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(54) Title: UNPRICED ORDER AUCTION AND ROUTING

(57) Abstract: An unpriced order auction and related market center and process are disclosed which allow posting market centers (e.g., exchanges) to schedule an auction that includes unpriced (Market) orders only. Such unpriced order auction executes at the midpoint of the NBBO, ensuring that the cross reflects the best prices in the entire marketplace, while discouraging the manipulation of the auction price on the posting market center. The disclosed auction also executes concurrently, but separately from the regular continuous matching process.

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UNPRICED ORDER AUCTION AND ROUTING

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from and claims the benefit of U.S. Provisional Application No. 60/678,021, filed May 5, 2005, entitled "Unpriced Order Auction and Routing", which is hereby incorporated by reference.

BACKGROUND

[0002] Various market centers (including exchanges, alternative trading systems, and crossing networks) offer investors the opportunity to participate in scheduled auctions (or call auctions) throughout the trading day. These may be opening auctions, closing auctions, or intra-day auctions. Depending on the venue and the time of day, the auction may include limit orders, market orders, auction-only orders or any combination or limitation thereof. Regardless of the order types that participate in the different auction models, a characteristic that scheduled auctions generally share is that all orders matched in the auction execute at a single price that maximizes the quantity that can cross. Some of these auction models, however, have the significant drawback that regular trading is restricted or frozen until the auction process is conducted and completed. Historically, some market centers have imposed a "freeze time" of as much as ten minutes, during which traders are restricted in some cases from canceling or changing their orders if they are participating in the auctions. Additionally, during the actual execution of the auction, some market centers freeze their regular continuous trading order books (as well as their auction orders) for five seconds or longer, effectively halting all trading while the auction executes. Such extended freeze periods put traders at risk, as the market can move away from their prices.

[0003] One auction model includes only limit orders. When an auction consists solely of limit-priced orders, the limit prices resident on the market center typically

determine the price or prices at which the auction may execute. As orders are received throughout the designated pre-auction period, the market center typically updates and disseminates an indicative match price, i.e., the anticipated auction clearing price as of that moment in time. If more than one match price is possible, then other external prices (e.g., the previous closing price) are often used as a tie-breaker for pricing the auction.

[0004] A second auction model includes both limit orders and market orders. When an auction includes both limit orders and market orders, the limit prices on the market center once again typically determine the price or prices at which the auction may execute, while the market orders add liquidity to the cross. Although market orders are unpriced by definition, they can negatively impact the auction pricing if they cause an imbalance in buy or sell interest. This model can be problematic, especially in thinly-traded issues, as outlier limit prices that are significantly away from the market price can sometimes disproportionately skew the auction price away from what the real market price should be when there is an excess of market order volume on the contra side. As a result, some market centers apply pre-established "price collars" to the indicative match price, whereby the auction is canceled if the indicative match price is outside of specific threshold parameters (e.g., more than $1.00 or 10% away from the consolidated last sale price or the previous closing price). This ensures that the auction only executes at prices within the range of where the issue generally trades.

[0005] A third auction model consists solely of market orders. When an auction consists solely of market orders, the market center excludes all limit orders from its pricing algorithm. Such auctions allow size discovery while minimizing the ability to manipulate the auction price. With the exclusion of limit orders, however, the market

center must rely solely on external pricing for the auction. Some marketplaces look to the best bid and offer (BBO) on the primary listing market, i.e., the main market on which a given issue is listed. The problem with this approach is that the primary listing market center's BBO may not be the best indication of true marketplace prices, especially when liquidity is fragmented across exchanges, ECNs, and other market centers.

[0006] Accordingly, there is a need for a single-price market order auction that is protected from unusual pricing variations, even if participation in the auction is uneven, by deriving its pricing from the best prices in the entire marketplace (e.g. the National Best Bid and Offer (NBBO)), not just from fragments of the marketplace, as, for example, just from an issues' primary listed market center. There is a further need that such auction executes concurrently, but separately from the regular continuous limit order matching process. There is also a further need that such auction process does not require a halt or freeze in either the scheduled auction process or the continuous matching process.

SUMMARY

[0007] According to an aspect of the present invention, a method for crossing unpriced orders in a single-price auction in an issue on a posting market center includes providing a posting market center with an unpriced order book, specifying a time at which a scheduled auction is to execute, receiving unpriced buy and sell orders prior to the scheduled auction time and storing the received unpriced orders in the unpriced order book. It further includes, at the scheduled auction time, matching as many buy orders to sell orders as possible, retrieving an indicator external to the posting market center to establish the best prices in the entire marketplace, deriving a single auction price from the retrieved external indicator and executing trades in the

issue between the matched buy and sell orders at the derived auction price. According to another aspect of the present invention, the retrieved external indicator may be a national best bid and offer quote, and the single auction price may be derived by computing the midpoint of the retrieved national best bid and offer quote. Furthermore, the posting market center may include a continuous matching process and the orders that are not matched during the unpriced order auction process may be released to the continuous matching process for execution. The continuous matching process may be set up to operate concurrently with the unpriced order auction process.

DESCRIPTION OF THE DRAWINGS

[0008] These and other features, aspects and advantages of the present invention will become better understood with regard to the following description, appended claims and accompanying drawings where:

[0009] FIG. 1 is a block diagram illustrating the trading environment in which an embodiment of the present invention operates;

[0010] FIG. 2 is a block diagram illustrating an order matching engine in an embodiment of the present invention;

[0011] FIG. 3 is a flow diagram illustrating the stages of the auction process;

[0012] FIG. 4 is a flow diagram illustrating a process implemented by an embodiment of the present invention for determining whether an incoming market order should participate in the unpriced order auction, should be released to the continuous matching engine 52 or should be routed directly to a primary listing market center;

[0013] FIG. 5 is a flow diagram illustrating a process implemented by an embodiment of the present invention wherein the posting market center disseminates

indicative information regarding the upcoming unpriced order auction until the scheduled auction execution time;

[0014] FIG. 6 is a flow diagram illustrating a process implemented by an embodiment of the present invention for disseminating an indicative unmatched volume (auction imbalance) and an indicative match volume;

[0015] FIG. 7 is a flow diagram illustrating a process implemented by an embodiment of the present invention for storing an incoming market order in an auction book and determining whether there is an imbalance between buy interest and sell interest;

[0016] FIG. 8 is a flow diagram illustrating a process implemented by an embodiment of the present invention to determine if there is both buy interest and sell interest;

[0017] FIG. 9 is a flow diagram illustrating a process implemented by an embodiment of the present invention to execute the unpriced order auction if there is both buy interest and sell interest and to release any unmatched orders for regular trading; and

[0018] FIG. 10 is a flow diagram illustrating a process implemented by an embodiment of the present invention to price the orders matched in the unpriced order auction based on the NBBO quote price.

DETAILED DESCRIPTION

[0019] Referring to Fig. 1, a trading environment in which an embodiment of the system and method of the present invention operates is depicted. The examples discussed herein primarily describe the use and application of the present invention in an equity security market center environment, but it should be understood that the

present invention could be used in any type of financial instrument market center environment (*e.g.*, equities, futures, options, bonds, etc.). The trading environment of this embodiment includes a posting market center 20 which interacts with a number of other market centers 24 (*i.e.* away markets), traders at order sending firms 26 and Market Makers 31. It should be understood that the trading environment of this embodiment supports but does not require Market Makers 31, a Market Maker Interface 32, or Market Maker Quotes 33. It should also be understood that the posting market center 20 referred to herein refers to a computing system having sufficient processing and memory capabilities and does not refer to a specific physical location. In fact, in certain embodiments, the computing system may be distributed over several physical locations. It should also be understood that any number of traders 26 or Market Makers 31 or away market centers 24 can interact with the posting market center 20. The posting market center 20 is the market center on which a specific trader at an order sending firm 26 posts a specific order, and on which a specific Market Maker 31 posts a specific quote. The posting market center 20 includes an order matching engine 21, which validates, matches and processes all orders and quotes on the posting market center 20. In this embodiment, the code for the order matching engine 21 is stored in the posting market center's memory.

[0020] The posting market center 20 may also include a quote and last sale interface 23 that interacts with the away market centers 24 to capture quote and last sale information. This information is stored to a best bids and offers and last sales data structure 25. This data structure 25 is where the market best bid and offer information is stored. This data structure 25 is also where the market trade reports (prints) are stored. The posting market center 20 may also include an order and trade parameters data structure 27. The order and trade parameters data structure 27 stores

pre-defined trading parameters and rules that are used by the order matching engine 21 in matching orders and executing trades. The posting market center 20 may also include an order and execution interface 28 which interacts with the traders 26, the Market Makers 31, the away market centers 24 and the order matching engine 21 in the order execution process. The posting market center 20 may also include an order information data structure 29 where order information is stored and a trade information data structure 30 where completed trade information is stored. The posting market center 20 may also include a Market Maker interface 32 that interacts with Market Makers 31 to capture Market Maker bids and offers in assigned issues. These bids and offers are logically depicted in a Market Maker Quotes structure 33 in this illustration. In actuality, the Market Maker bids and offers may physically reside in the away market center best bids and offers data structure 25.

