(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 February 2001 (08.02.2001)

PCT

(10) International Publication Number
WO 01/09698 A2

(51) International Patent Classification[7]: G06F

(21) International Application Number: PCT/US00/20953

(22) International Filing Date: 1 August 2000 (01.08.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

09/365,992	3 August 1999 (03.08.1999)	US
09/365,993	3 August 1999 (03.08.1999)	US
09/366,383	3 August 1999 (03.08.1999)	US

(71) Applicant: TRADEWORX, INC. [US/US]; Suite 1010, 304 Park Avenue South, New York, NY 10010 (US).

(72) Inventor: NARANG, Manoj; 260 West 52nd Street #20E, New York, NY 10019 (US).

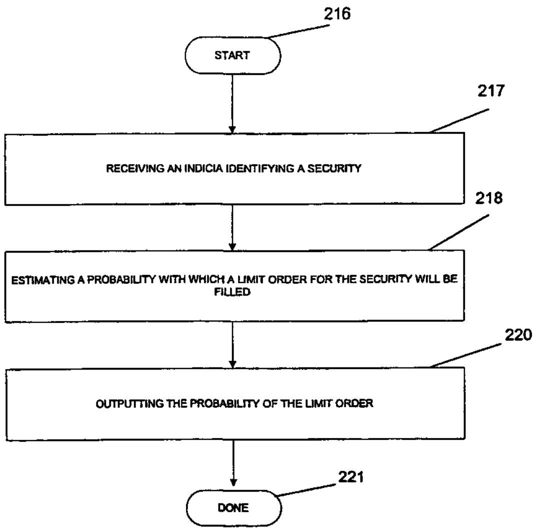
(74) Agent: HICKMAN, Paul, L.; Hickman Coleman & Hughes, LLP, P.O. Box 52037, Palo Alto, CA 94303-0746 (US).

(81) Designated States *(national)*: AU, CN, JP, KR, SG.

Published:
— *Without international search report and to be republished upon receipt of that report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SYSTEM, METHOD, AND ARTICLE OF MANUFACTURE FOR ESTIMATING A PROBABILITY WITH WHICH A LIMIT ORDER WILL BE FILLED



(57) **Abstract:** A system, method and article of manufacture are provided for estimating a probability associated with a limit order. First, an indicia identifying a security is received from a user. A probability with which a limit order for the security will be filled is then estimated. Estimation of the probability may be based on various factors such as a desired time interval during which the limit order is to be filled, a desired price for the limit order, and/or a current bid price and offered price of the security. Thereafter, the probability of the limit order is outputted. The probability may be estimated on a server connected to a plurality of client computers via a network. By this structure, the indice may be received from the client computers over the network. Further, the estimated probability of the limit order may be outputted to the client computers over the network.

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SYSTEM, METHOD, AND ARTICLE OF MANUFACTURE FOR ESTIMATING A PROBABILITY WITH WHICH A LIMIT ORDER WILL BE FILLED

FIELD OF THE INVENTION

The present invention relates generally to software packages for buying and selling exchange-traded securities and, more particularly, to a system, method, and article of manufacture for strategically estimating a probability with which a limit order will be filled.

BACKGROUND OF THE INVENTION

Using limit orders is a standard way to buy and sell exchange-traded securities. A limit order is similar to an ordinary "market" order, except for a few characteristics. For example, in addition to specifying the size of the trade, limit orders also specify a worst acceptable price for the trade. Further, a limit order is not guaranteed to be filled, as opposed to a market order.

Because of the increasing volatility of the markets, brokerages are under ever-increasing pressure by the SEC (Securities and Exchange Commission) to encourage their customers to use limit orders. Limit orders protect customers from paying "too much" for a rapidly-moving stock because the customer gets to decide how "too much" is defined. A customer who attempts to buy a volatile stock using a market order will likely be dissatisfied with the price of the resulting trade. In fact, mounting litigation arising from bad fills on market orders is a major threat to the on-line brokerage business.

Unfortunately, brokers have been only marginally successful in persuading their customers to use limit orders. The main reason for this trend is that ordinary people have a difficult time coming up with good prices at which to place their limit orders. In the case of a buy order, a "good" price would be one that is high enough to give a high likelihood of being filled, but one which is low enough to ensure that the buyer does not overpay for the stock.

The determination of a "good" price is a complex task, because it depends on numerous factors that are difficult for people to account for, especially simultaneously. Currently, people have no tools at their disposal to help them compute good limit prices. As a result, people often either avoid using limit orders or resort to guesswork in order to price the same.

Avoiding limit orders is often detrimental for a broker, because customers are more likely to be dissatisfied with the result of a market order, and because the SEC wants people to use limit orders. Even worse, employing guesswork in determining a price of a limit order is problematic because sub-optimal limit orders may render the order not competitive enough, so it never gets executed, or too competitive, so the buyer ended up paying too much. Ultimately, the only sub-optimal limit orders which ever get filled are the ones where the customer pays too much. As such, people waste vast amounts of money annually in submitting sub-optimal limit orders for execution.

There is thus a need for a method capable of strategically estimating a price of a limit order.

Disclosure of the Invention

A system, method and article of manufacture are provided for estimating a probability associated with a limit order. First, an indicia identifying a security is received from a user. A probability with which a limit order for the security will be filled is then estimated. Estimation of the probability may be based on various factors such as a desired time interval during which the limit order is to be filled, a desired price for the limit order, and/or a current bid price and offered price of the security. Thereafter, the probability of the limit order is outputted. The probability may be estimated on a server connected to a plurality of client computers via a network. By this structure, the indicia may be received from the client computers over the network. Further, the estimated probability of the limit order may be outputted to the client computers over the network.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing aspects are better understood from the following detailed description of a preferred embodiment of the invention with reference to the drawings, in which:

Figure **1** is a schematic diagram of one possible hardware implementation in accordance with one embodiment of the present invention;

Figure **1A** is a schematic diagram of one embodiment of the present invention implemented on a network, i.e. the Internet;

Figure **2** is a flow diagram depicting a method by which a price is estimated for a limit order in accordance with one embodiment of the present invention;

Figure **2A** is a flow diagram depicting a method by which a probability is estimated for a limit order in accordance with another embodiment of the present invention;

Figure **2B** is a flow diagram depicting a method by which a time is estimated for a limit order in accordance with another embodiment of the present invention;

Figure **3** is a flow diagram depicting a method by which a price is estimated for a limit order based on a user-specified time interval and probability in accordance with another embodiment of the present invention;

Figure **4** is a flow diagram depicting a method by which a time interval is estimated for a limit order based on a user-specified price and probability in accordance with another embodiment of the present invention;

Figure **5** is a flow diagram depicting a method by which a probability is estimated for a limit order based on a user-specified price and time interval in accordance with another embodiment of the present invention;

Figure **6** is a flow diagram illustrating the operation **306** of Figure **3** in greater detail;

Figure **7** is a flow diagram illustrating the operation **604** of Figure **6** in greater detail; and

Figure **8** is a flow diagram illustrating the operations **704** and **706** of Figure **7** in greater detail.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In general terms, the present invention facilitates the placement of a limit order without requiring focus on more complex aspects of the problem. More particularly, the present invention involves selecting a few intuitive parameters which are easy for unsophisticated users to supply. Next, a formal, rigorous mathematical model is utilized which relates the price of a limit order to these user-supplied factors. Such mathematical model also incorporates more complicated factors into the model, while hiding their complexity from the user.

Figure **1** is a schematic diagram of one possible hardware implementation by which the present invention may be carried out. As shown, the present invention may be practiced in the context of a personal computer such as an IBM compatible personal computer, Apple Macintosh computer or UNIX based workstation.

A representative hardware environment is depicted in Figure **1**, which illustrates a typical hardware configuration of a workstation in accordance with one embodiment having a central processing unit **110**, such as a microprocessor, and a number of other units interconnected via a system bus **112**. The workstation shown in Figure **1** includes a Random Access Memory (RAM) **114**, Read Only Memory (ROM) **116**, an I/O adapter **118** for connecting peripheral devices such as disk storage units **120** to the bus **112**, a user interface adapter **122** for connecting a keyboard **124**, a mouse **126**, a speaker **128**, a microphone **132**, and/or other user interface devices such as a touch screen (not shown) to the bus **112**, communication adapter **134** for connecting the workstation to a communication network (e.g., a data processing network) and a display adapter **136** for connecting the bus **112** to a display device **138**.

The workstation typically has resident thereon an operating system such as the Microsoft Windows NT or Windows/95 Operating System (OS), the IBM OS/2 operating system, the MAC OS, or UNIX operating system. Those skilled in the art will appreciate that the present invention may also be implemented on platforms and operating systems other than those mentioned.

Figure **1A** is a schematic diagram of one embodiment of the present invention implemented on a network **200**, i.e. the Internet. In particular, such embodiment includes a plurality of clients **202** each connected to a server **204** via the network **200**. By this structure, the present invention may be executed at a large scale.

With specific reference now to Figure **2**, a simplified framework is shown to be provided for estimating limit order prices for a security, i.e. stock, bond, etc. First, upon starting in **209,** an indicia identifying a security is received from a user in operation **210**. A price is then estimated for a limit order for the security in operation **212**. Estimation of the price may be based on various factors such as a desired time interval during which the limit order is to be filled, a desired probability with which the limit order is to be filled, and/or a current bid price and offered price of the security. In addition, the estimation of the price may be at least partly dependent on whether the limit order is a sell order or a buy order. Any or all of the foregoing parameters may be received as a component of the indicia. Finally, as indicated in operation **214,** the price for the limit order is outputted after which the method is terminated in **215**.

With specific reference now to Figure **2A**, a simplified framework is shown to be provided for estimating a probability with which a limit order is to be filled. First, upon starting in **216,** an indicia identifying a security is received from a user, in operation **217**. A probability is then estimated for a limit order for the security in operation **218**. Estimation of the probability may be based on various factors such as a desired time interval during which the limit order is to be filled, a desired price for the limit order being filled, and/or a current bid price and offered price of the security. In addition, the estimation of the probability may be at least partly dependent on whether the limit order is a sell order or a buy order. Any or all of the foregoing parameters may be received as a component of the indicia. Finally, as indicated in operation **220,** the desired probability with which the limit order is to be filled is outputted after which the process is terminated in **221.**

With specific reference now to Figure **2B**, a simplified framework is shown to be provided for estimating a time interval during which the limit order is to be filled. First, upon starting in **223,** an indicia identifying a security is received from a user in operation **224**. As an option, in each of the foregoing embodiments, the indicia may include a ticker symbol of the security. A time interval is then estimated for a limit order for the security in operation **226**. Estimation of the time interval may be based on various factors such as a desired price of the limit order to be filled, a desired probability with which the limit order is to be filled, and/or a current bid price and offered price of the security. In addition, the estimation of the time interval may be at least partly dependent on whether the limit order is a sell order or a buy order. Any or all of the foregoing parameters may be received as a component of the indicia. Finally, as indicated in operation **228,** the time interval for the limit order is outputted after which the method is terminated in **229**.

It should be noted that any of the user-specified parameters, i.e. price, time interval, probability, current bid price, offered price, etc., may be inputted by any input device such as the keyboard **124**, the mouse **126**, the microphone **132**, the touch screen (not shown), or anything else that is capable of conveying such information. Further, the estimations may be carried out via the CPU **110** which in turn may be governed by a computer program stored on a computer readable medium, i.e. the RAM **114**, ROM **116**, the disk storage units **120,** and/or anything else capable of storing the computer program. In the alternative, dedicated hardware such as an application specific integrated circuit (ASIC) may be employed to accomplish the same. Further, the outputting of the price may be effected by way of the display **138**, the speaker **128,** a printer (not shown) or any other output mechanism capable of delivering the price to the user. It should be understood that the foregoing components need not be resident on a single computer, but also may be a component of either a networked client **202** and/or a server **204,** as shown in Figure **1A**.

In one embodiment of the present invention, the price may be estimated using the formula:

P = P1 + sign * sigma * discount,

where:

- P1 = a price selected between a current bid price and an offered price, inclusive;
- sign = 1 if the limit order is a sell order, and sign = -1 if the limit order is a buy order;
- sigma = a constant that will be set forth hereinafter;
- discount satisfies the equation: prob= 2*CUMNORM(discount);

  where:

  - prob = a desired probability with which the limit order is to be filled;
  - CUMNORM(x) = a definite integral of a standard normal density function f(x) over an interval [0, x]; and
  - f(x) = 1/sqrt(2*   ) exp($-x^2/2$).

In the foregoing formula, the variable x represents an arbitrarily or intentionally selected upper limit of a time interval during which the limit order is to be filled. In a similar manner, the variable P1 may be arbitrarily or intentionally selected. In the present description, the current bid price may be defined as _____________. Further, the offered price may be defined as _____________________.

