up. Relay 401 operates and locks itself to conductor 606 at its upper armature, and at its lower armatures shifts the conductors 1 to 5 of the group CD2 from in connection with the relays 1 to 5 of the stock-tens register ST into connection with the relays 6—0, respectively. Since the tens code digit ordinarily transmitted for stock BBA (code 152) is the digit 5, this digit is now transmitted as the digit 0, selecting a different stock-register group in the receiver.

If, instead, the second-preferred key 2—PF is operated, relay 209 operates instead of relay 210, and, upon operating and closing a locking circuit for itself at its lower armature, it closes a circuit over conductor 211 and through contacts of relay 405 for the second-preferred relay 402. In this case the first-preferred relay 401 is not operated, and the tens code digit is sent out as the digit 5, but relay 402 makes a similar change as regards the conductor set CD3, with the result that the units digit instead of being the units digit 2 is sent out as the units digit 7.

70 *Operation of modified receiver*

Referring now to Fig. 16, the modification of the receiver RE7 shown therein will now be described. It will be recalled that the grids of the vacuum tubes 1041 and 1042 of the receiver RE7, Figs. 10 to 12—11A and 12A are conductively

connected by way of the conductors and resistance 857, 903, 905, 909, and 910, Fig. 9, to the transmitter, and that the impulses transmitted to the grids of the vacuum tubes are voltage variations with respect to ground potential at the transmitter T1, Figs. 1 to 8 and 8A. It occasionally happens, that street-railway systems, and other systems which carry heavy currents and which depend upon return conductors, such as street rails, which are grounded, cause substantial variations in ground potential between specific points. It may happen, therefore, that the difference in the ground potential at a receiver and the ground potential at a transmitter will render the transmitted voltage impulses ineffectual to secure the desired operations of the receiving relays such as relays 1001, 1002, and 1003 of the receiver RE7, Fig. 10. When such a condition obtains, the receiving circuit may be modified by inserting condenser 1601, Fig. 16 between the conductor 910 and the grid elements of the vacuum tubes 1041 and 1042. The condenser 1001 insulates the grids of these vacuum tubes from conductor 910 insofar as a prolonged flow of current in one direction is concerned, but the impulses transmitted by the transmitting apparatus disclosed herein may pass freely through the condenser 1601 and cause the desired voltage changes on the grids of the vacuum tubes 1041 and 1042 because the transmitted impulses are of only momentary duration, and further because each impulse is of a polarity opposite to the polarity of the preceding impulse.

In order to maintain the grid elements of the tubes 1040 and 1042 in the modification of Fig. 16 normally at a potential negative with respect to the filaments of the tubes to an amount determined by the voltage of the section of the battery connected between the filaments and the ground, the high resistance 1602 is connected between the grids of the tubes and ground, maintaining the grids normally at the ground potential existing at the receiver. It will be recognized that the resistance 1602 corresponds to the so-called "grid-leak" resistance used extensively in circuits employing vacuum tubes for the amplification of currents of audible frequency. This resistance may be in the neighborhood of one-half to one megohm, higher or lower depending upon the particular characteristics of the tubes 1041 and 1042.

In order to prevent a so-called parolization of the tubes 1041 and 1042, which occurs in case the grid elements thereof become sufficiently positive at any time in their operation to draw substantial current from the filaments, the voltage of the so-called "C" battery section connected between ground and the filaments of the tubes should be sufficiently high, with respect to the voltage of the batteries in the transmitter from which the impulses come, that the grid elements of the tubes are never rendered positive with respect to the filaments. It should be kept in mind, of course, that, with the grid elements of the tubes maintained at a normally high negative potential with respect to the filaments, it is necessary to employ correspondingly high potentials in the section of the battery which drives current through the plate-filament circuits.

It may be mentioned that best results are obtained if the condenser 1601 is of several microfarads capacity so that the small current taken by the grid-leak resistance 1602 upon a heavy

impulse does not result in an appreciable, residual charge being left on the grid elements of the tubes when the heavy impulse subsides.

It may happen in a commercial installation that the ground potential at a majority of the receivers does not vary appreciably with respect to the ground potential at the transmitter, in which case it is sufficient to equip only the few receivers at which substantial ground-potential variations occur, with a condenser such as 1001 and a grid-leak resistance such as 1002.

What is claimed is:

1. In a stock-quotation system, a transmitter including a group of registers arranged to register a variable number of price digits in a stock quotation, sending means in the transmitter arranged to send signals corresponding to the registered price digits and to send signals corresponding to an additional digit having a value dependent upon the number of registered price digits, a stock-quotation receiver having registers arranged to register all of the said digits in accordance with the signals transmitted by the transmitter, a group of price-digit indicators, and means for operating said indicators to display an indication dependent upon the joint value of all of the registered digits.

2. In a stock-quotation system, a stock-quotation transmitter including a group of price-digit registers arranged to be set in accordance with a variable number of price digits of a stock transaction, sending means arranged to send signals corresponding to a digit indicative of the number of price digits recorded on said registers and to then send signals corresponding to the registered price digits, a stock-quotation receiver including registers responsive to all of the said digits in accordance with the signals sent by said sending means, a group of stock-

quotation indicators arranged to display the price digits of a stock quotation, and means controlled in accordance with the value of the digit first received at the receiver for operating said indicators to display the price digits registered at the receiver.

3. In a stock-quotation system, a stock-quotation transmitter and a stock-quotation receiver, means in the transmitter for registering a variable number of digits and sending signals corresponding thereto, means operative after the variable number of digits have been registered and before the signals corresponding thereto have been sent to cause the sending means to send signals corresponding to a digit of a value dependent upon the number of registered digits to be sent, means in the stock-quotation receiver responsive to the retransmitted signals of the registered digits, and means in the stock-quotation receiver responsive to the signal first received for preparing the receiver in accordance with the number of digits which are to follow.

4. In an automatic broker's display board, groups of indicators for posting the varying quotations of stocks or other items, permutation devices and means for operating varying numbers of them over a relatively small number of impulse channels for controlling the selection and actuation of indicators in any desired group to cause them to post digits representative of the quotations, and means also operable over said channels after part of said permutation devices have been set pursuant to a given quotation and before all have been set for receiving and storing a group of impulses indicative of the number of said permutation devices to be set pursuant to such quotation.

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