[0021] Throughout the discussion herein, it should be understood that the details regarding the operating environment, data structures, and other technological elements surrounding the posting market center 20 are by way of example and that the present invention may be implemented in various differing forms. For example, the data structures referred to herein may be implemented using any appropriate structure, data storage, or retrieval methodology (*e.g.*, local or remote data storage in data bases, tables, internal arrays, etc.). Furthermore, a market center of the type described herein may support any type of suitable interface on any suitable computer system.

Order Matching Engine

[0022] In this embodiment of the invention, the order matching engine 21 on the posting market center 20 refers to the structure and processes that implement the validation, posting, and internal matching of orders on the posting market center 20, as well as the routing of orders to away market centers 24. Referring to Fig. 2, at the

heart of the order matching engine 21 is the continuous matching engine 52, which, when activated, immediately executes incoming marketable orders against the posting market center's order book in a continuous matching process. The order matching engine 21 also includes an unpriced order auction engine 50. The unpriced order auction engine 50 includes sub-routines 54-66, explained in detail below. During one or more designated market periods, the order matching engine 21 activates the unpriced order auction engine 50 and initiates the unpriced order auction process, which queues incoming market orders that are eligible to participate in an upcoming scheduled auction. The continuous matching process and the unpriced order auction process execute concurrently, but are logically separate processes from a business standpoint, as illustrated in Figs. 2 and 3.

The Continuous Matching Process

[0023] During the pre-auction period, the pre-auction order entry routine 68, using rules stored on the data structure 27, directs incoming limit-priced orders automatically to the continuous matching engine 52 for immediate execution if possible. If an incoming limit order is not marketable, then it is included in the posting market center's order book of active limit orders 29a on data structure 29 and disseminated to the public marketplace if the order is a disclosed order type. Depending on the business rules of the posting market center 20, limit orders may also be eligible to be routed to one or more away market centers 24 during the pre-auction period before the regular trading day commences.

The Unpriced Order Auction Process

[0024] During the pre-auction period, the pre-auction order entry routine 68, using rules stored on the data structure 27, directs incoming market orders automatically to the unpriced order auction engine 50 for possible inclusion in an upcoming scheduled

auction. In this embodiment, market orders eligible for the unpriced order auction are queued in a separate auction order book 29b in the data structure 29 on the posting market center 20. Although the details of the orders are not publicly displayed, a pending auction is advertised to the marketplace. As new market orders are received and existing market orders are canceled or modified during the pre-auction period, the unpriced order auction process continuously calculates and disseminates an updated Auction Imbalance parameter and Indicative Match Volume parameter. At the scheduled auction time, the unpriced order auction process executes the auction if orders exist on both sides of the auction order book and uses the first eligible NBBO quote to price the match. The matched market orders are executed, the trades are stored in data structure 30 and reported to the Tape, and the unmatched market orders, which are temporarily stored in data structure 29c, are released to the continuous matching engine 52 for execution against its order book 29a. The unpriced order auction process terminates, and all subsequent incoming market orders are automatically passed to the continuous matching engine 52.

Market Maker Quotes

[0025] The posting market center 20 may appoint Market Makers 31 in some issues. These Market Makers have a responsibility for maintaining two-sided quotes 33 in accordance with the business rules of the posting market center 20. Market Maker quotes 33 do not participate in the unpriced order auction. However, any market orders that do not match in the unpriced order auction may subsequently trade against orders generated on behalf of Market Maker quotes at the NBBO upon completion of the opening process. The unmatched market orders trade according to the normal business rules for incoming market orders, e.g., the orders may execute according to Lead Market Maker guarantee rules.

The Auction Sequence

[0026] Referring to Figs. 3A-3B, in a preferred embodiment, the unpriced order auction follows this sequence:

- Pre-Auction Period
- Opening
- Post-Auction Period

[0027] These periods are configurable by issue according to the business rules of the posting market center 20, but generally correspond to the trading sessions in effect across the marketplace. For example, the Pre-Auction period may be configured to start at 08:00:00 am ET and end at 09:29:59 am ET, whereas the Opening is typically configured to start at 09:30:00 am ET. The Post-Auction period commences immediately upon completion of the Opening and may be configured to end at 15:59:59 pm ET by way of example.

[0028] Although this embodiment of the invention describes the unpriced order auction in the context of an Opening Auction, it should be noted that this invention could also be scheduled at different times during the trading day. In such an intra-day embodiment of the invention, only market orders designated as "Auction Only" are passed to the unpriced order auction engine 50, while regular, non-designated market orders are passed to the continuous matching engine 52 as normal. During the designated pre-auction period (e.g., with a start time of 11:30:00 am ET and an end time of 12:29:59 pm ET), the unpriced order auction process advertises the auction as described below and at the scheduled auction time (e.g., 12:30:00 pm ET) attempts to execute and price the unpriced order auction as described in detail herein.

The Pre-Auction Period

[0029] During the designated Pre-Auction period, limit orders and market orders are accepted for processing on the posting market center 20. If the primary listing market center 24 for the issue is not yet open for regular trading, then the posting market center 20 is still in the Pre-Opening period. Market Makers 31 who wish to trade on the posting market center 20 during the Pre-Opening period must do so using orders, as Market Maker quotes 33 do not trade during this period. However, Market Makers are expected to quote in their assigned issues in accordance with the business rules of the posting market center 20, in preparation for the Opening.

[0030] All incoming limit orders received during the Pre-Opening period are automatically passed to the continuous matching engine 52 where they will execute immediately if they are marketable or else are posted to the posting market center's public order book 29a if they are not marketable. Limit orders may also be eligible to be routed to superior away market centers 24 during the Pre-Opening period, as determined by the business rules of the posting market center 20.

[0031] All incoming market orders received during the Pre-Opening period are automatically passed to the unpriced order auction engine 50. If the unpriced order auction process determines that the issue is eligible for participation in the upcoming unpriced order auction, then it stores the order in time priority in the auction order book 29b for the issue. Throughout the Pre-Opening period, the unpriced order auction process continuously calculates and disseminates the Indicative Match Volume and the Auction Imbalance Volume. Traders 26 are allowed to cancel their market orders or change their size throughout the Pre-Opening period, as there is no freeze between the Pre-Opening and the Opening.

The Opening

[0032] At the scheduled Opening time, the unpriced order auction process attempts to execute an auction for each issue in which it has market orders. The completion of the unpriced order auction signals the Opening of the regular trading session on the posting market center 20. If market orders exist on both sides of the book, then the unpriced order auction is allowed to proceed. After the unpriced order auction executes and the orders are matched, the unpriced order auction process, in this embodiment, retrieves the first eligible NBBO quote published after the auction time, e.g., the first NBBO quote after 09:30:00 am ET. After the unpriced order auction process calculates and assigns an NBBO-midpoint price to the unpriced order auction, the executions are reported to the Tape with the relevant identifier (e.g., opening trade, closing trade, or regular-way trade if intra-day). Any unmatched market orders are released to the continuous matching engine 52 (unless they are designated as Auction-Only Orders, in which case they are canceled).

The Post-Auction Period

[0033] After the auction, unmatched market orders execute according to the normal business rules in effect for the processing of incoming market orders received during the regular trading day. Instead of executing at the midpoint of the NBBO, market buy orders execute at the NBO or better and market sell orders execute at the NBB or better. The unmatched market orders execute against the best contra trading interest in the marketplace, which may be a resident book order 29a; an order dynamically generated by the order matching engine 21 on behalf of a Market Maker quote 33; or an away market quote 25 whose price is superior to those on the posting market center 20.

Determining the Eligibility of Incoming Orders for the Unpriced Order Auction

[0034] The business rules for the posting market center 20 determine whether an issue is eligible to trade in the unpriced order auction or not. In this implementation of the present invention, eligibility is indicated by means of an unpriced order auction Participation Flag, which can be set differently for specific issues or for broader categories of issues. For example, in a preferred but not limiting embodiment of the invention, the posting market center 20 could implement business rules whereby orders in NASDAQ-listed stocks are eligible to participate in the unpriced order auction, whereas orders in NYSE-listed stocks and AMEX-listed stocks are not eligible to participate. Similarly, the posting market center 20 could implement business rules whereby orders in options whose underlying stock is listed on NASDAQ are eligible to participate in the unpriced order auction, whereas orders in options whose underlying stock is listed on the NYSE or AMEX are not eligible to participate. In a preferred embodiment, orders not eligible to participate in the unpriced order auction are instead immediately routed to the primary listing market center before it opens for trading. The primary listing market center typically queues the routed orders for its opening process. If the primary listing market center has already opened for trading (e.g., if the unpriced order auction is run intra-day instead of at the opening), then orders not eligible for the auction are generally released to the continuous matching engine 52 for immediate execution instead.