It should be noted that, if the variable that is to be estimated is a probability with which the limit order is to be filled instead of a price, the aforementioned formula may be substituted with prob = 2 - 2*CUMNORM((P-P1) /(sign*sigma)). On the other hand, if the variable that is to be estimated is a time interval during which the limit order is to be filled, the aforementioned formula may substituted with $T = ((P-P1)/(P-Q)^2$, where Q is the optimal price of a limit order, as calculated hereinabove, with the same odds of execution, and with a one minute desired waiting period.

In various alternate embodiments of the present invention, sigma may be selected by the user or any other entity based on an assortment of different factors. It should be noted that sigma may also be received as a component of the aforementioned indicia. Examples of the various factors on which selection of sigma may be based include: a historical volatility of the security over an arbitrarily predetermined time period; a forecasted volatility of the security over an arbitrarily predetermined time period; a current volatility of the security, a forecasted trading range of the security over an arbitrarily predetermined time period, an implied volatility of the security, and/or another type of factor. The various meanings of the foregoing terms are well known to those skilled in the art. For example, it is well known that an implied volatility is a volatility which is implied by current prices of options on the security.

In yet another embodiment, sigma may be calculated using the formula:

sigma= k*RF,

where:

- k = sqrt(/8) (it should be noted that may be estimated with 4*Arctan(1));
- RF = sqrt(T/n)* SUM [$a_i(H_i-L_i)$] for i = 0....y;

where:

- o a_i = a constant (possibly 0);

- n = a constant length of a trading day in an arbitrarily selected units of time (T);
- H_0 = a current highest trading price of the security;
- L_0 = a current lowest trading price of the security;
- y = an arbitrarily predetermined number of days;
- H_i = the highest trading price of the security i days ago; and
- L_i = the lowest trading price of the security i days ago.

While the variable y may be an arbitrarily predetermined number of days, it is preferred that a large number of days be chosen to enhance accuracy of the estimation. In various embodiments of the present invention, a_i may be non-zero for only a finite number of values of i. Further, at least one value of a_i may be calculated via a regression or be a function of sqrt(i). In an alternate embodiment, H_i and L_i may be defined as the highest and lowest trading price of the security at any time within i previous days, respectively.

With reference now to Figures **3-8**, another method of estimating price or other related parameters will now be set forth. The instant method begins in operation **300**. Then, in operation **302**, a desired time interval during which a limit order is to be filled is received from a user. Also received from the user is a desired probability with which the limit order is to be filled, as indicated in operation **304**. Next, a price associated with the limit order is estimated based on the desired time interval and the desired probability. Note operation **306**. Finally, the price is then outputted for facilitating the filling of the limit order in operation **308** after which the method is done in operation **310**.

Figures **4** and **5** each illustrate alternate embodiments of the embodiment shown in Figure **3**. Figure **4** shows a variation wherein, upon starting in operation **400**, a desired probability and desired price are received from a user in operations **402** and **404**, respectively. Next, a time interval during which the limit order is to be filled is estimated and outputted in operations **406** and **408**, respectively. It should be noted that the time internal is estimated based on the desired price and probability. The method of Figure **4** is then terminated in operation **410**.

Figure **5** shows a variation wherein, upon starting in operation **500**, a desired time interval and desired price are received from a user in operations **502** and **504**, respectively. Next, a probability with which the limit order is to be filled is estimated and outputted in operations **506** and **508**, respectively. In the present embodiment, the probability is estimated based on the desired price and time interval. The method of Figure **5** is then terminated in operation **510**. The various information of the alternate embodiments of Figure **4** and Figure **5** may inputted, processed, and outputted in a manner similar to the embodiment of Figure **1A.**

With reference now to Figure **6,** a more detailed flowchart is shown which relates to operation **306** of Figure **3**. As shown, upon starting in operation **600**, the present method includes calculating the price in real-time using a particular algorithm which represents a relationship between the time interval, probability, and price. Note operation **602**. Such algorithm may assume a sufficiently short time interval and that the price may be described by a driftless Brownian motion.

In one embodiment, such algorithm includes prob[L(P,T)] = 1 – k*F(P)/R(T), where (P) denotes the price of a limit order on a financial instrument, (T) denotes the lifespan or time interval in which the limit order is valid(or is to be filled), and prob[L(P,T)] is the probability that the limit order whose price is (P) is filled within the time interval (T). Further, (k) is a constant, F(P) is an anti-derivative of the exp(-k*x^2), and R(T) is a random variable representative of a trading range over the time interval (T). The constant (k) may be calculated k = 4/Π, where Π = 3.14....

With continuing reference to Figure **6,** the random variable R(T) is calculated using an estimator in operation **604**. Letting max(T) and min(T) denote the maximum and minimum values, respectively, of the price over the interval (now, now+T), or (T), R(T) = E[max(T) - min(T)], where E[] denotes a mathematical expectation operator. The method of Figure **6** terminates in operation **606.**

The present invention thus reduces the problem of calculating the odds of execution of a limit order priced at (P) to the problem of estimating the random variable R(T), the mathematical expectation of the ensuing trading range in time interval (T). A forecast, R_f(T), for the forthcoming trading range can serve effectively as an estimator for R(T) provided that it meets certain engineering standards for accuracy, robustness, and adaptivity. If this criteria is met, output, R_f(T), can be substituted in place of R(T) in the algorithm prob[L(P,T)] = 1 – k*F(P)/R(T) in order to yield the probability that a limit order priced at (P) will get filled within time interval (T).

The estimator R_f(T) thus represents an adaptive, robust algorithm for predicting the future trading range of an exchange-traded security in real time. As set forth hereinabove, R(T) denotes the trading range of some security over the forthcoming interval (T), and the estimator R_f(T) is a valid substitute for R(T). In order for the estimator $R_f(T)$ to be useful in the context of pricing limit orders for commercial use, it should have certain characteristics.

For example, the estimator $R_f(T)$ should exhibit a high signal-to-noise ratio when tested on out-of-sample data. Further, it should be adaptive to unexpected changes in real time volatility and be able to incorporate real time data in a mathematically consistent way, without requiring explicit calibration to real time data. In addition, the robust estimator $R_f(T)$ should forecast over a fixed interval smoothly with time; that is to say, without extreme swings. The estimator $R_f(T)$ should further exhibit its robust qualities by producing meaningful and useful results regardless of extreme market conditions. The estimation of the model's parameters should also yield consistent results over the space of all related securities. Finally, the estimator $R_f(T)$ should measure the model's goodness-of-fit and yield consistent results for all securities over the same periods of out-of-sample data.

Any forecasting technique requires the identification of explanatory variables. In a financial setting, lagged values of the quantity being predicted are a natural choice. Statistical investigations reveal that lagged values of the trading range have historically had significant explanatory power over the following day's trading range. A good trade-off can be achieved by using two trading ranges spanning different lengths of time, since shorter time periods contribute to increased adaptivity, whereas longer time periods contribute to increased robustness.
In one embodiment of the present invention, the estimator may take the form of $R_f(T) = c_S (T)*r(S) + c_L (T)*r(L)$, where r(x) is the size of the trading range over the time interval (T), i.e. (now-x, now). In one implementation, (S) is arbitrarily chosen to be one day, while the (L) is chosen to be seven days. The calibration of the parameters c_S (t) and c_L (t) for arbitrary values of (t) , where (t) is less than one day, is discussed hereinafter.

- Step 1: Estimate c_S (t) and c_L (t) for t = 1 day. The form of the above model suggests the use of regression to estimate the parameters. To enhance robustness, use a two-phase least-squares linear fit. In the first phase, fit a standard regression line. Then, discount outliers to the fit so that the standardized residual of any observation is no greater than a fixed threshold, i.e. number two, and then re-estimate a new regression line using the appropriate discounting schedule.

- Step 2: Estimate c_{S+1} (t) and c_{L+1} (t) for t = 1 day, using the same technique as in step 1.

- Step 3: Step 1 gives a forecast of the 1-day trading range which is valid at the start of the day. Step 2 yields a forecast of the 1-day trading range which is valid at the end of the day. Let x be the fraction of the trading day which has elapsed at some point p during the day. Derive a forecast of the 1-day trading range starting at p by blending forecasts 1 and 2 in the proportion (1-x, x). The model is thus calibrated so that it can accept real-time information on the size of the prior range without having directly used real time data in the estimation process.

- Step 4: Derive from first principles that $R_f(T)$ varies as the square root of (T). Thus, one can forecast the range over an arbitrary interval by taking the output of Step 3 and multiplying by the square root of (T), where (T) is in units of days.

Figure **7** is a flowchart illustrating a summary of the foregoing four steps. After the process is started in operation **700**, r(S) and r(L) are determined, in operation **702**. Next, $c_S(t)$ and $c_L(t)$ are estimated using regression with a time interval (t) = 1 day in order to generate a first preliminary estimator $R_{f1}(t)$ which is valid for a start of the day. Note operation **704**. Thereafter, $c_{S+1}(t)$ and $c_{L+1}(t)$ are estimated using regression with the time interval (t) = 1 day in order to generate a second preliminary estimator $R_{f2}(T)$ which is valid for an end of the day, as indicated in operation **706**. The estimator $R_f(T)$ is then generated using the first preliminary estimator $R_{f1}(T)$ and the second preliminary estimator $R_{f2}(T)$, as indicated in operation **708**. The process is then terminated in operation **710**.

With reference now to Figure **8**, step 1, as set forth hereinabove, begins in operation **800**, after which a standard regression line is fitted in order to afford a fit. See operation **802**. Next, outliers to the fit are discounted in operation **804**. The regression line is then re-estimated using a discounting schedule in operation **806** after which the process is terminated in operation **808**.

Historical tests of the resulting model for various securities on out-of-sample data demonstrate a high signal to noise ratio usually well in excess of one. Moreover, the signal to noise ratio improves with the size of the forecast, which is an important characteristic for the application of limit order pricing, since limit orders are most useful for volatile instruments.

Additional detail will now be provided which may be combined with the principles of the present invention. At present, there exist several types of financial markets in which securities, commodities, and other negotiable instruments are traded. Among known types of financial markets is the auction market, the most prominent example being the New York Stock Exchange. In an auction market, buyers and sellers congregate on the exchange floor and announce their respective bid (price offered to buy) and ask (price acceptable to sell) prices. As a result of the continuous auction process, a trade in any particular security occurs at the highest price any buyer is willing to pay and at the lowest price any seller is willing to accept. Transaction costs are minimized by eliminating dealers who otherwise come between the buyer and seller as in other types of exchanges, for example, the over-the-counter exchange.

The physical auction floor is divided into several rooms, each of which has posts or columns around which trading panels are arranged. The trading panels are where particular securities are designated to be traded. Each security is traded at a certain trading panel.

There are three principal players in the trading crowd on the floor of an auction exchange: the specialist, the floor broker, and the floor trader. The specialist is situated at one of the trading panels and has several roles in the trading process including: auctioneer to call out the best bids and offers to brokers that request quotes during the trading session and to ensure that all trades are posted; catalyst to call a particular broker who has previously expressed a buying interest to the post in response to a selling interest at the post; agent to represent investors in trades that have limits imposed thereon, for example, a price floor, etc.; and franchiser to provide capital when necessary to maintain liquidity when supply and demand are out of balance. The floor broker roams about the trading floor, and, as an agent, transacts orders on behalf of the buyers and sellers. Approximately ninety percent of the orders that the floor broker executes are obtained from a clerk who is situated on the perimeter of the exchange. The floor trader is like a floor broker, except the floor trader trades for his or her own account. For further information on the stock market and current automation thereof.

The clerk is not part of the trading crowd, but he or she plays a role in investor transactions. The clerk receives orders and quote requests from investors and relays them to one of the floor brokers for handling. Once handled, the clerk reports the execution or quote to the investor. Alternatively, the order can be electronically routed to the trading post for matching and reporting. As used in this specification, an investor is an order originator which may include institutions such as banks and pension funds, other broker/dealers, trading desks (institutional, retail, arbitrage, etc.), public customers (including individuals), and the like.

A typical transaction originates when an order is placed with an off-the-floor trading desk to buy or sell a particular security. The trading desk may either convey the order to a clerk (electronically or by telephone), or electronically to the specialist at the trading post. The clerk is known as the "order" or "booth clerk." The booth clerk notes the parameters of the order, for example, the side of the transaction (buy or sell), the symbol of the security (e.g., IBM, GM, etc.), the quantity (e.g., 9,000 shares), the price (market or limit), any special conditions (e.g., all or none, fill or kill, good 'till canceled, on opening, etc.), and the time that the order is placed. Because the market in any one security fluctuates with each trade and is influenced by the activity in other securities, an important aspect of the clerk's function is to ensure that the order is delivered to the broker so that it is executed in a timely fashion. An executed order is one that is filled or partially filled, that is, the security is bought or sold according to the parameters of the order.