[0035] Fig. 4 illustrates an embodiment of the process implemented by the order matching engine 21 when a trader 26 sends a market order to the posting market center 20 during the designated pre-auction period. At step 100, a new market order is received by the Market Order Triage Routine 54, which first determines whether this issue is eligible to participate in the scheduled auction by retrieving the unpriced

order auction Participation Flag for this issue in step 102. In step 104, the process checks whether the issue participates in the unpriced order auction.

[0036] If the issue does not participate in the unpriced order auction, then the process continues to step 110, where it determines the primary listing market center for the issue, i.e., the main market center where the issue is listed (e.g., away market 24a). (Although a given issue may trade on multiple market centers including the posting market center 20, it will only have one primary listing market center.) At step 112, the process checks if the primary listing market center is open for trading yet. If the primary listing market center is not open for trading yet, then the process continues to step 116, where it routes the market order to the primary listing market center. The routed market order will participate in the opening process of the primary listing market center instead of the opening process of the posting market center 20. The process is completed at step 118.

[0037] Returning to step 112, if the primary listing market center is already open for trading (e.g., if this is an intra-day auction and not an opening auction), then the process releases it to the continuous matching engine 52 in step 114, which either cancels the order immediately if it is an Auction-Only order or else attempts to execute the order if it is a regular market order.

[0038] Returning to step 104, if the process determines that the issue is eligible to participate in the unpriced order auction, then it continues to step 106, where it invokes the Continuous Unpriced Order Auction routine 56 and proceeds to step 120 (Fig. 5).

[0039] Referring to Fig. 5, the process checks for the onset of the scheduled unpriced order auction execution time in step 122. If it is not time to execute the auction yet, then the process proceeds to step 124, where it invokes the Disseminate

Indicative Auction Volumes routine 58, which includes the incoming market order in the upcoming unpriced order auction and continuously advertises the unpriced order auction up until its scheduled time. At the designated auction time, the process proceeds to step 126, where it executes the Unpriced Order Auction routine 64 and then terminates in step 128.

[0040] Referring to Fig. 6, the unpriced order auction advertisement process includes invoking the Auction Imbalance routine 60 in step 132 and the Indicative Match Volume routine 62 in step 134. Whenever the process receives a new market order, receives a request for canceling an existing market order or receives a request to change the size of an existing market order, it recomputes the Auction Imbalance Volume and the Indicative Match Volume and disseminates the updated volumes to the marketplace in real-time. The Auction Imbalance Volume and the Indicative Match Volume are continuously displayed throughout the entire pre-auction period.

Calculating and Disseminating the Auction Imbalance and the Indicative Match Volume

[0041] The posting market center 20 maintains a separate auction order book 29b (logically equivalent to the regular limit order book 29a) for each issue in which it receives one or more eligible market orders during the designated pre-auction period. Throughout the designated pre-auction period, incoming market orders are included in the auction order book 29b in time priority. In this embodiment, when the size of an existing market order is increased, the order loses time priority and is treated as a new order. Similarly, in this embodiment, when the size of an existing market order is decreased, the order may or may not lose time priority depending on the business rules in effect on the posting market center 20. With each new incoming order, or with each order cancellation or change of size, the unpriced order auction process

recalculates the aggregate quantity of buys and sells that can presently match. This quantity is disseminated to the marketplace as the Indicative Match Volume. If interest exists on one side only, then the Indicative Match Volume is zero.

[0042] If there is an imbalance between the aggregate buy interest and the aggregate sell interest, then the unpriced order auction process calculates and disseminates the unmatched difference to the marketplace. If buy interest exceeds sell interest, then the Auction Imbalance (i.e., the unmatched quantity) is identified as a buy imbalance. If, on the other hand, the sell interest exceeds the buy interest, then the Auction Imbalance is identified as a sell imbalance. If the buy interest and sell interest are equal, then the Auction Imbalance is zero.

Examples of Advertising the Unpriced Order Auction to the Marketplace

[0043] Prior to the execution of the unpriced order auction, an issue can have

- Match Volume only;
- Imbalance Volume only; or
- Match Volume and Imbalance Volume

Several examples illustrating how the Indicative Match Volume and the Imbalance Volume are computed are shown in the cases below.

Case 1: Matched Volume with Sell Imbalance

Total volume of Market Buy orders: 5100 shares

Total volume of Market Sell orders: 6000 shares

Indicative Match Volume: **5100 shares**

Auction Imbalance: **900 shares, *Sell Imbalance***

Case 2: Matched Volume with Buy imbalance

Total volume of Market Buy orders: 1050 contracts

Total volume of Market Sell orders: 720 contracts

Indicative Match Volume: **720 contracts**

Auction Imbalance: **330 contracts, *Buy Imbalance***

Case 3: Sell Imbalance only, no Matched Volume

Total volume of Market Buy orders: 0 shares

Total volume of Market Sell orders: 4500 shares

Indicative Match Volume: **0 shares**

Auction Imbalance: **4500 shares, *Sell Imbalance***

Case 4: Matched Volume only, no Imbalance

Total volume of Market Buy orders: 8400 shares

Total volume of Market Sell orders: 8400 shares

Indicative Match Volume: **8400 shares**

Auction Imbalance: **0 shares**

Computing and Disseminating the Auction Imbalance

[0044] Referring to Fig. 7, the process for storing the incoming market order in the auction order book 29b and determining whether there is an Auction Imbalance, i.e., an excess of aggregate buy interest or aggregate sell interest, is illustrated. In step 142, the process checks whether the incoming market order is a buy order or a sell order. If the incoming order is a sell order, then the process continues to step 144, where it adds the quantity of the incoming market sell order to the aggregate value of the UnpricedSellVolume parameter. If, on the other hand, the incoming order is a buy order, then the process continues instead to step 146, where it adds the quantity of the incoming market buy order to the aggregate value of the UnpricedBuyVolume parameter. The UnpricedSellVolume represents the total quantity (i.e., number of

shares or contracts) of market sell orders participating in the upcoming unpriced order auction, while the UnpricedBuyVolume represents the total quantity of market buy orders participating in the upcoming unpriced order auction.

[0045] In step 148, the process stores the incoming market order in time priority, with earlier orders having priority over later orders. Market buy orders are stored in time priority in the bid side of the auction order book 29b, while market sell orders are stored in time priority in the offer side of the auction order book 29b. Each issue participating in the unpriced order auction has its own auction order book.

[0046] Next, the process determines whether there is an excess of interest, i.e., an "ImbalanceVolume," on either side of the auction order book by comparing the aggregate buy volume to the aggregate sell volume. In step 150, the process computes the value of the ImbalanceVolume by subtracting the value of the UnpricedSellVolume from the value of the UnpricedBuyVolume. If at step 152 the computed ImbalanceVolume has a positive value (greater than zero), then the buy interest exceeds the sell interest, and the process continues to step 154, where it publishes the computed ImbalanceVolume to the marketplace and denotes that the excess interest is on the buy side.

[0047] Returning to step 152, if the process determines that the computed Imbalance Volume is not greater than zero, then the buy interest does not exceed the sell interest. The process continues to step 156, where it checks if the computed ImbalanceVolume is negative instead. If the ImbalanceVolume is negative (less than zero), then the sell interest exceeds the buy interest, and the process continues to step 158, where it publishes the computed ImbalanceVolume to the marketplace and denotes that the excess interest is on the sell side.

[0048] Returning to step 156, if the computed ImbalanceVolume is not negative, then the process continues to step 160. As the process has now determined that the ImbalanceVolume is neither greater than zero nor less than zero, then no imbalance exists. This means the aggregate quantity of buy interest is equal to the aggregate quantity of sell interest, and all shares (or contracts) would be matched if the unpriced order auction were to execute with the presently queued quantities. The process publishes the computed ImbalanceVolume as zero to the marketplace, and at step 162, it returns to the step where the Auction Imbalance Process was invoked, in step 132 of Fig. 6.

Computing and Disseminating the Indicative Match Volume

[0049] Referring to Fig. 6, the process continues to step 134, where it invokes the Indicative Match Volume routine 62 for computing and disseminating the Indicative Match Volume, i.e., the quantity of shares (or contracts) that can presently match in the upcoming unpriced order auction. Referring to Fig. 8, the process determines if orders are present on both sides of the auction order book 29b, and if a match is possible because interest exists on both sides, the process advertises the computed "MatchVolume" for the upcoming auction to the marketplace. As market orders have no prices, the Indicative Match Volume is simply the volume of buy interest that equals the sell interest, which is the lesser of the aggregate buy quantity and the aggregate sell quantity.

[0050] In step 172, the process checks whether the value of the UnpricedBuyVolume is greater than zero, i.e., if any market buy orders are present in the auction order book. If no buy orders exist, then the UnpricedBuyVolume is zero, and the process continues to step 176, where it sets the computed MatchVolume to zero because no match is possible without buy interest. The process continues to step

184, where it publishes the MatchVolume of zero to the marketplace. The process completes at step 186 as indicated.

[0051] Returning to step 172, if the UnpricedBuyVolume is greater than zero, then market buy orders exist, so the process continues to step 174 to determine if market sell orders also exist. If no sell orders exist, then the UnpricedSellVolume is zero, and the process continues to step 176, where it sets the computed MatchVolume to zero because no match is possible without sell interest. The process continues to step 184, where it publishes the MatchVolume of zero to the marketplace. The process completes at step 186 as indicated.

[0052] Returning to step 174, if the UnpricedSellVolume is also greater than zero, then interest exists on both sides of the auction order book 29b, and a match is possible to the degree to which the buys and sells overlap. The Indicative Match Volume is the lesser of the aggregate buy interest and the aggregate sell interest. In step 178, the process compares the value of the UnpricedBuyVolume to the value of the UnpricedSellVolume. If the UnpricedBuyVolume is greater than the UnpricedSellVolume, then the process sets the Indicative Match Volume ("MatchVolume") equal to the value of the UnpricedSellVolume in step 180. If, on the other hand, the UnpricedBuyVolume is not greater than the UnpricedSellVolume, then the process sets the MatchVolume equal to the value of the UnpricedBuyVolume in step 182. In step 184, the process publishes the computed MatchVolume to the marketplace, and the process completes at step 186.

Executing the Unpriced Order Auction at its Scheduled Time

[0053] At a configurable, pre-determined scheduled auction time parameter stored in data structure 27, the unpriced order auction process attempts to execute an unpriced order auction for each issue in which it has market orders queued in the

auction order book. If interest exists on one side of the book only, i.e., buys but not sells (or sells but not buys), then no match is possible and the auction is canceled. The unmatched market orders are immediately released to the continuous matching engine 52 for execution in the regular trading session.

[0054] If interest exists on both sides of the book, then orders can match in the auction. The unpriced order auction process determines the quantity that can match, i.e., the lesser of the aggregate buy volume and the aggregate sell volume. Buy orders are paired with sell orders up to the computed MatchVolume, in accordance with time priority (i.e., earlier orders are paired before later orders). After the buy orders and sell orders have been paired, the unpriced order auction, in this embodiment, retrieves the NBBO quote for the issue. If the auction is an opening auction, then the first NBBO quote published after 09:30 am ET is retrieved. In a different implementation of this invention, if the auction is an intra-day auction, then the first NBBO quote after the designated auction time (e.g., 12:30 pm ET) is retrieved instead.

[0055] When the NBBO quote is retrieved, the unpriced order auction process evaluates whether the disseminated NBBO is eligible to price the auction. If the NBBO is neither locked nor crossed (i.e., the NBB is not higher than the NBO, nor is it equal to the NBO), then the unpriced order auction process calculates the midpoint of the NBBO quote. If the spread between the NBB and the NBO is one price increment, then the auction is priced at the midpoint of the increment, even though customers are not allowed to send limit orders at those increments. For example, if the NBBO is $20.00 to $20.01 for an issue trading in pennies, then the auction is priced at $20.005 even if subpenny trading is not allowed.

[0056] If the NBBO is crossed, then the unpriced order auction process discards the crossed NBBO quote and waits for the next uncrossed NBBO quote to be

disseminated. If the NBBO is locked, the business rules of the posting market center 20 must be consulted. In one implementation of the invention, the auction is priced at the NBBO even if the market is locked. For example, if the NBBO is $20.00 to $20.00, then the auction is priced at $20.00. In a different implementation of the invention, the unpriced order auction process discards the locked NBBO and waits for the next uncrossed, unlocked NBBO. The business rules may differ depending on whether the posting market center 20 is a party to the lock or not.

[0057] If no eligible NBBO quote is received within a reasonable period of time after 09:30 am ET as determined by the business rules of the posting market center 20, then the unpriced order auction is typically canceled manually by the Trading Desk, and regular trading commences when the issue (or the underlying stock, in the case of equity options) opens on the primary listing market center.

[0058] Fig. 9 illustrates how the process determines whether it should execute or cancel the unpriced order auction at its scheduled auction time, and the method whereby the queued market orders are matched in the unpriced order auction and/or released from the process. If an issue has interest on both sides of the auction order book, then the process executes the unpriced order auction and releases any unmatched market orders. If an issue has interest on one side only of the auction order book, then the process cancels the unpriced order auction and releases all the queued market orders.

[0059] In step 192, the process determines if market buy orders exist by checking if the value of the UnpricedBuyVolume is greater than zero. If the UnpricedBuyVolume is not greater than zero, then no buy interest exists for this issue, and the process proceeds to step 214, where it releases the unmatched market orders (Sell Orders, in this case) to the continuous matching engine 52 and cancels the

unpriced order auction. (If a market sell order has been designated as Auction-Only, then it is automatically canceled as well.) The process then stops at step 216 as indicated, and the normal trading session commences when this issue opens.

[0060] Returning to step 192, if the UnpricedBuyVolume is greater than zero, then buy interest does exist for this issue, and the process continues to step 194, where it determines if market sell orders also exist. If the UnpricedSellVolume is not greater than zero, then no sell interest exists for this issue, and the process proceeds to step 214, where it releases the unmatched market orders (buy orders, in this case) to the continuous matching engine 52 and cancels the unpriced order auction. (If a market buy order has been designated as Auction-Only, then it is automatically canceled as well.) The process then stops at step 216 as indicated, and the normal trading session commences when this issue opens.

[0061] Returning to step 194, if the UnpricedSellVolume is greater than zero, then sell interest does exist for this issue, and the process can execute the unpriced order auction. To determine the volume that can match in the unpriced order auction, the process sets the matchable quantity (MatchVolume) to the lesser of the aggregate market buy order volume and the aggregate market sell order volume. In step 196, the process compares the UnpricedBuyVolume to the UnpricedSellVolume. If the UnpricedBuyVolume is greater than the UnpricedSellVolume, then the process continues to step 200, where it sets the value of the MatchVolume equal to the value of the UnpricedSellVolume. Returning to step 196, if, on the other hand, the UnpricedBuyVolume is not greater than the UnpricedSellVolume, then the process continues to step 198, where it sets the value of the MatchVolume equal to the value of the UnpricedBuyVolume.

[0062] Having determined the MatchVolume, the process continues to step 202, where it matches the market buy orders and the market sell orders up to the computed MatchVolume. The orders are paired according to time priority, with the oldest orders matching prior to the newest orders. Depending on the value of the MatchVolume, it is possible that the last participating buy order or sell order is only partially matched in the unpriced order auction. After pairing the eligible market buy orders and market sell orders, the process momentarily adds them to a "MatchedOrders" data structure 29d in step 204, where the trades await pricing.

Pricing the Unpriced Order Auction at the Midpoint of the NBBO Quote

[0063] After the process has paired the eligible market buy orders and market sell orders, in this embodiment, it must determine the NBBO midpoint price at which the orders will execute, as indicated at step 206. Fig. 10 illustrates the process for computing the price of the auction. Referring to Fig. 10, the process retrieves the first NBBO quote published after the scheduled auction time and evaluates its eligibility in pricing the unpriced order auction. If the process determines the currently-evaluated NBBO quote to be ineligible, then it discards it and waits for the next NBBO quote, until it finally determines that the NBBO quote is indeed eligible to price the unpriced order auction.

[0064] In step 222, the process retrieves the first published NBBO quote after the scheduled auction time, e.g., after 09:30 am ET if this is an opening auction. In step 224, the process checks whether the NBBO is crossed, i.e., if the NBB is higher than the NBO. If the NBBO is crossed, then the process continues to step 226, where it waits for the next published NBBO quote.

[0065] Returning to step 224, if the NBBO is not crossed, then the process continues to step 228, where it checks whether the NBBO is locked, i.e., if the NBB is

equal to the NBO. In the preferred embodiment of this invention, a locked NBBO is permitted to price the unpriced order auction according to the business rules of the posting market center 20. However, in a different embodiment of this invention, a locked NBBO may not be permitted to price the unpriced order auction, in which case the process must wait for the next uncrossed, unlocked NBBO. If the NBBO is locked, then the process proceeds to step 230, where it checks whether a locked NBBO can price the unpriced order auction according to the business rules of the posting market center 20. If a locked NBBO cannot price the unpriced order auction, then the process discards the currently evaluated NBBO and continues to step 226 to wait for the next NBBO quote. If, however, a locked NBBO can price the unpriced order auction, then the process continues to step 234, where it sets the price of the unpriced order auction (the "AuctionPrice") equal to the locked NBBO price and proceeds to step 238, where the process returns to where it was invoked in Fig. 9 (step 206).

[0066] Returning to step 228, if, however, the NBBO is not locked, then the process calculates the midpoint of the NBBO quote in step 232. As previously described, if the difference between the NBB and the NBO is one price increment, then the midpoint of the price increment is computed, even though such increment is not valid in the continuous matching engine 52. Having computed the midpoint of the uncrossed, unlocked NBBO quote, the process continues to step 236, where it sets the AuctionPrice equal to the computed midpoint price and proceeds to step 238, where the process returns to where it was invoked in Fig. 9 (step 206).