The investor may also request that the trading desk obtain a quote from the floor of the exchange to get the "feel" of what is happening in the market of a particular security. Unlike an official quote provided by the quotation services such as ADP and Quotron, which includes the best bid and ask prices, the market size at the best prices, and perhaps opening and closing prices on the day for the stock as well as the last trade, this quote provides more insight or "flavor" into the market. By way of illustration, and not exhaustive of the possible varieties of "flavor quotes" obtainable, the "flavor quote" or "market look" may indicate: (1) who were the recent buyers and sellers of the security and the size and price of those trades; (2) the market depth (the extent of market interest) and who are the players at the current market and at differing price levels, as obtained from the trading crowd and perhaps the specialist's book; (3) the learned opinion and interpretation of the market from the floor brokers themselves; and (4) the possible trading interest of people not currently in the trading crowd, based on prior history, previous days, etc. The trading crowd, which includes the specialist who makes the market in that security and the other floor brokers and floor traders that may be working that post, provides a view of the market not obtainable from an official quote. Using the information obtained from the trading crowd and the floor broker's experience and understanding, the investor is able to discern the real story of the market in a particular security so that he or she can make an educated decision as to what position to take in a security.

In this specification, quote requests and orders are generally referred to as instructions whereas the quotes and executions are generally referred to as responses to the instructions, but are transmitted as instructions.

The floor broker executes orders and obtains quotes according to instructions from the booth clerk. The floor broker is typically stationed at one of several trading panels. It is not uncommon for a floor broker to specialize in a few select securities. The specialized floor broker can therefore generally be located on the crowded trading floor in the vicinity of a certain trading panel; however, the floor broker is only effective in his or her function if he or she is free to move from panel to panel, and to different posts.

Traditionally, the booth clerk transcribes the instructions onto either an order slip or a quote request form, depending on the nature of the instruction. The booth clerk decides whether to send the instruction to the trading post electronically, or to use a floor broker. In the event that the booth clerk decides to use a floor broker, he or she enlists the aid of pages or runners to carry the instructions to the floor broker because the booth clerk is situated around the perimeter of the trading floor. Likewise, the floor broker provides the page with transcribed quotes and executions in response to all of the instructions that the floor broker has handled since the last time a page found that broker in the trading crowd. In this manner, the floor broker can remain in the crowd, doing his or her job. Further, the floor broker may provide the page with an "unsolicited quote," that is, insight on the market that may be important to investors being represented by the floor broker, but who have yet to specify such a request. Hence, the astute floor broker, recognizing activity at the trading panel that may be of interest to the investors he or she represents, transmits unsolicited quotes back to the booth clerk so that the clerk can disseminate the information as appropriate. The page runs the quotes, executions, and unsolicited quotes to the booth clerk for reconciliation and reporting.

By law, orders must be handled in a timely manner. The transcribed instructions must be delivered to the floor brokers and the transcribed executions and quotes must be retrieved from the floor brokers and returned to the booth clerk promptly. However, the slips of paper on which orders and quotes are recorded can be easily misplaced, and if dropped, can be lost among a plethora of discarded slips that were scribbled in a trading frenzy. Any attempt to locate a slip dropped onto the crowded trading floor will be frustrated by the constant movement of floor brokers, pages, and the like.

Until an order or quote is returned to the booth clerk, the booth clerk cannot apprise the investor of progress on the instruction. For example, in an upwardly mobile market, a booth clerk cannot report the partial execution of a buy order, or the average price for that portion of the filled order, until the executions are retrieved from the floor brokers and reconciled with the order. The floor broker on either side of a transaction transcribes the time of the transaction, the side of the transaction (buy or sell), and the time, so that the trades can later be reconciled. A unique badge number is usually reprinted on each floor broker's "deck" of execution slips to facilitate reconciliation.

While there has been automation of virtually every aspect of the marketplace, the actual auction, and the participation of the floor brokers, has been safeguarded against obsolescence in view of the fairness and efficiency of the pricing mechanism that results from the auction process. The automation process has been driven, in part, by the desire to make the auction market more efficient and effective. First, it is desired to decrease the time between the decision to buy a stock and the actual execution and report. By eliminating paper, the market is more efficient. This is desirable to enable the auction market to effectively compete with emerging third markets, and to handle the ever growing volume of daily trading.

A concern to investors and commission houses is that the instruction be accurately transcribed. If either the original instruction or the handled response is illegible, processing of the instruction will be delayed. For example, one side of an execution may not be reconcilable with the other because either the price or quantity is misconstrued. Alternatively, the instruction may not be handled at all until clarified. The potential for error increases with each transcription of the instruction. Further, these transcriptions delay processing of instructions which can jeopardize the utility of each instruction. For example, a one day limit buy order might be unexecutable if the market advances beyond the highest acceptable purchase price in the time since the investor placed his or her order and the floor broker received the order slip.

With the advent of "beeper" technology, the physical markets have modified the traditional system of transferring instructions and responses thereto between booth clerks and floor brokers. Using this technology, in lieu of handing the instruction slip over to a squad member or page, the booth clerk uses a beeper--usually equipped with a vibrator because of the noise on the trading floor--to alert the floor broker that an order has been received. Once alerted, the floor broker leaves the trading crowd to locate a "yellow phone" with which he or she contacts the booth and receives instructions (and possibly reports executions and quotes). The floor broker transcribes the instruction relayed by the clerk and returns to the trading panel. Because numerous instructions are typically received at the booth while the floor broker is in the trading crowd, the floor broker is constantly "beeped" in an attempt to forward more instructions in the midst of trading sessions. Further, inquiries from investors as to the status of an order or quote can only be satisfied by again beeping the floor broker and pulling him or her from the crowd. Accordingly, this advance in technology has not provided assurances that instructions are being faithfully followed and timely processed, and has required the broker to continuously leave the trading crowd and locate an available yellow phone to communicate with the booth clerk.

In June, 1994, cellular phone headsets were introduced onto the floor of the New York Stock Exchange ("NYSE"). However, this arrival has its own limitations. Because the booth clerk communicates with several brokers, perhaps ten or more, the brokers may not be able to reach the booth clerk if he or she is already talking to another broker. Further, communications with the clerk from the midst of the trading crowd can confuse other members of the crowd insofar as it may not be readily apparent that the floor broker is talking to his clerk and not another person in the trading crowd, especially if the floor broker communicating with the clerk is facing another floor broker or a specialist. When a floor broker is reporting an execution of a sale of 5,000 shares of GM, for example, another person in the crowd may mistakenly counter with an offer to buy. Thus, while cellular phone headsets have permitted the floor broker to communicate with booth clerks while retaining their mobility, the possibility of mistranscription and delays in reporting still abound.

Compounding these problems, a clear audit trail of the orders and executions is not created at the time of the trade, but rather only at some time thereafter, and in some cases only after the close of the trading day. As a result, the traditional procedure has subjected investors to undesirable risk. One solution includes a system that provides brokers on a commodities exchange with a computer terminal that matches buy and sell orders in accordance with the investor's instructions, such as limit orders, etc., and further provides an electronic audit trail of executed orders. However, the disclosed workstation is not portable, and therefore is not usable within the trading crowd. Further, while this system provides an acknowledgement that a message was received at the broker's workstation, it does not inform the sender that the recipient has seen the received order. As a result, users of this system are left in a quandary as to whether the transmitted instruction was noticed until an execution is received. Because the workstation remains unattended while the broker is in the trading crowd, in the bathroom, etc., orders or quote requests could remain unnoticed for unacceptable periods of time.

Efforts are underway to phase-out the job of the runner or page by introducing hand-held computers to the exchanges. For example, handheld instant trade matching terminal known as "AUDIT" (Automated Data Input Terminal) is presently being tested on the floor of the Chicago

Board of Trade, with some difficulty. This device uses limited handwriting recognition to allow brokers to enter trade information into a handheld terminal. The AUDIT system broadcasts data on each trade from the trading pits to the exchange computers. Also, at the Coffee, Sugar & Cocoa Exchange, a handheld terminal which resembles a calculator with dedicated alphanumeric and function keys is being tested for reporting the price and month of each futures and options contract.

Transactions on the trading floor must be reported to the membership and the general public. This is accomplished through a variety of communications systems by the various exchanges. Transaction information is typically entered by exchange-employed market reporters in each trading pit and is accessible through computer terminals and electronic wallboards on each trading floor. At present the open outcry auction in the pit produces a large quantity of information which must be recorded accurately and quickly by hand.

At the end of each day the clearing house, which may be a subsidiary of the exchange or an independent entity, assumes one side of all open contracts: the clearing house becomes the buyer to each seller of a futures contract, and a seller to each buyer. The clearing house guarantees its members the performance of both sides of all open contracts.

Floor traders are generally classified in two ways: (1) speculators, or "locals," buy and sell for their own accounts; and (2) floor brokers fill orders for commission houses, producers and processors seeking to lock in a price for their products. Unless a trader is a member of an exchange, it is necessary for the trader to deal on the exchange through a member brokerage firm. Normally, firms that handle public business (the "commission houses") must be registered as "Futures Commission Merchants," or "FCMs." A "local" can take long-term positions (i.e., weeks or months) or "scalp" over very short periods (liquidating positions within seconds or minutes of entering the transactions). He may trade in one or more pits. He benefits from the speed with which he can take or liquidate positions, but this is in itself no assurance of a profit. Some floor traders specialize in spreads by taking opposite positions between future or options when the price difference appears abnormal. Floor traders have the advantage of lower transaction costs available to all members of exchanges.

The floor traders who execute orders for others but seldom or never trade for themselves are the brokers who may specialize in orders from customers such as commercial processors, exporters, financial institution commodity trading funds and the like. They may receive only a small percentage of the commissions paid by the customer to his commission house, but the commission revenues may be substantial depending on the volume of business. The orders held by a floor broker at any given time are referred to as his "deck." He is allowed to trade for his own account if he chooses, but he can not use the public orders to benefit his own trading.

When a registered representative of the commission house receives an order from a customer, the representative sends the order to the commission house's order desk on the trading floor, where it is usually handed to a messenger and taken directly to an appropriate broker in the trading pit or ring. Once the broker in the trading pit has the order, he typically uses voice and hand signals to announce his bid or offer price, the delivery month, and the quantity to be bought or sold. Once the order has been executed, it is carried by messenger back to the commission house's order desk on the trading floor, and the confirmation of the order is dispatched back to the office where it was initiated. The representative then usually telephones the confirmation to the customer or hands him a confirmation slip if he is present in the office.

The communication of orders from the registered representative to the order desks on the trading floor takes place with great speed. All orders are time-stamped at various stages along the order route as a check that the order is being expedited in the best possible fashion. Increasingly, this process is performed by computerized communications systems which start with a terminal used by the registered representative and end with a printer near the broker. Often the computer simultaneously records the terms of the order for later use in preparing statements for the registered representative and his customer.

The floor brokers' stock in trade is their skill in executing the orders they receive and accept. They must decide, instantly, the tactics that will be most effective in filling a given order: whether to wait for bids or offers, or whether to hold with the current price, or to bid up or offer down promptly. To be effective, they must know the pit: who will do how much at what price. They must read the intentions of scalpers, locals, and other brokers while concealing their own intentions.

One of the skills of a broker is in knowing his deck. As described above, the deck is a stack of orders that are to be executed by the broker. The orders are typically written on pieces of paper about five by seven inches which are then arranged by the broker in a sequence for execution as the market price moves up or down. The broker usually folds them for concealment and puts them in his pocket so that his hands will be free to signal and to handle his trading card and pencil. Occasionally, the decks are as much as an inch thick and require great memory skill and anticipatory planning.

Perhaps the most common type of order is the "market order" in which the customer states how many contracts of a given delivery month he wishes to buy or sell. He does not specify the price at which he wants to initiate the transaction but simply wants it placed as soon as possible at the best possible price.

"Contingency orders" are those that impose certain limitations beyond the quantity and delivery month, such as limits in price or time, or both. A "price limit order" contains a price limitation that is specified by the customer; it can be executed only at the price specified or at a better price level. A "fill or kill" order contains a specified price at which the order must be executed or it is to be immediately cancelled.

"Stop orders" are sometimes confused with "limit orders," but they are actually quite different. A "buy stop order" instructs a broker to execute the order when the price of a commodity rises to a specified level above the current market price. The "buy limit order" is usually placed below the current market price and must be executed at the limit price or better. The difference between a buy limit order and a buy stop order is exemplified as follows. A customer may be inclined to buy December sugar, which could be selling at a price of 5.43 cents per pound. The customer could tell his broker to buy a contract at a price not to exceed 5.35 cents; this is a "buy limit order." Another customer under the same circumstances could tell his broker to buy a contract of December sugar but not until the price rises to at least 5.55 cents, at which point the order will be executed at the market; this is a "buy stop order". The buy stop order is placed above the current market and may be executed at the price specified on the stop, above it, or below it because it is executed at the market price after the stop price is touched; at that point, the stop is said to be "elected".

A "sell stop order" instructs a broker to execute an order when the price falls to a given level, at which point it is to be executed at the market price. Unlike a typical "sell limit order", the sell stop order is below the current market price and may be executed at a price at, above, or below the specified stop price when it is elected.

Some customers will raise their stop prices as the market price advances in an effort to gain as much as possible from a major move, while making certain that they can probably lose back only a little of the gain. Such an order is frequently called a "trailing stop."

A somewhat more complex order is the "stop limit order." The customer might instruct his broker not to buy sugar until it rises to 5.53 cents per pound and not to pay more than 5.55 cents. This is unlike the unlimited stop, which becomes a market order when the stop price has been touched. The limit price may be the same or different from the specified stop.

A "market-if-touched (M.I.T.) order" is like a limit order, but the M.I.T. order is executed at the market when the market has traded at the price specified on the order, and so it may be filled either at that specified price, above it, or below it. M.I.T. orders are sometimes called "board orders." The order may be entered for one day, a specified period, or open (i.e., good until cancelled).

Sometimes a customer may wish to take a position within a short time but would like the broker on the floor of the exchange to use some of his personal judgment in the timing of the fill. The broker could do this if the order indicates that he is to fill it at the market but is to take his time and will not be responsible if by waiting too long or not waiting long enough the price is unsatisfactory to the customer. Such orders may be marked "not held." Customers may also specify the time at which they wish their orders filled, e.g., "on opening," "on close," or at a particular specified time.

"Alternative orders" provide for one of two possible executions: a customer may order 5,000 bushels of corn at $1.45 a bushel and 5,000 bushels of wheat at $2.56 a bushel, but not want both. A far more common example of the alternative order is the placing of an objective and a stop, with instructions to cancel one if the other is filled; for example, having bought one contract of soybean oil at 14.50 cents a pound, a customer may order his broker to sell the oil either at 14.95 or 14.25 cents stop, whichever occurs first, and then immediately cancel the remainder of the order to avoid inadvertently reversing his position.

"Scale orders" are used to establish or liquidate positions as the market moves up or down. The sugar trader may instruct his broker to buy a contract of sugar at 5.45 cents and another contract each time the price drops five points from that level until he has accumulated six contracts. When he sells out his position, he may order the broker to sell one contract at 5.70 cents and another contract each time the price rises five points until his six contracts have been sold.

"Contingent orders" are filled by the broker after the price of another contract or even another commodity reaches a specified level.

"Spreads" may be established at a fixed difference rather than at specified prices because the spreader is concerned only with the difference rather than the level. He may therefore order his broker to "buy one July pork bellies and sell one February bellies at 80 points difference or more, premium February." Such an order could be used to establish a new spread position, which the trader believes will narrow, or to take the profit in a position at a narrower difference and be satisfied with the profit at 80 points difference.

Although the foregoing description has concentrated on the commodity futures markets, it will be understood that the order management system of the present invention is applicable to all markets, including those for securities trading. Securities markets are usually based on actions by specialists, each of whom is the market maker for one or more specific securities. In the New York Stock Exchange, for example, the ultimate determination of price for any given transaction frequently is determined by a specialist who deals in a particular stock and who maintains a running list or "book" of offers to sell and orders to purchase that stock. The specialist may complete a transaction in the stock whenever one or more purchase and sell orders can be matched with respect to price; on occasion, the same specialist purchases the particular stock in which he specializes or sells the same stock in order to maintain a market for the stock and prevent violent fluctuations in its price. Similar functions, particularly with respect to the matching of orders to purchase and to sell, must be carried out in all auction markets for the marketing of fungible goods, including such commodities as wheat, corn, and the like as well as stocks and bonds.

In one system that relates to the present invention, prices are established in auction trading for the securities market. This computation system comprises a main data store for recording encoded data items representative of orders to buy and to sell the goods, such orders including orders at specific prices and other orders "at the market." The system includes a buy order sequencing device for arranging and recording purchase offers first in descending order by price and secondly by time of entry so that at each price level the oldest orders are uppermost. A sell order sequencing device is provided for arranging and recording all offers to sell first in ascending order by price and secondly in descending order by time so that once again the oldest orders are the highest at each price level. A closing price store is provided to record the last actual selling price for the goods. The closing price store and the main data store are coupled, by suitable control means, to the sequencing devices in order to transfer the recorded data items from the data store to the sequencing devices with "at market" prices being transferred at the aforementioned last selling price. The two sequencing devices are coupled to a comparator that compares the sell orders and the buy orders, when they have been arranged in sequence, to determine the lowest buy order price that is equal to or greater than a recorded sell order and thus establish a new selling price for the goods.

More than such a system for merely matching buy and sell orders, the present invention provides a system that allows brokers to manage their decks and to improve the accuracy of communications between the trading floor and the customers. The present invention can also reduce the back office costs to trading firms by reducing the volume of paperwork and consequent errors.

Systems for transacting trades of commodities are well known, such as those using the conventional telephone. These systems offer the rapid communication needed for trading in commodities with rapidly changing prices; however telephone based systems do not provide any hard copy records of a transaction. Hard copy records are essential to commodities traders as a means of documenting completed transactions. Furthermore, telephone based systems are mere communication systems and are unable to process data regarding a transaction to provide a trader with instantaneous information regarding all transactions performed within a given time period (such as a day) and the trader's cumulative position for a particular commodity.

Also well known are video telex based systems that essentially allow traders to exchange typed messages. While these systems can provide for the generation of hard copy records, rapid communication with another party is greatly inhibited by the need to manually type in lengthy text messages to be sent, and by the need to read all received messages. Network response time also suffers because of the length of the transmitted messages. The use of free text messages also makes it difficult for a single trader to simultaneously monitor the progress of more than one trade. An additional problem of video telex systems is that hard copy is generated for all messages sent and received; consequently, to find desired information or documentation, one must search entire "transcripts" of free text communications to find records documenting a desired communication, such as a final agreement to buy or sell a commodity. While attempts have been made to circumvent this problem by using a computer translator to scan the free text "transcripts" for certain key words that might indicate that an agreement has occurred, such computer translation systems are inherently unreliable and their translations must be constantly checked to verify their accuracy. Furthermore, the video telex systems of the prior art are incapable of monitoring input to prevent the transmission of gross input errors in quantities relevant to a transaction, such as price and volume.

By structuring the permitted trader input, the display output, the data messages themselves and the manner of trading, the present invention overcomes these disadvantages of the prior art. The structured trading of the present invention provides a sufficiently flexible environment to permit negotiation of complex trades while greatly reducing the data input needed from both traders and greatly enhancing comprehension of responses. Furthermore, the structured data transmissions of the present invention can be accurately processed by digital computers to create errorless records of a completed transaction. In a similar manner, the structured data transmissions can be monitored to reduce costly data entry errors that are possible when prices and amounts are being entered.

Recently there has been an increase in automated trading exchanges having a central processor associated with one or more remote terminals through which trades can be made by members of the exchange or that provide market information to members of the exchange upon request.

While the automated systems provide many advantages for traders such as preventing or at least inhibiting market manipulation, increasing the speeds at which trades are made, time dating the purchase or sale of a particular commodity, and the like, there is still no practical provision in the art for exchanges located at various sites around the world being able to communicate with each other and allow users in one exchange to trade through electronics directly with users who are members of other exchanges around the world.

The present invention overcomes the disadvantages and problems of the prior art by providing a central exchange host arrangement and system that is in communication, through means such as a satellite system, with local exchanges located at various sites around the world. A remote terminal user member of any one exchange can trade with a remote terminal user member of its own exchange or with a user member of any other exchange around the world through its local exchange and the central exchange host which monitors all of the trades in each of the local exchanges and provides market information to a remote terminal user member that belongs to any of the local exchanges at the various sites around the world. Thus, the user member of any one local exchange can communicate directly with the central exchange host to obtain market information relative to any member exchange. He can also make bids and offers to any other local exchange user member through his own local exchange which communicates through the satellite system with the central exchange host and with the other selected exchange. Thus, if a user member of the World Energy Exchange in Dallas would like to obtain market information concerning trading of a particular commodity on a Paris commodity exchange, he may communicate directly with the central exchange host and obtain that information. If the same user member wishes to trade with another user member of the Paris Commodity Exchange, he would enter a bid or an offer through his remote terminal to his local exchange which would then communicate that information to the central exchange host and then to the Paris Commodity Exchange through the satellite system where the bid or offer would be displayed on the user member remote terminal. Thus, a user member of the Dallas World Energy Exchange could effect a commodity trade with a user member of the Paris Commodity Exchange or any other member exchange around the world.

The commodity information and trading transaction paths from the individual local commodity exchanges takes places as follows. A central gathering point (central exchange host) of commodity information from the individual local commodity exchanges is established. The commodity information will come in via land or satellite communication connections. The information is then transmitted via satellite(s) world wide to local exchanges. The traders have the necessary equipment to receive the broadcasted commodity information at remote user terminals and sort out and display the preselected individual exchanges around the world with which they wish to trade as well as displaying the commodities in which they are interested. From the correlations and observation of the commodity information the trader decides upon a position (i.e., bid or offer). The desired position is entered and transmitted via satellite to the central gathering point and routed to the individual local commodity exchange(s). Upon confirmation of receipt by all involved local commodity exchanges participating in the submitted position and the acceptance of the position by another trader, the central exchange host transmits a position confirmation to the individual trader at the remote user terminals completing the establishment of a position transaction.

Information flow is then in two basic forms. First, the gathering and subsequent worldwide broadcast of participating local commodity exchanges marketing information. This commodity marketing information is received in bulk by the traders' remote user terminals where it is selectively displayed. The second information flow is independent of the first but uses the same communications paths. The second information flow is a transaction consisting of the entry of a proposed commodity trading transaction and the notification of its acceptance by a trader member of the designated local exchange. The established position and its subsequent liquidation or completion is also routed through the central exchange host.

A touch screen data entry system is associated with the remote user terminals screen display for displaying input information and data representing the bids and offers. By physically touching symbols representing a bid or an offer, the commodity selected, and the local exchange selected, the pertinent data is input from the user terminal into the system for transmission through the user's local exchange, the central exchange host, and the selected local exchange to the remote user terminals associated with the selected exchange.

On a traditional exchange, after a trade is made a card is handed to an exchange employee who then keypunches the data into the computer. At the same time trading cards must be manually sorted to match trades. At the end of the day the computer lists are checked against the trading cards to reach agreement as to the trades which have been made. As can be well understood, there, first, may have been a mistake in the keypunching process. Secondly, there may be a difference given in the two cards as to the price at which a trade was made and thirdly because the trades are based on eye contact, there may be a difference in opinion as to whether a trade was actually made at all. When there is disagreement, a list of "out trades" is made and agreement must be reached as to whether the trade was made at all and if so at what price. The nature of the discrepancy determines whether the trader, the broker, or the customer must bear the cost of an out trade. Again, because the customer is at a lengthy distance, he is at a disadvantage because he takes no part in the resolution process.

The accounting process also has its problems. Once the matching of trades takes place, the information is fed into the clearing process of an exchange. The present clearing process in most exchanges is a computerized process. However, since information is manually entered, after the fact of the trade, its value lies only in the accounting process and not in the control of the exchange process. The exchange only knows at the end of the day if a trader has exceeded his position limits or has incorrectly identified a clearing member or has provided other incorrect information. On most exchanges 300 to 400 individuals are required to process trading cards and complete the clearing function.

The surveillance of the system as it now exists (to insure proper operation and minimize mistakes and abuse) also has numerous problems. Surveillance is completed on existing exchanges through live observation. An exchange employee stands in the middle of a ring and observes trading as it takes place. With close to a 1,000 people on the floor of an exchange, observation is spotty at best. Some exchanges have programs for detecting illegal trade practices which are repetitive but even when such practices are detected often the information available as evidence is inaccurate and unreliable.

The present invention, the automated futures trade exchange, has created an entire automated process for trading futures contracts which provides accurate and precise information, trading based on factual data, assurance of execution and immediate confirmation of the contracts, control through real time processing of information and electronic surveillance, and the use of computer hardware to implement the process. It does not separate clearing and surveillance from the futures trading process as do other exchanges because it is the combined process which allows the markets to function properly.

All trading conducted on the automated futures trading system will be effected through a central computer complex programmed to handle orders for the exchange's futures contracts. Access to this central computer will be available only through specially programmed remote computer terminals which will be distributed only to exchange members who will have a coded membership number. Each remote terminal will consist of a keyboard, a printer, on-line storage, and a video monitor, the latter displaying a variety of information regarding the futures contracts traded on the exchange. Members will be able to utilize these terminals to transmit to the central computer bids and offers for their own accounts as principals or for the accounts of customers for whom they are agents.

When an order is transmitted to the central computer, its pertinent characteristics will be recorded including quantity, price, the time that the order was placed, and the capacity in which the order is entered; that is, whether as agent or principal. The exchange central computer will retain all orders received, arranging each bid and offer on the basis of its price, quantity and entry time and displaying all bids in descending order of price and all offers in ascending order of price. Thus, each bid or offer will become part of the market data displayed in every member's remote terminal video monitor. The breadth of the market will also be indicated. That is, whether a bid of 200 contracts represents one offer to buy 200 contracts or 20 offers to buy 10 contracts.

In addition, the video monitor of each remote terminal will display lot sizes, last sale prices, daily price ranges, the volume for each contract month, the spread relationships or price differential among the various contract months, and allows simultaneous spread trades (both in time and by commodity) to take place.