Completing the Unpriced Order Auction After the Midpoint Price Has Been Determined

[0067] After the process has determined the match price for the unpriced order auction, it continues to step 208, where it assigns the AuctionPrice as the trade price for all the market orders stored on the MatchedOrders data structure 29d. In step 210, the process executes the trades and disseminates the MatchVolume and the AuctionPrice to the marketplace.

[0068] In step 212, the process checks whether there are any remaining market buy orders or market sell orders that were not matched in the unpriced order auction. If there are no unmatched market orders, then the process stops at step 216. However, if any unmatched market orders exist, then the process continues to step 214, where it releases the unmatched market orders to the continuous matching engine 52 (unless an order has been designated as Auction-Only, in which case it is canceled instead.) The process then stops at step 216 as indicated. It should be understood that in another embodiment the unmatched market orders could be released to the continuous matching engine 52 immediately after the matching of the market orders in step 202, prior to the pricing and execution of the matched orders.

[0069] At step 216, the unpriced order auction process is complete, and all subsequent incoming market orders are passed to the continuous matching engine 52.

[0070] Examples of how market orders participate in the unpriced order auction are provided below. Most of the examples use equity securities as their basis, although several examples use equity options as their basis. The invention is equally applicable to other financial instruments as well. It should be understood that the order prices and market prices discussed in these examples are by way of example

only to illustrate how the process of an embodiment of the invention handles unpriced order auctions when executed at the Opening.

Example 1: Market Buy Order is Received for an Issue That Does Not Participate in the Unpriced Order Auction

[0071] During the designated Pre-Auction period (which in this example occurs before the national markets open for the regular trading session at 09:30 am ET), the posting market center 20 receives the following order in step 100:

→ Order A: Buy 200 @ Market

Referring to Fig. 4, when the process receives an incoming market order, it must determine whether the issue is eligible to participate in the upcoming unpriced order auction or not. In step 102, the process retrieves the unpriced order auction Participation Flag for this issue and checks whether the issue is eligible to participate in the unpriced order auction in step 104. In this example, the unpriced order auction Participation Flag is set to "No," indicating that the issue is not eligible to participate in the unpriced order auction.

[0072] Upon determining that the issue is not eligible for the unpriced order auction, the process proceeds to step 110, where it determines the primary listing market center for the issue. In this example, the primary listing market center for this issue is Away Market Center A, 24a. In step 112, the process determines that Away Market Center A is not open for trading yet, so it continues to step 116, where it routes incoming Order A to Away Market Center A. Order A may participate in the opening of Away Market Center A 24a, but will not participate in the opening of the posting market center 20. The process stops as indicated at step 118.

Example 2: Market Buy Order is Received for an Issue That Participates in the Unpriced Order Auction

[0073] During the designated Pre-Auction period, the posting market center 20 receives the following order in step 100:

→ Order B: Buy 600 @ Market

As in the prior example, the process must determine whether the issue is eligible to participate in the upcoming unpriced order auction or not. In step 102, the process retrieves the unpriced order auction Participation Flag for this issue and checks whether the issue is eligible to participate in the unpriced order auction in step 104. In this example, the unpriced order auction Participation Flag is set to "Yes," indicating that the issue is indeed eligible to participate.

[0074] Upon determining that the issue is eligible for the unpriced order auction, the process continues to step 106, where it invokes the Continuous Unpriced Order Auction routine 56. As illustrated in Fig. 5, the invoked process checks for the onset of the scheduled auction time in step 122. As the scheduled auction time is still pending in this example, the process continues to step 124, where it invokes the routines that advertise the upcoming unpriced order auction to the marketplace. As illustrated in Fig. 6, the two invoked routines that advertise the upcoming auction are the Auction Imbalance routine 60 invoked at step 132 and the Indicative Match Volume routine 62 invoked at step 134.

[0075] Incoming Market Buy Order B is presented to the Auction Imbalance routine 60, as illustrated in Fig. 7. In step 142, the process determines that incoming Market Order B is a buy order, and therefore adds the order quantity (600 shares) to the aggregate buy interest, whose quantity is reflected in the UnpricedBuyVolume. As Order B is the first market order received for this issue, the UnpricedBuyVolume is presently set to zero. At step 146, the process adds the quantity of incoming Order

B (600) to the UnpricedBuyVolume (zero) to derive the updated UnpricedBuyVolume = 600 shares.

[0076] In step 148, the process inserts Order B in the auction order book, in time priority. The auction order book looks like this:

Bids	Offers
Order B: Buy 600 @ Market	

[0077] In step 150, the process computes the Auction Imbalance, which is the excess of buy interest over sell interest, or vice versa. The process computes the ImbalanceVolume by subtracting the UnpricedSellVolume from the UnpricedBuyVolume. As no Sell Orders have been received yet for this issue, the UnpricedSellVolume is presently set to zero. The process therefore computes the ImbalanceVolume as + 600 shares (600 less zero).

[0078] In step 152, the process checks whether the computed ImbalanceVolume (+600) is greater than zero. As the ImbalanceVolume is greater than zero, the process continues to step 154, where it publishes the ImbalanceVolume and denotes it as an excess of interest on the buy side. For example, in this implementation of the invention, the process publishes "Imbalance Volume: + 600 *Buy Imbalance*" to the marketplace. In step 162, the process then returns, and continues to step 134 (Fig. 6), where the Indicative Match Volume routine 62 is invoked next. As illustrated in Fig. 8, the process for the invoked Indicative Match Volume routine 62 determines the volume that can match in the upcoming unpriced order auction and advertises the matched quantity, if any, to the marketplace.

[0079] In step 172, the process checks whether the UnpricedBuyVolume is greater than zero. In this example, the UnpricedBuyVolume = 600, so the process continues to step 174, where it checks whether the UnpricedSellVolume is also

greater than zero. As no Sell Orders have been received yet and the UnpricedSellVolume = zero, no match is possible. The process continues to step 176, where it sets the MatchVolume = zero. In step 184, the process publishes the MatchVolume. The advertised auction looks like this:

Symbol	Auction Imbalance	Indicative Match Volume	Match Price
XYZZ	+ 600 *Buy*	0	

Example 3: Market Buy Order Increases the Auction Imbalance

[0080] During the designated Pre-Auction period, the posting market center 20 receives the following order in step 100:

→ Order C: Buy 400 @ Market

[0081] In this example, Order C is processed much like Order B, as it is a market order in the same issue. The process determines the issue is eligible to participate in the unpriced order auction, determines that the scheduled time has not commenced yet (steps 102, 104, 106, 120, 122, and 124), and proceeds to step 140, where the incoming market buy order is presented to the Auction Imbalance routine 60.

[0082] In step 142, the process determines that incoming Market Order C is a buy order and continues to step 146. At step 146, the process adds the quantity of incoming Order C (400) to the UnpricedBuyVolume (600) to derive the updated UnpricedBuyVolume = 1000 shares.

[0083] In step 148, the process inserts Order C in the auction order book, in time priority behind Order B. The auction order book looks like this:

Bids	Offers
Order B: Buy 600 @ Market	
Order C: Buy 400 @ Market ←	

[0084] In step 150, the process computes the Auction Imbalance by subtracting the UnpricedSellVolume from the UnpricedBuyVolume. As no Sell Orders have

been received yet for this issue, the UnpricedSellVolume is presently set to zero. The process therefore computes the ImbalanceVolume as +1000 shares (1000 less zero).

[0085] In step 152, the process checks whether the computed ImbalanceVolume (+1000) is greater than zero. As the ImbalanceVolume is greater than zero, the process continues to step 154, where it publishes the ImbalanceVolume and denotes it as an excess of interest on the buy side. For example, in this implementation of the invention, the process publishes "Imbalance Volume: + 1000 *Buy Imbalance*" to the marketplace. In step 162, the process then returns, and continues to step 134 (Fig. 6), where the Indicative Match Volume routine 62 is invoked next.

[0086] Referring to Fig. 8, in step 172, the invoked process checks whether the UnpricedBuyVolume is greater than zero. In this example, the UnpricedBuyVolume = 1000, so the process continues to step 174, where it checks whether the UnpricedSellVolume is also greater than zero. As no sell orders have been received yet and the UnpricedSellVolume = zero, no match is possible. The process continues to step 176, where it sets the MatchVolume = zero. In step 184, the process publishes the MatchVolume. The advertised auction look like this:

Symbol	Auction Imbalance	Indicative Match Volume	Match Price
XYZZ	+1000 *Buy*	0	

Example 4: Market Sell Order Results in a Matched Volume and Creates a Sell Imbalance

[0087] During the designated Pre-Auction period, the posting market center 20 receives the following order in step 100:

→ Order D: Sell 1500 @ Market

[0088] In this example, Order D is processed initially like Orders B and C, as it is a market order in the same issue. The process determines the issue is eligible to

participate in the unpriced order auction, determines that the scheduled time has not commenced yet (steps 102, 104, 106, 120, 122, and 124), and proceeds to step 140, where the incoming market sell order is presented to the Auction Imbalance routine 60.