Pertinent to this process is the capability to modify prices at a remote terminal by moving a cursor on the video display to the bid or offer desired to be modified by the user which modification is then accomplished through the keyboard. The capability to see the display of buys and sells is analogous to the open outcry system of trading and is pertinent to good trading because it shows the supply and demand in the market. On the floor of an existing exchange, a trader would have a "feel" for the market but would not be able to relay to a customer with any degree of accuracy information pertaining to the distribution of bids and offers.

The exchange central computer will automatically match equal bids and offers on a first come, first served basis thereby executing the transaction. Each transaction execution will be immediately confirmed to the members on both sides of the trade by the printing mechanisms of those members terminals. Each execution report will include information regarding the date, time, quantity and price of the transaction. The exchange central computer will be able to handle a full array of futures orders including straddles, limit orders, and stop orders. Because bids and offers are transmitted from the remote terminals directly into the computer there will be no chance for an "out trade," that case where a trade is made but the bid and offer do not match. Moreover, because trading will be effected solely by the computer, a record will exist of the precise time each order was entered, the precise time it was executed and the precise time an execution report was transmitted.

Another important factor in trading is the capability to determine the liquidity of the market. Again, on the floor of an exchange a trader may note that trading is active but by the time information is relayed back and forth between the principal and the trader the price may have moved considerably or the bids and offers may no longer be present. No presently existing exchange can determine with accuracy during the trading the volume of trading immediately taking place. The present system will record trades exactly as they are made, when they are made, and thus a member would be able to determine the volume of trading taking place at any particular time and would have the information necessary to determine whether it is likely that he can come in and out of the market at his desired price level.

Each terminal on the system will be specifically designated to trade a certain number of contracts. Position limits for each principal are thus determined by the fiduciary capabilities of the participant. Under the present system of trading on exchanges, a member may execute trades far in excess of his limit without detection by the exchange. In the present trading system, limits will be programmed into each individual terminal thus further eliminating the possibility of "out trades" because an individual trader has exceeded his limits. During trading times live surveillance of the market will take place through control terminals at the exchange. Information may be fed directly into the surveillance system to detect the patterns of trading which may be manipulative and since all information is recorded as trading takes place, accuracy is assured.

All information from the trading system will be moved directly to the clearing system. Thus, there is no manual matching of trades and accuracy of the data is assured. Earlier and more rapid transfer of funds will be possible thus increasing the financial viability of the exchange as a whole.

It has been recognized for some time in the futures industry that multiple factors determine the pricing of commodities. Thus, the use of computerized analysis has rapidly developed and multiple tools for graphing and receiving information has been developed. But the process for trading and processing trades remains archaic. The present system provides a means of executing trades, validating the information, and notifying parties of pertinent changes without bias to those who participate. Thus, a larger more efficient marketplace may be accommodated at lower cost.

While various embodiments have been described above, it should be understood that they have been presented by way of example only, and not limitation. Thus, the breadth and scope of a preferred embodiment should not be limited by any of the above described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

CLAIMS

What is claimed is:

1. A method for estimating a probability (prob) associated with a limit order, comprising the steps of:

(a) receiving an indicia identifying a security;

(b) estimating a probability with which a limit order for the security will be filled; and

(c) outputting the probability of the limit order.

2. The method as recited in claim 1, wherein the probability is estimated as a function of a desired time interval during which the limit order is to be filled.

3. The method as recited in claim 1, wherein the probability is estimated as a function of a desired price (P) for the limit order.

4. The method as recited in claim 1, wherein the probability is estimated as a function of at least one of a current bid price and an offered price of the security.

5. The method as recited in claim 1, wherein the probability is estimated on a server connected to a plurality of client computers via a network and the indicia is received from the client computers over the network.

6. The method as recited in claim 1, wherein the probability is estimated using the formula:

prob = 2 - 2*CUMNORM((P-P1) /(sign*sigma)),

where:

- P1 = a price selected between a current bid price and an offered price, inclusive;
- sign = 1 if the limit order is a sell order, and sign = -1 if the limit order is a buy order;
- sigma = a constant;
- CUMNORM(x) = a definite integral of a standard normal density function f(x) over an interval [0, x]; and
- f(x) = 1/sqrt(2*) exp($-x^2/2$).

7. The method as recited in claim 6, wherein sigma is calculated as a function of a historical volatility of the security over a predetermined time period.

8. The method as recited in claim 6, wherein sigma is calculated as a function of a forecasted volatility of the security over a predetermined time period.

9. The method as recited in claim 6, wherein sigma is calculated as a function of a current volatility of the security.

10. The method as recited in claim 6, wherein sigma is calculated as a function of an implied volatility of the security.

11. The method as recited in claim 6, wherein sigma is calculated as a function of a forecasted trading range of the security over a predetermined time period.

12. The method as recited in claim 6, wherein sigma is calculated using the formula:

sigma= k*RF,

where:

- k = a constant;
- RF = sqrt(T/n)* SUM [$a_i(H_i-L_i)$] for i = 0....y;

  where:

  - a_i = a constant;
  - n = a length of a trading day in the units of time (T);
  - H_0 = a current highest trading price of the security;
  - L_0 = a current lowest trading price of the security;
  - y = a predetermined number of days;
  - H_i = the highest trading price of the security i days ago; and
  - L_i = the lowest trading price of the security i days ago.

13. The method as recited in claim 12, wherein k = sqrt(/8).

14. The method as recited in claim 12, wherein at least one value of a_i is calculated via a regression.

15. The method as recited in claim 12, where at least one value of a_i is a function of sqrt(i).

16. The method as recited in claim 6, wherein sigma is calculated using the formula:

sigma= k*RF,

where:

- k = a constant;
- RF = sqrt(T/n)* SUM [$a_i(H_i-L_i)$] for i = 0....y;

  where:

  - a_i = a constant;
  - n = a length of a trading day in the units of time (T);
  - H_0 = a current highest trading price of the security;
  - L_0 = a current lowest trading price of the security;
  - y = a predetermined number of days;
  - H_i = the highest trading price of the security at any time within i previous days; and
  - L_i = the lowest trading price of the security at any time within i previous days.

17. The method as recited in claim 16, wherein at least one value of a_i is calculated via a regression.

18. The method as recited in claim 16, wherein k = sqrt(/8)

19. A computer program embodied on a computer readable medium for estimating a probability associated with a limit order, comprising:

(a) a code segment that receives an indicia identifying a security;

(b) a code segment that estimates a probability with which a limit order for the security will be filled; and

(c) a code segment that outputs the probability of the limit order.

20. A system for estimating a probability associated with a limit order, comprising:

(a) logic that receives an indicia identifying a security;

(b) logic that estimates a probability with which a limit order for the security will be filled; and

(c) logic that outputs the probability of the limit order.

21. A method for estimating a probability (prob) associated with a limit order on a computer system, comprising the steps of:

(a) receiving an indicia identifying a security from an input device;

(b) estimating a probability with which alimit order for the security will be filled automatically based on user-specified parameter using prescribed model stored in memory device, the security being identified by the indicia, the parameter including desired time interval during which the limit order is to be filled and desired price for the limit order being filled; and

(c) outputting the probability of the limit order to an output device.

22. A computer readable recording medium for causing a computer to execute processing for estimating a probability (prob) associated with a limit order, the process comprising:

(a) a process for receiving an indicia identifying a security from an input device;

(b) a process for estimating a probability with which alimit order for the security will be filled automatically based on user-specified parameter using prescribed model stored in memory device, the security being identified by the indicia, the parameter including desired time interval during which the limit order is to be filled and desired price for the limit order being filled; and

(c) a process for outputting the probability of the limit order to an output device.

23. A computer system for estimating a probability (prob) associated with a limit order, comprising:

(a) a unit for receiving an indicia identifying a security from an input device;

(b) a unit for estimating a probability with which alimit order for the security will be filled automatically based on user-specified parameter using prescribed model stored in memory device, the security being identified by the indicia, the parameter including desired time interval during which the limit order is to be filled and desired price for the limit order being filled; and

(c) a unit for outputting the probability of the limit order to an output device.

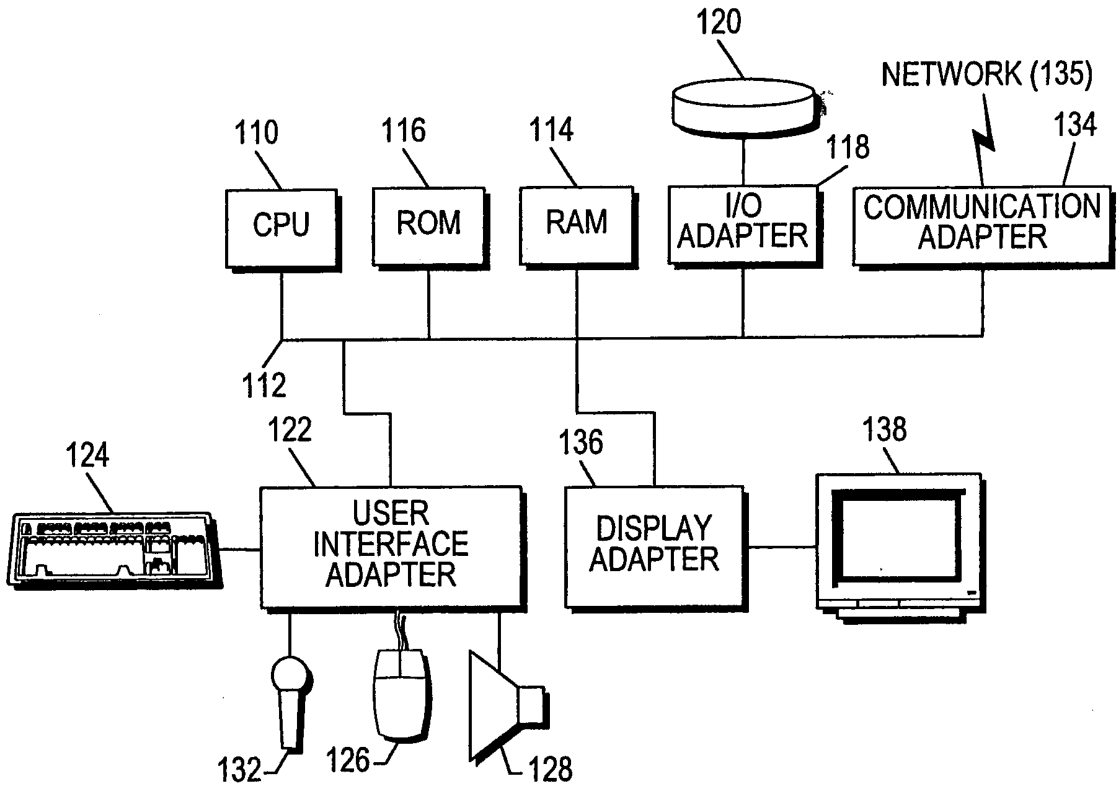
120
NETWORK (135)
110
116
114
118
134
CPU
ROM
RAM
I/O ADAPTER
COMMUNICATION ADAPTER
112
122
124
136
138
USER INTERFACE ADAPTER
DISPLAY ADAPTER
132
126
128

Figure 1

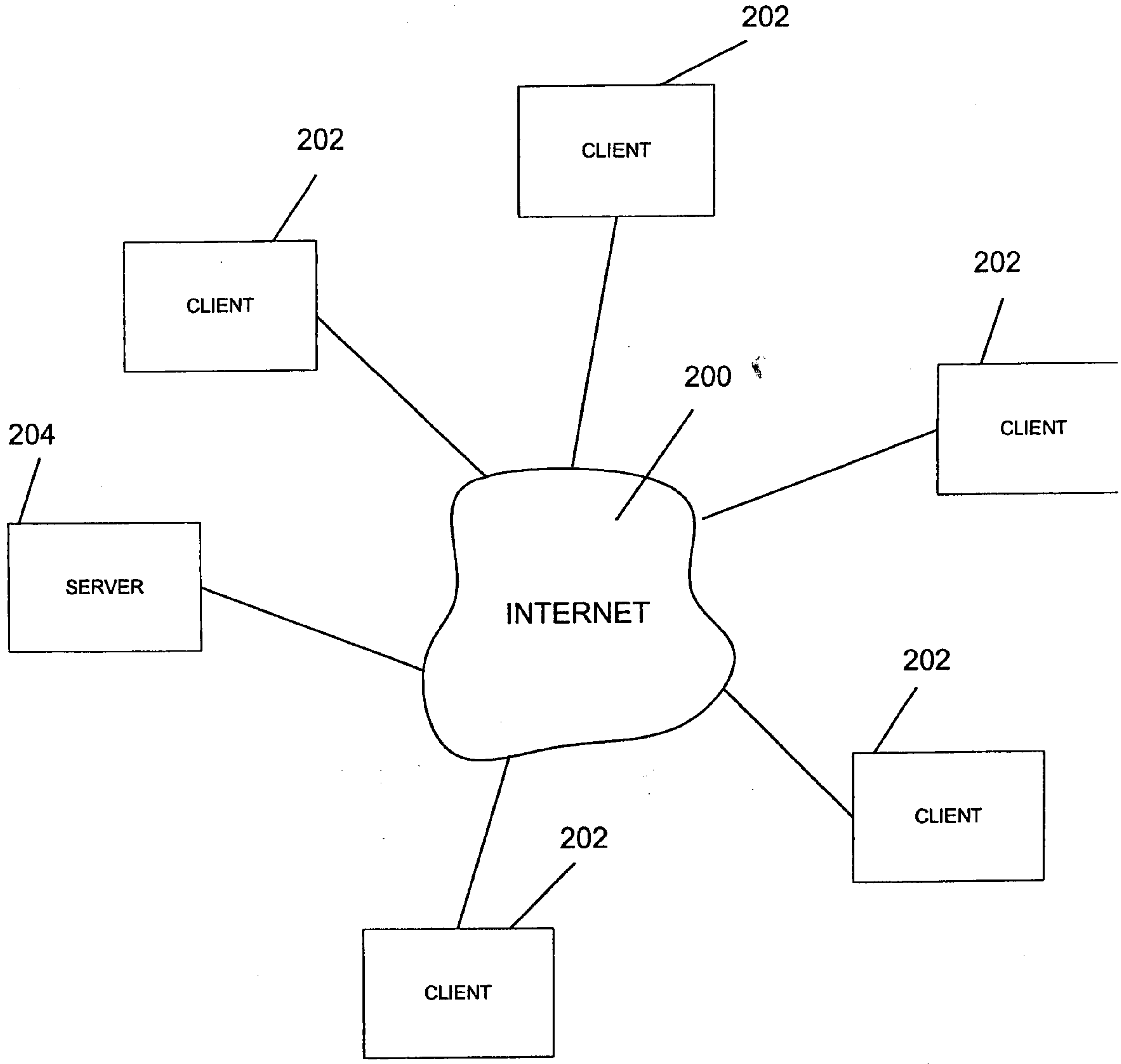
202
CLIENT
202
CLIENT
202
200
CLIENT
204
SERVER
INTERNET
202
CLIENT
202
CLIENT

Figure 1A

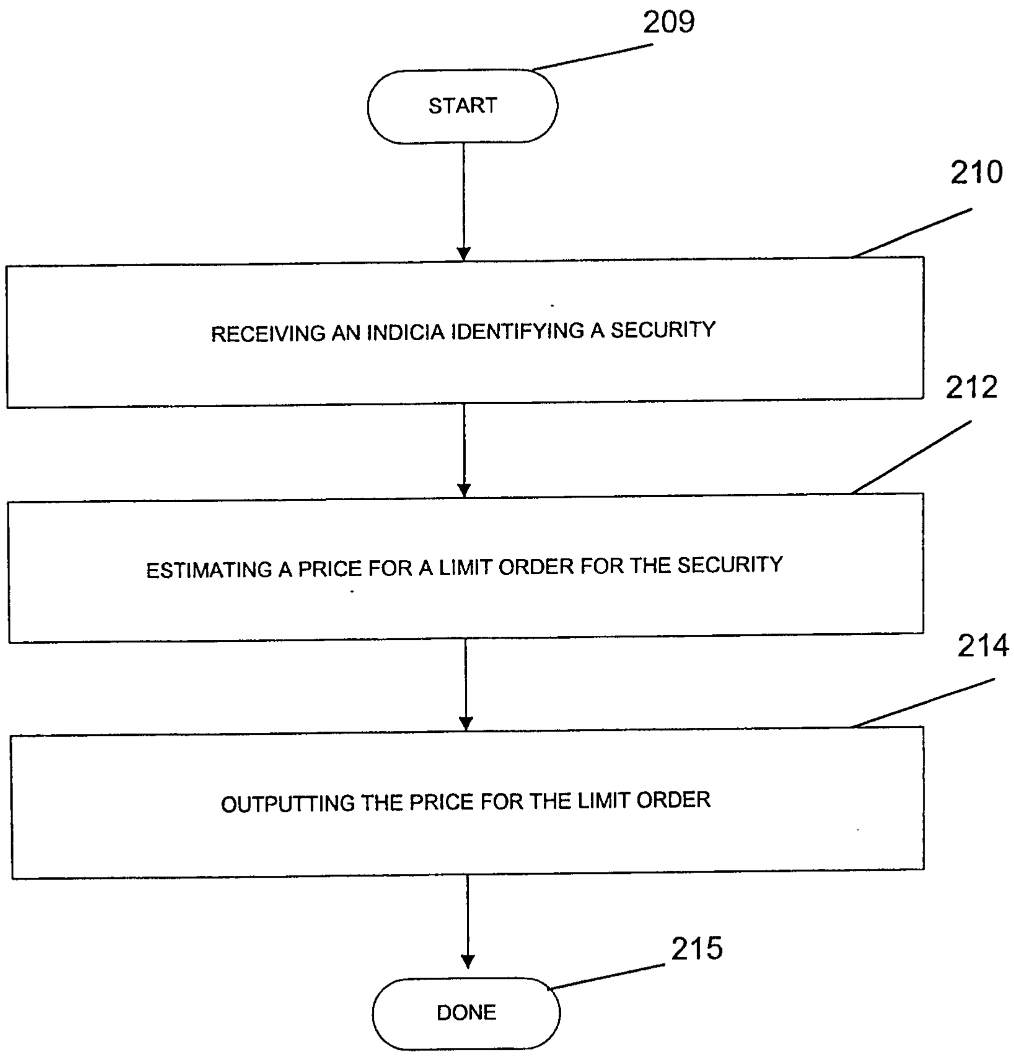
209
START
210
RECEIVING AN INDICIA IDENTIFYING A SECURITY
212
ESTIMATING A PRICE FOR A LIMIT ORDER FOR THE SECURITY
214
OUTPUTTING THE PRICE FOR THE LIMIT ORDER
215
DONE

Figure 2

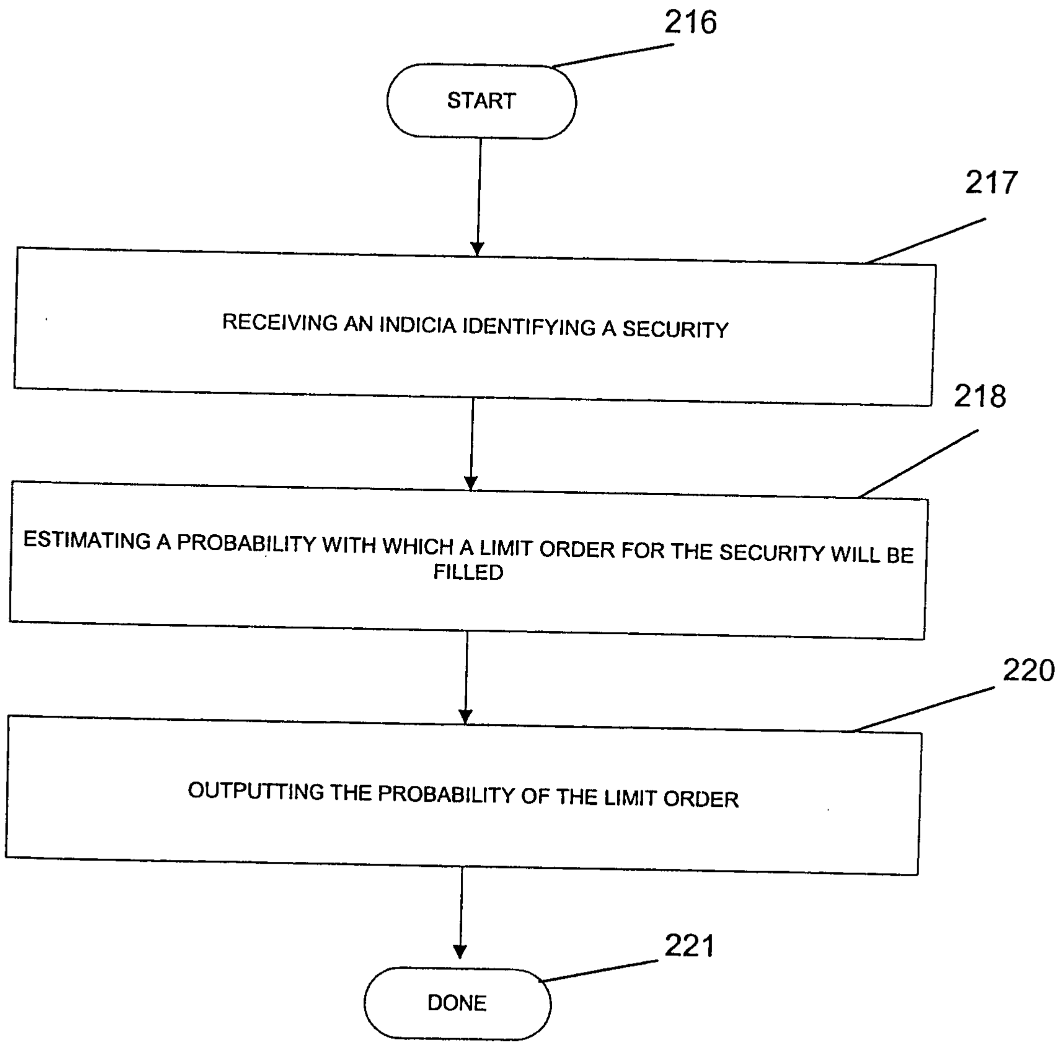
216
START
217
RECEIVING AN INDICIA IDENTIFYING A SECURITY
218
ESTIMATING A PROBABILITY WITH WHICH A LIMIT ORDER FOR THE SECURITY WILL BE FILLED
220
OUTPUTTING THE PROBABILITY OF THE LIMIT ORDER
221
DONE

Figure 2A

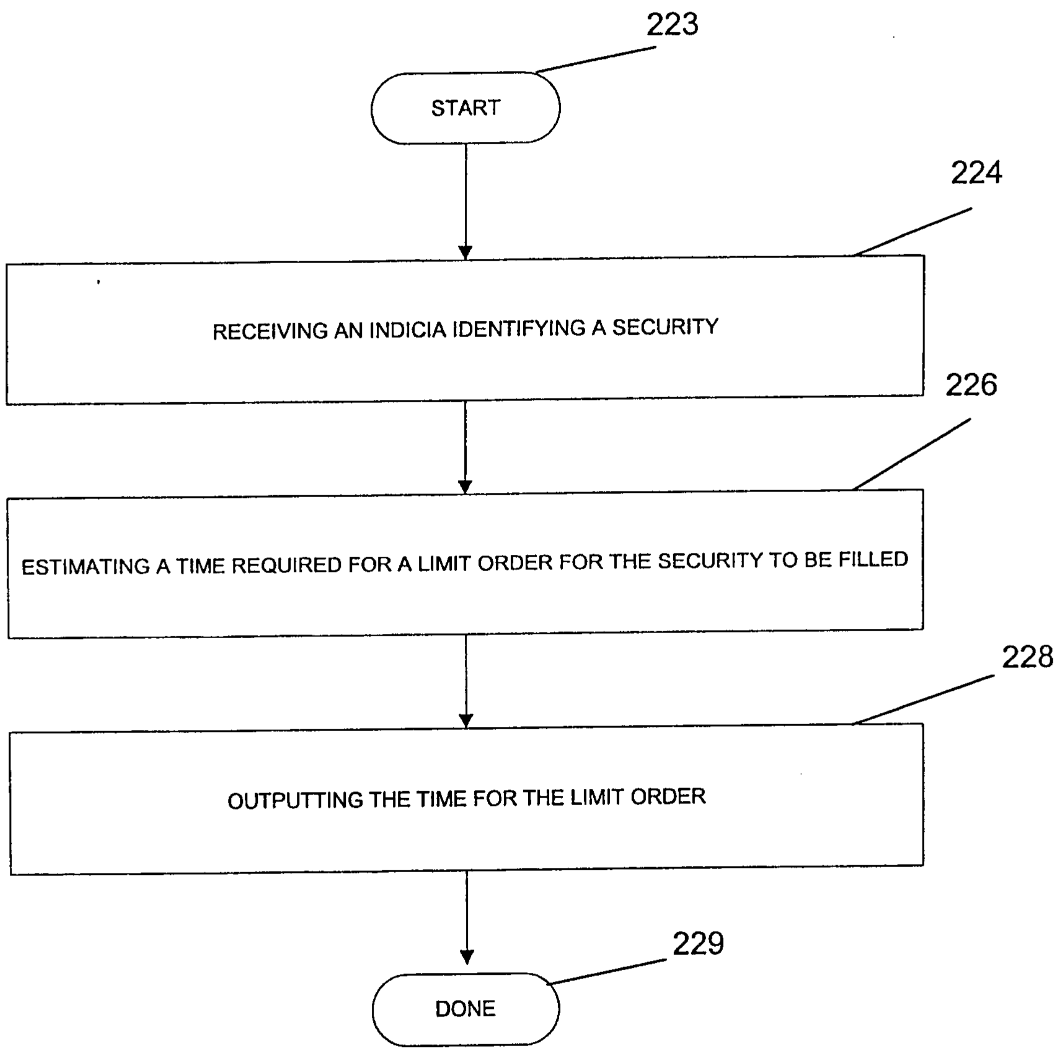
223
START
224
RECEIVING AN INDICIA IDENTIFYING A SECURITY
226
ESTIMATING A TIME REQUIRED FOR A LIMIT ORDER FOR THE SECURITY TO BE FILLED
228
OUTPUTTING THE TIME FOR THE LIMIT ORDER
229
DONE