[0089] In step 142, the process determines that incoming Market Order D is a sell order, and therefore adds the order quantity (1500 shares) to the aggregate sell interest, whose quantity is reflected in the UnpricedSellVolume. As Order D is the first market sell order, the UnpricedSellVolume is presently set to zero. At step 144, the process adds the quantity of incoming Order D (1500) to the UnpricedSellVolume (zero) to derive the updated UnpricedSellVolume = 1500 shares.

[0090] In step 148, the process inserts Order D in the auction order book, in time priority. The auction order book looks like this:

Bids	Offers
Order B: Buy 600 @ Market	Order D: Sell 1500 @ Market ←
Order C: Buy 400 @ Market	

[0091] In step 150, the process computes the Auction Imbalance by subtracting the UnpricedSellVolume (1500) from the UnpricedBuyVolume (1000) to derive an updated ImbalanceVolume = -500.

[0092] In step 152, the process then checks whether the computed ImbalanceVolume (-500) is greater than zero. As the ImbalanceVolume is not greater than zero (it is actually less than zero), the process continues to step 156, where it checks if it is less than zero. As the ImbalanceVolume is less than zero, the process continues to step 158, where it publishes the ImbalanceVolume and denotes it as an excess of interest on the sell side. In step 162, the process then returns, and continues to step 134 (Fig. 6), where the Indicative Match Volume routine 62 is invoked next.

[0093] In step 172, the invoked process checks whether the UnpricedBuyVolume is greater than zero. In this example, the UnpricedBuyVolume = 1000, so the process continues to step 174, where it checks whether the UnpricedSellVolume is also greater than zero. As the UnpricedSellVolume = 1500, orders can match in the upcoming unpriced order auction. To determine the quantity that can match in the unpriced order auction, the process continues to step 178, where it checks whether the UnpricedBuyVolume (1000) is greater than the UnpricedSellVolume (1500). As the UnpricedBuyVolume is lower, the process continues to step 182, where it sets the MatchVolume = 1000 shares, the value of the UnpricedBuyVolume. In step 184, the process publishes the MatchVolume to the marketplace. The advertised auction looks like this:

Symbol	Auction Imbalance	Indicative Match Volume	Match Price
XYZZ	- 500 *Sell*	1000	

Example 5: Market Buy Order Increases the Matched Volume and Creates a Buy Imbalance

[0094] During the designated Pre-Auction period, the posting market center 20 receives the following order in step 100:

→ Order E: Buy 2000 @ Market

[0095] In this example, Order E is processed initially like Orders B, C, and D, as it is a market order in the same issue. The process determines the issue is eligible to participate in the unpriced order auction, determines that the scheduled time has not commenced yet (steps 102, 104, 106, 120, 122, and 124), and proceeds to step 140, where the incoming market buy order is presented to the Auction Imbalance routine 60.

[0096] In step 142, the process determines that incoming Market Order E is a Buy Order. In step 146, the process adds the quantity of incoming Order E (2000) to the

UnpricedBuyVolume (1000) to derive the updated UnpricedBuyVolume = 3000 shares.

[0097] In step 148, the process inserts Order E in the auction order book, in time priority behind Orders B and C. The auction order book looks like this:

Bids	Offers
Order B: Buy 600 @ Market	Order D: Sell 1500 @ Market
Order C: Buy 400 @ Market	
Order E: Buy 2000 @ Market ←	

[0098] In step 150, the process computes the Auction Imbalance by subtracting the UnpricedSellVolume (1500) from the UnpricedBuyVolume (3000) to derive an updated ImbalanceVolume of +1500. In step 152, the process checks whether the computed ImbalanceVolume (+1500) is greater than zero. As the ImbalanceVolume is greater than zero, the process continues to step 154, where it publishes the ImbalanceVolume and denotes it as an excess of interest on the buy side. In step 162, the process then returns, and continues to step 134 (Fig. 6), where the Indicative Match Volume routine 62 is invoked next.

[0099] In step 172, the invoked process checks whether the UnpricedBuyVolume is greater than zero. In this example, the UnpricedBuyVolume = 3000, so the process continues to step 174, where it checks whether the UnpricedSellVolume is also greater than zero. As the UnpricedSellVolume = 1500, orders can match in the upcoming unpriced order auction. To determine the quantity that can match in the unpriced order auction, the process continues to step 178, where it checks whether the UnpricedBuyVolume (3000) is greater than the UnpricedSellVolume (1500). As the UnpricedBuyVolume is greater, the process continues to step 180, where it sets the MatchVolume = 1500 shares, the value of the UnpricedSellVolume. In step 184, the

process publishes the MatchVolume to the marketplace. The advertised auction looks like this:

Symbol	Auction Imbalance	Indicative Match Volume	Match Price
XYZZ	+ 1500 *Buy*	1500	

Example 6: Existing Market Sell Order Size is Decreased, Reducing the Matched Volume while Increasing the Buy Imbalance Volume

[00100] During the designated Pre-Auction period, the posting market center 20 receives the following request to change the size of Market Sell Order D:

→ Cancel/Replace Order D: Replace Sell 1500 @ Market with Sell 900 @ Market

[00101] In this example, a Cancel/Replace request is processed much like a new order in that the new order replaces an existing order. The process determines the issue is eligible to participate in the unpriced order auction, determines that the scheduled time has not commenced yet (steps 102, 104, 106, 120, 122, and 124), and proceeds to step 140. In step 142, the process determines that cancel/replaced Order D is a sell order, and therefore cancels the existing order quantity (1500 shares) and adds the revised order quantity (900 shares) to the aggregate sell interest, whose quantity is reflected in the UnpricedSellVolume. In step 144, the process computes the updated UnpricedSellVolume = 900 shares.

[00102] In step 148, the process cancel/replaces Order D in the auction order book. The auction order book looks like this:

Bids	Offers
Order B: Buy 600 @ Market	Order D: Sell **900** @ Market ←
Order C: Buy 400 @ Market	
Order E: Buy 2000 @ Market	

[00103] In step 150, the process computes the Auction Imbalance by subtracting the UnpricedSellVolume (900) from the UnpricedBuyVolume (3000) to derive an

updated ImbalanceVolume of +2100. In step 152, the process checks whether the computed ImbalanceVolume (+2100) is greater than zero. As the ImbalanceVolume is greater than zero, the process continues to step 154, where it publishes the ImbalanceVolume and denotes it as an excess of interest on the buy side. In step 162, the process then returns, and continues to step 134 (Fig. 6), where the Indicative Match Volume routine 62 is invoked next.

[00104] In step 172, the invoked process checks whether the UnpricedBuyVolume is greater than zero. In this example, the UnpricedBuyVolume = 3000, so the process continues to step 174, where it checks whether the UnpricedSellVolume is also greater than zero. As the UnpricedSellVolume = 900, orders can match in the upcoming unpriced order auction. To determine the quantity that can match in the unpriced order auction, the process continues to step 178, where it checks whether the UnpricedBuyVolume (3000) is greater than the UnpricedSellVolume (900). As the UnpricedBuyVolume is greater, the process continues to step 180, where it sets the MatchVolume = 900 shares, the UnpricedSellVolume. In step 184, the process publishes the MatchVolume to the marketplace. The advertised auction looks like this:

Symbol	Auction Imbalance	Indicative Match Volume	Match Price
XYZZ	+2100 *Buy*	900	

Example 7: Scheduled Auction Time Commences

[00105] Referring to Fig. 5, in step 122 the Continuous Unpriced Order Auction routine 56 determines that it is now time to execute the scheduled auction for this issue, and proceeds to step 126, where it initiates the procedures to execute the unpriced order auction.

[00106] Referring to Fig. 9, in step 192, the process checks if the UnpricedBuyVolume (3000) is greater than zero. As it is, the process continues to step 194, where it checks if the UnpricedSellVolume (900) is also greater than zero. As it is, in step 196, the process checks whether the UnpricedBuyVolume exceeds the UnpricedSellVolume. As the UnpricedBuyVolume (3000) is greater than the UnpricedSellVolume (900), in step 200 the process sets the computed MatchVolume = 900, the UnpricedSellVolume, as the lesser of the two quantities determines the size of the match.

[00107] In step 202, the process pairs the market buy orders with the market sell order in time priority. The auction order book presently looks like this:

Bids	Offers
Order B: Buy 600 @ Market	Order D: Sell 900 @ Market
Order C: Buy 400 @ Market	
Order E: Buy 2000 @ Market	

[00108] In this example, the orders are paired as follows:

- 600 shares of Buy Order B match 600 shares of Sell Order D, completely depleting Order B.
- 300 shares of Buy Order C match 300 shares of Sell Order D, completely depleting Order D.

Partially-matched Order C still has 100 shares remaining. Order E is unmatched. The auction order book now looks like this:

Bids	Offers
Order C: Buy **100** @ Market	
Order E: Buy 2000 @ Market	

The process adds the unmatched orders to the UnmatchedOrders data structure 29c.