Figure 2B

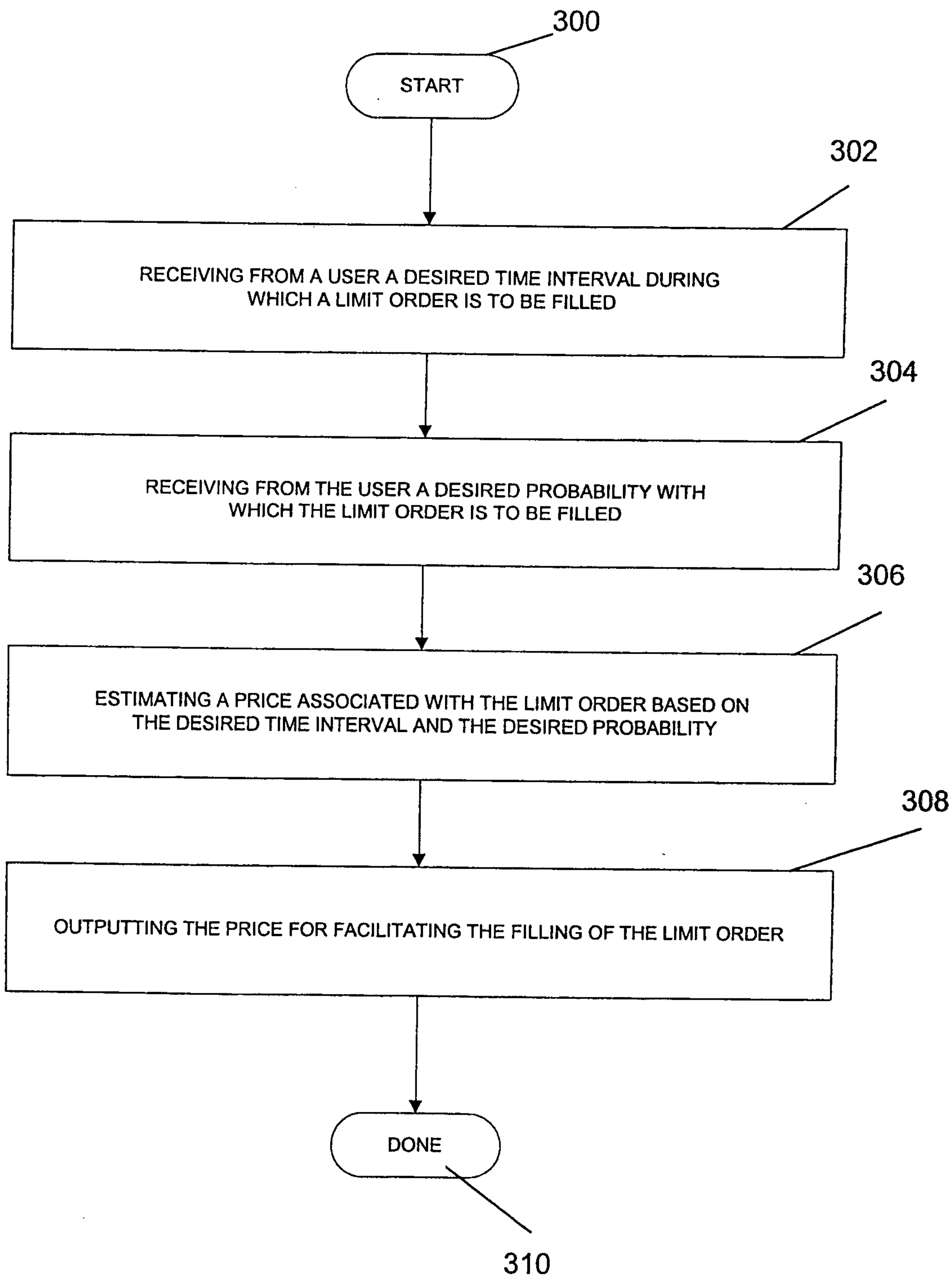
300
START
302
RECEIVING FROM A USER A DESIRED TIME INTERVAL DURING WHICH A LIMIT ORDER IS TO BE FILLED
304
RECEIVING FROM THE USER A DESIRED PROBABILITY WITH WHICH THE LIMIT ORDER IS TO BE FILLED
306
ESTIMATING A PRICE ASSOCIATED WITH THE LIMIT ORDER BASED ON THE DESIRED TIME INTERVAL AND THE DESIRED PROBABILITY
308
OUTPUTTING THE PRICE FOR FACILITATING THE FILLING OF THE LIMIT ORDER
DONE
310

Figure 3

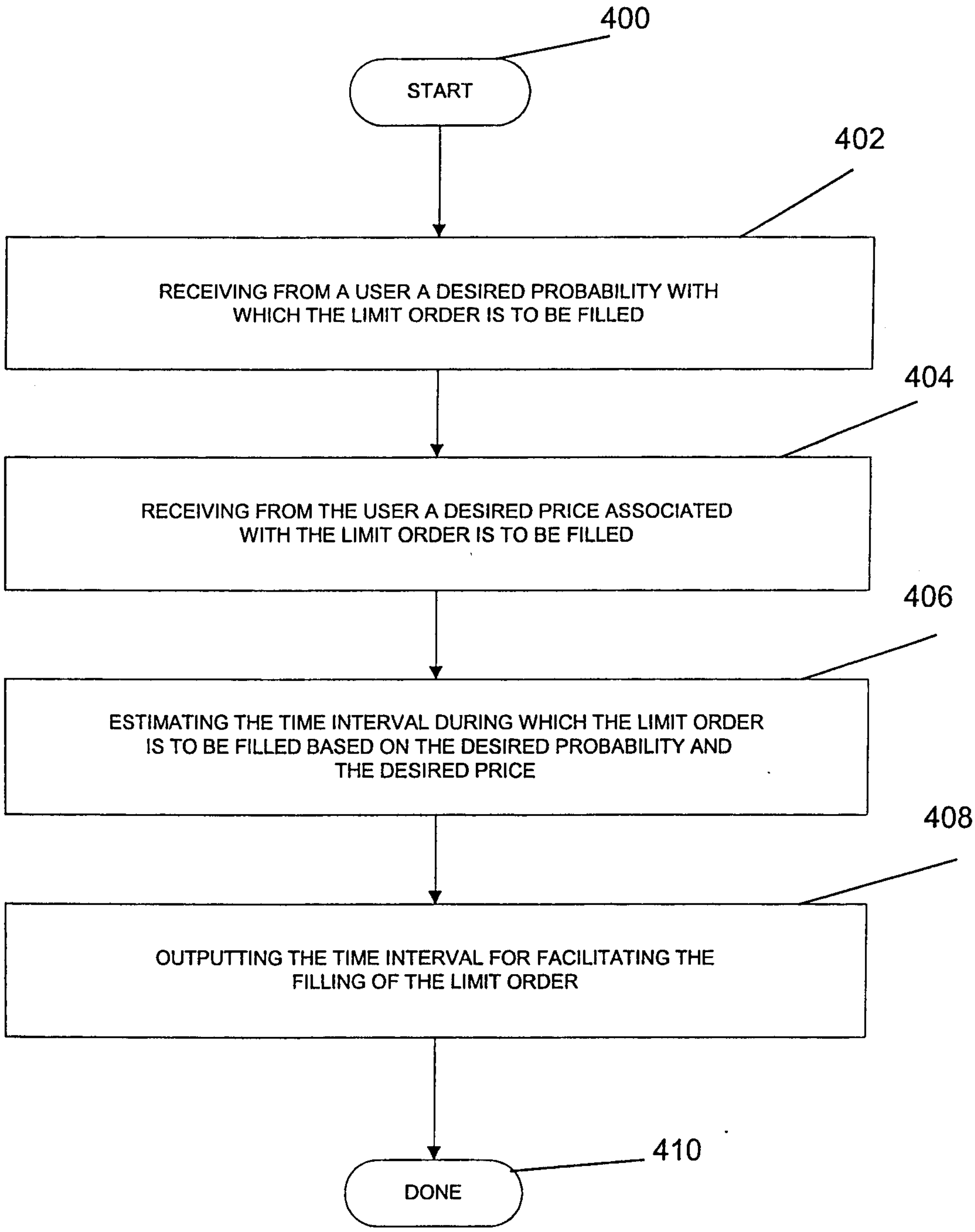
400
START
402
RECEIVING FROM A USER A DESIRED PROBABILITY WITH WHICH THE LIMIT ORDER IS TO BE FILLED
404
RECEIVING FROM THE USER A DESIRED PRICE ASSOCIATED WITH THE LIMIT ORDER IS TO BE FILLED
406
ESTIMATING THE TIME INTERVAL DURING WHICH THE LIMIT ORDER IS TO BE FILLED BASED ON THE DESIRED PROBABILITY AND THE DESIRED PRICE
408
OUTPUTTING THE TIME INTERVAL FOR FACILITATING THE FILLING OF THE LIMIT ORDER
410
DONE

Figure 4

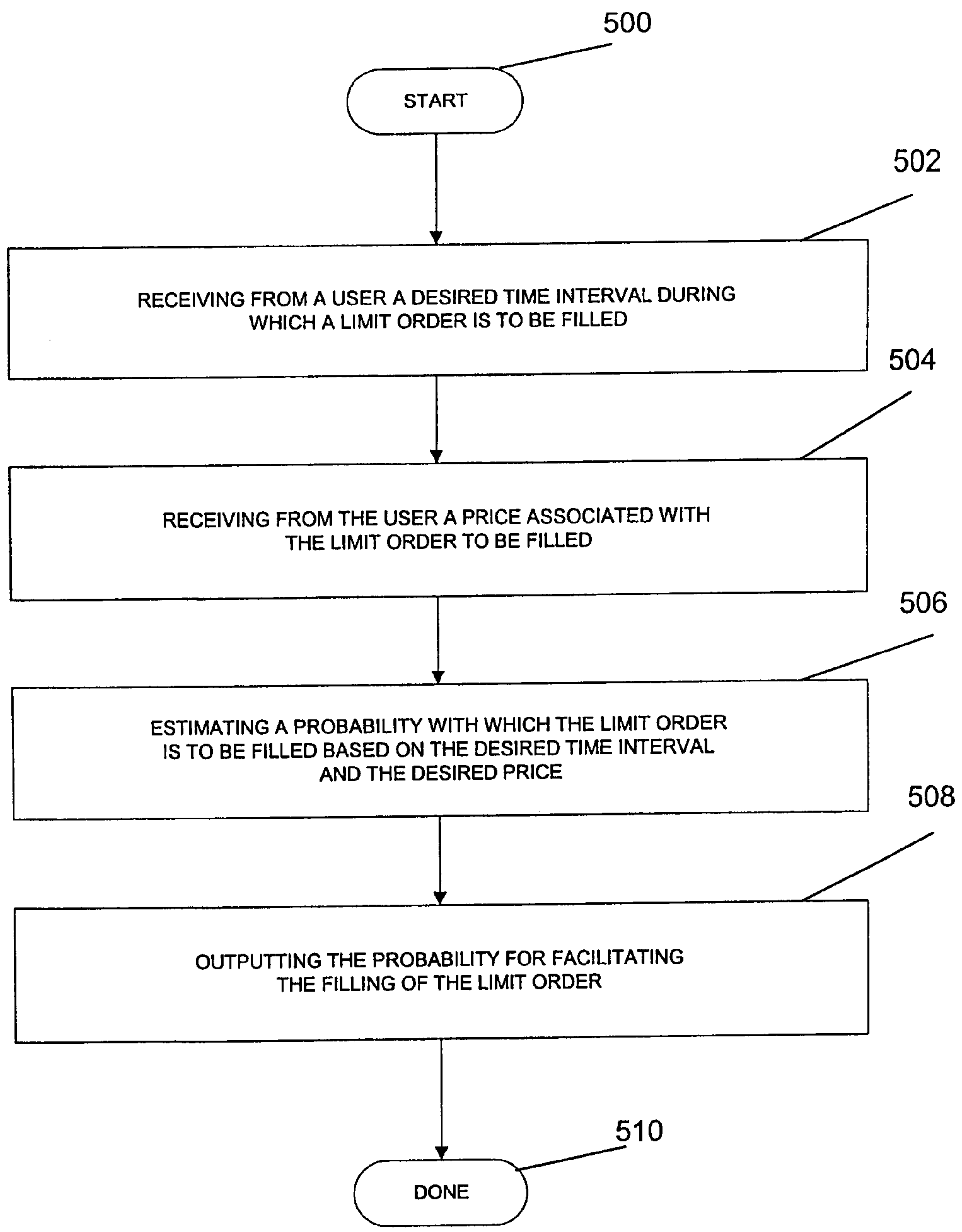
500
START
502
RECEIVING FROM A USER A DESIRED TIME INTERVAL DURING WHICH A LIMIT ORDER IS TO BE FILLED
504
RECEIVING FROM THE USER A PRICE ASSOCIATED WITH THE LIMIT ORDER TO BE FILLED
506
ESTIMATING A PROBABILITY WITH WHICH THE LIMIT ORDER IS TO BE FILLED BASED ON THE DESIRED TIME INTERVAL AND THE DESIRED PRICE
508
OUTPUTTING THE PROBABILITY FOR FACILITATING THE FILLING OF THE LIMIT ORDER
510
DONE

Figure 5

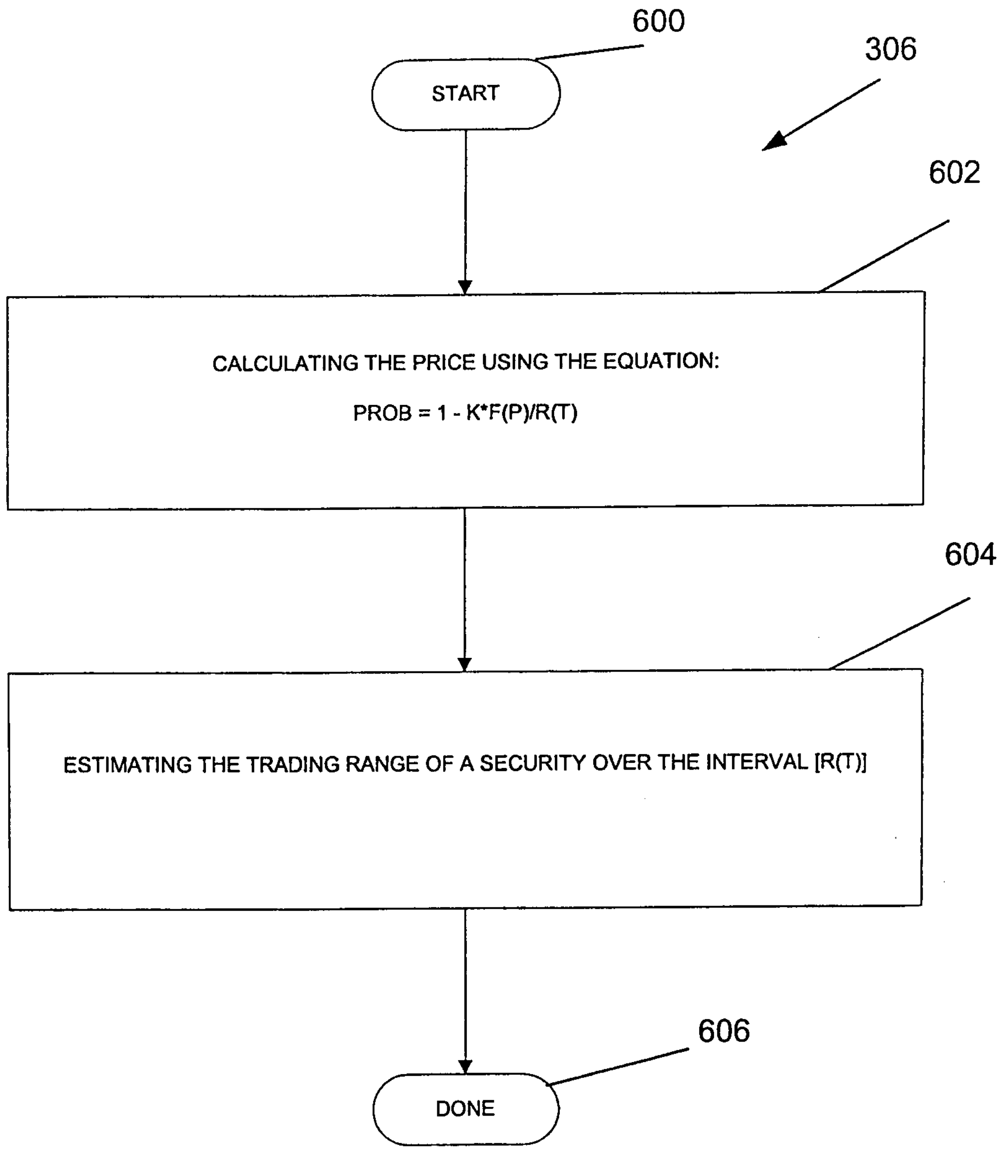
600
306
START
602
CALCULATING THE PRICE USING THE EQUATION:
PROB = 1 - K*F(P)/R(T)
604
ESTIMATING THE TRADING RANGE OF A SECURITY OVER THE INTERVAL [R(T)]
606
DONE

Figure 6

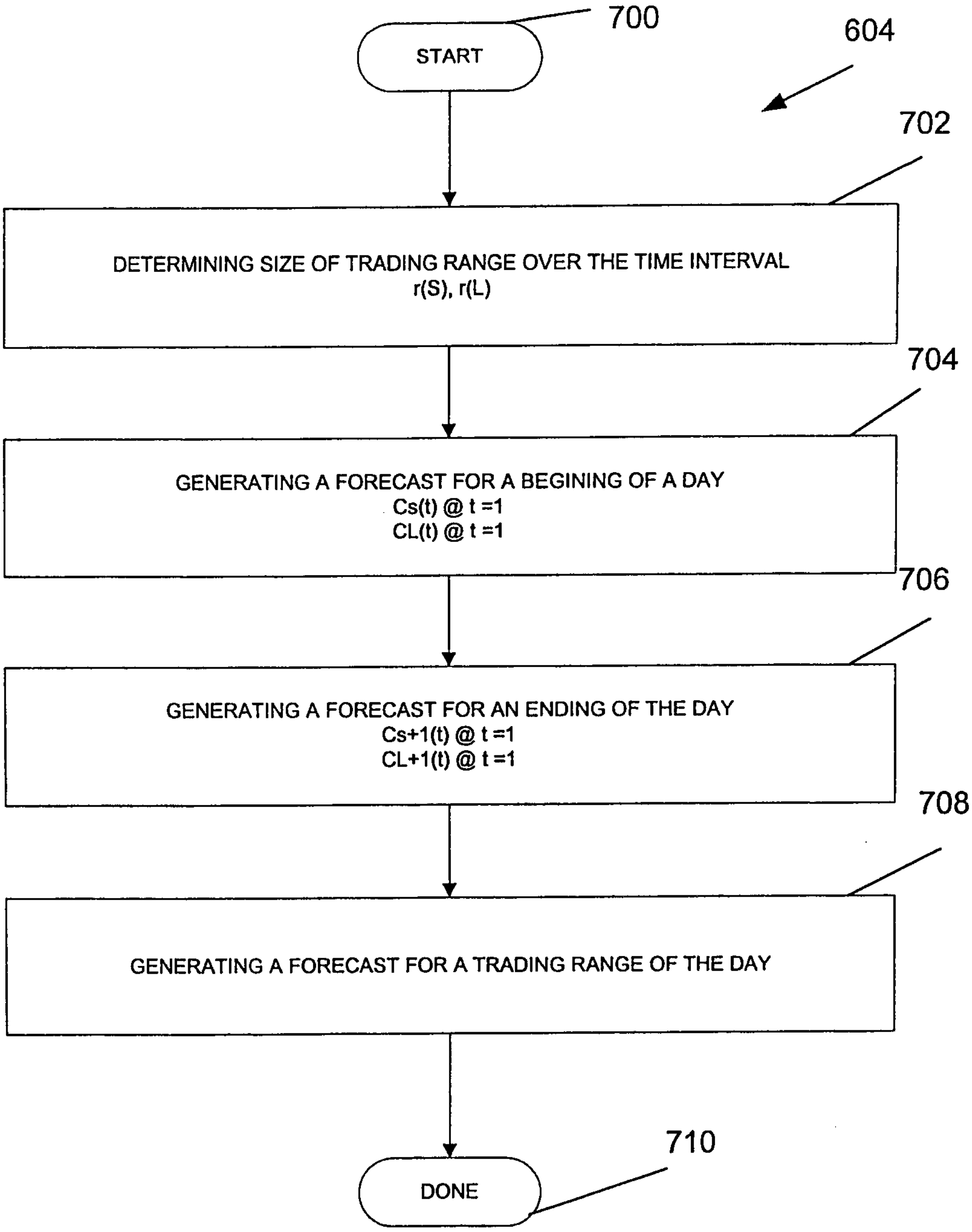
700
604
START
702
DETERMINING SIZE OF TRADING RANGE OVER THE TIME INTERVAL
r(S), r(L)
704
GENERATING A FORECAST FOR A BEGINING OF A DAY
Cs(t) @ t =1
CL(t) @ t =1
706
GENERATING A FORECAST FOR AN ENDING OF THE DAY
Cs+1(t) @ t =1
CL+1(t) @ t =1
708
GENERATING A FORECAST FOR A TRADING RANGE OF THE DAY
710
DONE

Figure 7

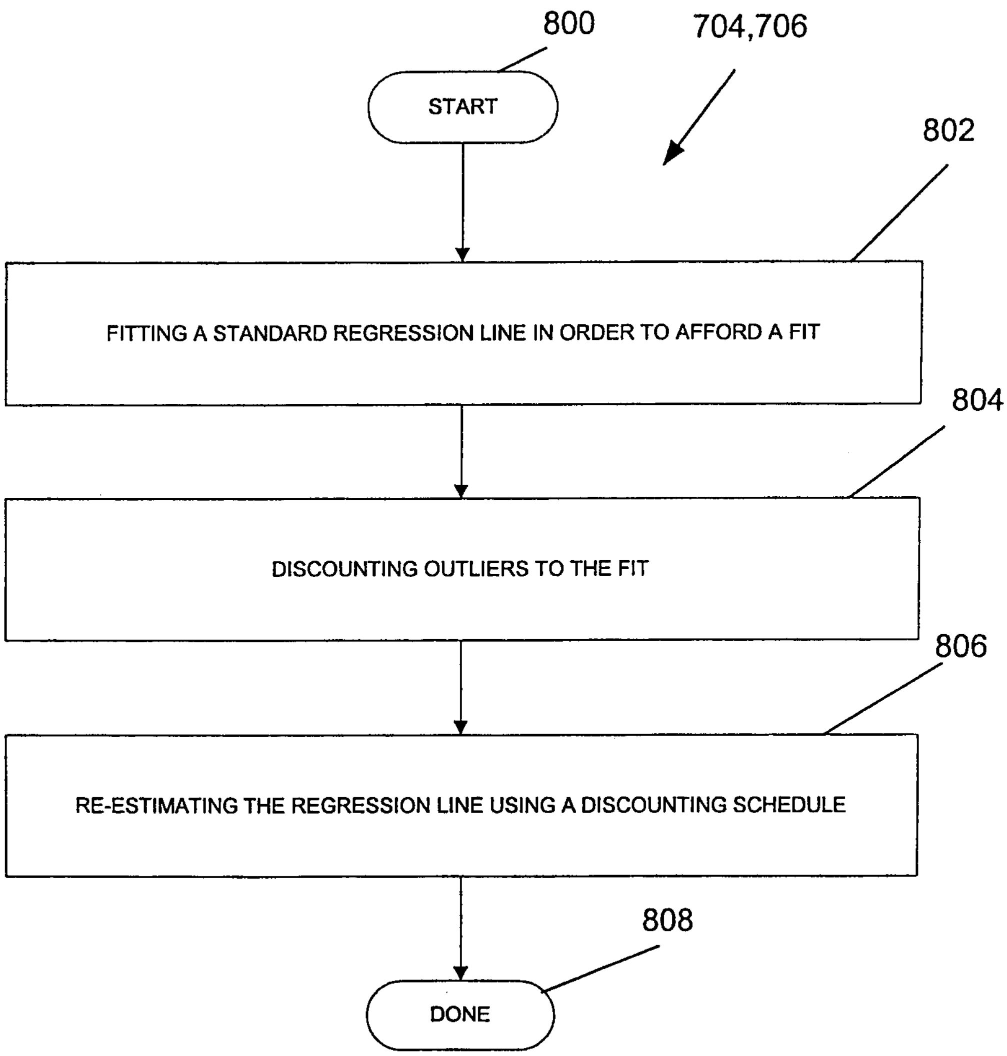
800
704,706
START
802
FITTING A STANDARD REGRESSION LINE IN ORDER TO AFFORD A FIT
804
DISCOUNTING OUTLIERS TO THE FIT
806
RE-ESTIMATING THE REGRESSION LINE USING A DISCOUNTING SCHEDULE
808
DONE

Figure 8