[00109] In step 204, the process adds the paired orders to the MatchedOrders data structure 29d:

- Order B: 600 shares pending match with Order D

- Order D: 600 shares pending match with Order B
- Order C: 300 shares pending match with Order D
- Order D: 300 shares pending match with Order C

In step 206, the process invokes the NBBO Midpoint Pricing routine 66, as indicated.

Example 8: Crossed NBBO is Ineligible To Price the Auction

[00110] Referring to Fig. 10, in step 222, the process retrieves the first published NBBO quote after the scheduled auction time, i.e., after 09:30 am ET in this example. The following NBBO quote is retrieved:

→ Market Center A: Bid 500 @ 20.04 Market Center B: Offer 1100 @ 20.03

In step 224, the process checks whether the NBBO quote is crossed. As the NBBO is indeed crossed, i.e., the NBB ($20.04) is higher than the NBO ($20.03), the process continues to step 226, where it waits for the next published NBBO quote. The reason for this is because a crossed NBBO is not allowed to price the unpriced order auction according to the business rules of the posting market center 20.

Example 9: Locked NBBO is Ineligible To Price the Auction

[00111] In this example, the following NBBO quote is published next:

→ Market Center A: Bid 500 @ 20.04 Market Center B: Offer 600 @ 20.04

The process returns to step 224, where it checks whether the NBBO quote is crossed. As the quote is not crossed, it continues to step 228, where it checks whether the NBBO is locked. As the NBBO is indeed locked, i.e., the NBB ($20.04) is equal to the NBO ($20.04), the process proceeds to step 230, where it checks whether the business rules of the posting market center 20 permit a locked NBBO to price the unpriced order auction or not. Although in one embodiment of the invention, a locked NBBO is allowed to price the unpriced order auction (in which case, the process would continue to step 234, where it would set the AuctionPrice = $20.04, the locked

NBBO price), for purposes of illustration, in this example, a locked NBBO is not allowed to price the unpriced order auction. Therefore, the process continues instead to step 226, where it waits for the next published NBBO quote.

Example 10: Unpriced Order Auction is Priced at the Midpoint of the NBBO

[00112] In this example, the following NBBO quote is published next:

→ Market Center A: Bid 300 @ 20.04 Market Center B: Offer 700 @ 20.05

The process returns to step 224, where it checks if the NBBO is crossed. As the NBBO is not crossed, the process continues to step 228, where it checks if the NBBO is locked. As the NBBO is not locked, the process continues to step 232, where it calculates the midpoint of the NBBO. The midpoint of the NBB ($20.04) and the NBO ($20.05) is computed as $20.045. As previously explained, although this issue does not trade in subpennies, and limit orders to buy or sell at $20.045 would therefore be rejected as invalid by the order matching engine 21, this subpenny price is valid in this implementation of the invention because it represents the true computed midpoint price. In step 236, the process sets the AuctionPrice = 20.045, and in step 238, it returns to where it was invoked, in step 206 (Fig. 9).

[00113] The process continues to step 208, where it assigns the computed AuctionPrice as the trade price for the paired orders on the MatchedOrders data structure 29d:

- Order B: Execute 600 shares @ 20.045 with Order D
- Order D: Execute 600 shares @ 20.045 with Order B
- Order C: Execute 300 shares @ 20.045 with Order D
- Order D: Execute 300 shares @ 20.045 with Order C

In step 210, the process executes the trades and reports them to the Tape. As this example is an opening auction, the execution reports include the relevant identifier for opening trades.

- 600 @ 20.045, *opening trade*
- 300 @ 20.045, *opening trade*
-

[00114] The process also publishes the auction price and volume to the marketplace:

Symbol	Auction Imbalance	Matched Volume	Match Price
XYZZ		900	20.045

Example 11: Unexecuted Market Orders are Released for Trading in the Marketplace

[00115] Continuing to step 212, the process checks whether there are any unmatched market orders in the UnmatchedOrders data structure 29c, which presently looks like this:

Bids	Offers
Order C: Buy 100 @ Market	
Order E: Buy 2000 @ Market	

As unmatched market orders are remaining after the completion of the unpriced order auction, the process releases the orders to the continuous matching engine 52 for further execution opportunities in step 214:

→ Order C: Buy 100 @ Market

→ Order E: Buy 2000 @ Market

Having released the orders, the process stops as shown in step 216. The unpriced order auction process has concluded.

Example 12: Unexecuted Market Orders Trade in the Marketplace

[00116] Throughout the entire Pre-Auction period, the continuous matching engine 52 has maintained a separate order book 29a. In this example, for purposes of illustration, an internal book is shown with limit orders resident on the posting market center 20, as well as the Best Bid and Offer from each market center on data structure 25, Market Center A ("Away Market A") 24a and Market Center B ("Away Market B") 24b.

→ The NBBO is 20.04 to 20.05 (300 x 900).

→

[00117] The internal book looks like this:

Bids		Offers	
Away Market A:	Buy 300 @ 20.04	Order 456:	Sell 200 @ 20.05
Order 123:	Buy 200 @ 20.02	Away Market B:	Offer 700 @ 20.05
Away Market B:	Buy 600 @ 20.01	Order 789:	Sell 1400 @ 20.07
		Away Market A:	Offer 2200 @ 20.08

[00118] The continuous matching engine 52 processes the released market orders as if they were newly received on the posting market center 20. The market buy orders are no longer eligible to match at the midpoint of the NBBO, they must now execute at the NBO price instead. The continuous matching engine 52 matches 100 shares of Market Buy Order C with 100 shares of posted Sell Order 456 at the Sell Order's price of $20.05, completely depleting Market Buy Order C.

[00119] The internal Book now looks like this:

Bids		Offers	
Away Market A:	Buy 300 @ 20.04	Order 456: ←	Sell **100** @ 20.05
Order 123:	Buy 200 @ 20.02	Away Market B:	Offer 700 @ 20.05
Away Market B:	Buy 600 @ 20.01	Order 789:	Sell 1400 @ 20.07
		Away Market A:	Offer 2200 @ 20.08

[00120] The process then matches 100 shares of Market Buy Order E with the remaining 100 shares of Sell Order 456 at the Sell Order's price of $20.05, completely

depleting Sell Order 456 and removing it from the internal book. Market Buy Order E still has 1900 shares remaining. The continuous matching engine 52 then routes 700 shares of Market Buy Order E to Away Market B at its Offer price of $20.05.

[00121] The NBBO is now 20.04 to 20.05 (300 x 700), as Away Market B has not moved its offer yet. The internal book looks like this:

Bids		Offers	
Away Market A:	Buy 300 @ 20.04	Away Market B:	Offer 700 @ 20.05
Order 123:	Buy 200 @ 20.02	Order 789:	Sell 1400 @ 20.07
Away Market B:	Buy 600 @ 20.01	Away Market A:	Offer 2200 @ 20.08

[00122] Market Buy Order E still has 1200 shares available to trade. As market buy orders can only execute at the NBO and Sell Order 789 ($20.07) is inferior to the NBO ($20.05), the remaining shares of Market Buy Order E are momentarily queued until the NBO changes. This momentary queuing is illustrated below by displaying Order E in reverse text. Order E is shown included in the internal book because if an incoming marketable sell order (i.e., priced at $20.05 or lower) were to be received while Market Buy Order E is queued, the orders would match.

[00123] The internal book momentarily looks like this:

Bids		Offers	
Order E: ←	Buy 1200 @ Market	Away Market B:	Offer 700 @ 20.05
Away Market A:	Buy 300 @ 20.04	Order 789:	Sell 1400 @ 20.07
Order 123:	Buy 200 @ 20.02	Away Market A:	Offer 2200 @ 20.08
Away Market B:	Buy 600 @ 20.01		

[00124] Away Market B fills the 700 shares routed to it and moves its Offer to $20.07. The NBO is now 2100 @ 20.07. The internal book momentarily looks like this:

Bids		Offers	
Order E:	Buy 1200 @ Market	Order 789:	Sell 1400 @ 20.07
Away Market A:	Buy 300 @ 20.04	Away Market B: ←	Offer 700 @ 20.07
Order 123:	Buy 200 @ 20.02	Away Market A:	Offer 2200 @ 20.08
Away Market B:	Buy 600 @ 20.01		

[00125] The continuous matching engine 52 matches the remaining shares of Market Buy Order E with 1200 shares of Sell Order 789 at the Sell Order's price of $20.07. Market Buy Order E is completely depleted. Sell Order 789 still has 200 shares remaining.

[00126] The NBBO is now 20.04 to 20.07 (300 x 900). The internal book looks like this:

Bids		Offers	
Away Market A:	Buy 300 @ 20.04	Order 789: ←	Sell **200** @ 20.07
Order 123:	Buy 200 @ 20.02	Away Market B:	Offer 700 @ 20.07
Away Market B:	Buy 600 @ 20.01	Away Market A:	Offer 2200 @ 20.08

Example 13: Market Orders Await a Scheduled Unpriced Order Auction on an Equity Options Marketplace

[00127] In this embodiment of the invention, market orders received for equity option issues on the posting market center 20 during a designated Pre-Auction period are processed in the same manner as for equity security issues. As described in the preceding examples, market orders eligible to participate in the upcoming unpriced order auction are queued in the auction order book 29b, and the Auction Imbalance Volume and Indicative Match Volume are advertised to the marketplace. Meanwhile, limit orders are processed separately but concurrently in the continuous matching engine 52, which has its own separate book 29a. As the processing is the same for equity securities and equity options throughout the Pre-Auction period, this example

illustrating the unpriced order auction process 50 for an equity option issue starts with an auction order book 29b that already includes four market orders.

[00128] The auction order book presently looks like this:

Bids	Offers
Order F: Buy 60 @ Market	Order H: Sell 90 @ Market
Order G: Buy 40 @ Market	
Order I: Buy 200 @ Market	

[00129] In this example, the UnpricedBuyVolume = 300 contracts (60 + 40 + 200). The UnpricedSellVolume = 90 contracts. The ImbalanceVolume = 210 contracts (300 Buy contracts less 90 Sell contracts) and reflects a Buy Imbalance. The MatchVolume = 90 contracts. The advertised auction looks like this:

Symbol	Auction Imbalance	Indicative Match Volume	Match Price
XYZUH	+210 *Buy*	90	

Example 14: Market Orders Match in the Unpriced Order Auction

[00130] At the scheduled auction time, the unpriced order auction process pairs the queued market orders as follows:

- 60 contracts of Buy Order F match 60 contracts of Sell Order H, completely depleting Buy Order F.
- 30 contracts of Buy Order G match 30 contracts of Sell Order H, completely depleting Sell Order H.

Partially-matched Order G still has 10 contracts remaining. Order I is unmatched. The auction order book now looks like this:

Bids	Offers
Order G: Buy 10 @ Market	
Order I: Buy 200 @ Market	

The process adds the unmatched orders to the UnmatchedOrders data structure29c.

[00131] In step 204, the process adds the paired orders to the MatchedOrders data structure 29d:

- Order F: 60 contracts pending match with Order H
- Order H: 60 contracts pending match with Order F
- Order G: 30 contracts pending match with Order H
- Order H: 30 contracts pending match with Order G

In step 206, the process continues to the NBBO Midpoint Pricing Process, as indicated.

Example 15: Unpriced Order Auction is Priced at the Midpoint of the NBBO

[00132] Referring to Fig. 10, in step 222, the process retrieves the first published NBBO quote after the scheduled auction time, e.g., after 09:30 am ET. In this example, the underlying stock is listed on a market center that is already open for trading. The following NBBO quote is retrieved:

→ Market Center A: Bid 30 @ 2.00 Market Center B: Offer 70 @ 2.05

[00133] The process continues to step 224, where it checks if the NBBO is crossed. As the NBBO is not crossed, the process continues to step 228, where it checks if the NBBO is locked. As the NBBO is not locked, the process continues to step 232, where it calculates the midpoint of the NBBO. The midpoint of the NBB ($2.00) and the NBO ($2.05) is computed as $2.025. Although this issue currently trades in increments of $.05, and limit buy orders or sell orders priced at $2.025 would be rejected as invalid by the order matching engine 21, this computed price is valid in this implementation of the invention because it represents the true computed midpoint price. In step 236, the process sets the AuctionPrice = $2.025, and in step 238, it returns to where it was invoked, in step 206 (Fig. 9).

[00134] The process continues to step 208, where it assigns the computed AuctionPrice as the trade price for the paired orders on the MatchedOrders data structure 29d:

- Order F: Execute 60 contracts @ 2.025 with Order H
- Order H: Execute 60 contracts @ 2.025 with Order F
- Order G: Execute 30 contracts @ 2.025 with Order H
- Order H: Execute 30 contracts @ 2.025 with Order G

[00135] In step 210, the process executes the trades and reports them to the Tape. As this example is an opening auction, the execution reports include the relevant identifier for opening trades:

- 60 @ 2.025, *opening trade*
- 30 @ 2.025, *opening trade*

The process also publishes the auction price and volume to the marketplace:

Symbol	Auction Imbalance	Matched Volume	Match Price
XYZUH		90	2.025

Example 16: Unexecuted Market Orders are Released for Trading in the Marketplace

[00136] Continuing to step 212, the process checks whether there are any unmatched market orders in the UnmatchedOrders data structure 29c, which presently looks like this:

Bids	Offers
Order G: Buy 10 @ Market	
Order I: Buy 200 @ Market	

[00137] As unmatched market orders remain after the completion of the unpriced order auction, the process releases the orders to the continuous matching engine 52 for further execution opportunities in step 214:

→ Order G: Buy 10 @ Market

→ Order I: Buy 200 @ Market

Having released the orders, the process stops as shown in step 216. The unpriced order auction process has terminated.

Example 17: Unexecuted Market Orders Trade in the Marketplace

[00138] Throughout the entire Pre-Auction period, the continuous matching engine 52 has maintained a separate order book. In this example, for purposes of illustration, an internal order book 29a is shown with limit orders resident on the posting market center 20. Also for purposes of illustration, a combined Quote Book is shown that includes Market Maker Quotes 33 published by Market Makers 31 assigned to make markets in this issue on the posting market center 20, as well as the Best Bids and Offers on data structure 25 published by the away market centers 24. In this example, the issue has an assigned Lead Market Maker LMM. According to the business rules of the posting market center 20, when the LMM is quoting at the NBBO, an incoming order may be eligible to be processed in the Lead Market Maker Guarantee Process, a set of procedures that are part of the continuous matching engine 52 in this example.

[00139] The NBBO is 2.00 to 2.05 (30 x 170) when the unmatched market orders 29c are released to the continuous matching engine 52. The order book looks like this:

Bids		Offers	
Order 012:	Buy 20 @ 1.95	Order 345:	Sell 10 @ 2.05
Order 678:	Buy 10 @ 1.90	Order 910:	Sell 20 @ 2.10

[00140] The combined Quote Book looks like this:

Bids		Offers	
Away Market A:	Bid 30 @ 2.00	LMM:	Offer 70 @ 2.05
LMM:	Bid 40 @ 1.95	Away Market B:	Offer 90 @ 2.05
Away Market B:	Bid 10 @ 1.95	Away Market A:	Offer 50 @ 2.10

[00141] The continuous matching engine 52 processes the released market buy orders as if they were newly received on the posting market center 20. The market buy orders are no longer eligible to match at the midpoint of the NBBO, they must now execute at the NBO instead. The continuous matching engine 52 must determine the best sell interest in the marketplace. In this example, Order 345 is a Customer Order that has time priority over the LMM Offer at the same price, $2.05. Order 345 is therefore entitled to trade ahead of the LMM quote, as both are priced at the NBO. The continuous matching engine 52 matches the 10 contracts of Market Buy Order G with Sell Order 345, completely depleting both orders.

[00142] The order book now looks like this with Order 345 removed:

Bids		Offers	
Order 012:	Buy 20 @ 1.95	Order 910:	Sell 20 @ 2.10 ←
Order 678:	Buy 10 @ 1.90		

[00143] The combined Quote Book remains unchanged.

[00144] The continuous matching engine 52 executes Market Buy Order I next. It determines that the LMM quote is at the NBO, and that no other Book orders have price/time priority. It automatically generates an order to Sell 70 at $2.05 on behalf of the LMM quote and matches 70 contracts of Market Buy Order I against the generated Sell Order. As Market Buy Order I still has 130 contracts available after the match and Away Market B is also quoting at the NBO, the process routes 90 contracts to Away Market B at the price of $2.05.

[00145] LMM moves its Offer to $2.10. The combined Quote Book now looks like this (Away Market B has not moved its quote yet):

Bids		Offers	
Away Market A:	Bid 30 @ 2.00	Away Market B:	Offer 90 @ 2.05
LMM:	Bid 40 @ 1.95	LMM:	Offer 70 @ **2.10** ←
Away Market B:	Bid 10 @ 1.95	Away Market A:	Offer 50 @ 2.10

→ The NBBO is now 2.00 to 2.05 (30 x 90).

[00146] Market Buy Order I still has 40 contracts available to trade. As market buy orders can only execute at the NBO and Sell Order 910 ($2.10) and the LMM Offer ($2.10) are inferior to the NBO ($2.05), the remaining contracts of Market Buy Order I are momentarily queued until the NBO changes. This momentary queuing is illustrated below by displaying Order I in reverse text. Order I is shown included in the order book because if an incoming marketable Sell Order (i.e., priced at $2.05 or lower) were to be received while Order I is queued, the orders would match.

[00147] The order book momentarily looks like this:

Bids		Offers	
Order I:	Buy 40 @ Market ←	Order 910:	Sell 20 @ 2.10
Order 012:	Buy 20 @ 1.95		
Order 678:	Buy 10 @ 1.90		

[00148] Away Market B fills the 90 contracts routed to it, and moves its Offer to $2.10. The NBBO is now 2.00 to 2.10 (30 x 230).

[00149] The combined Quote Book looks like this:

Bids		Offers	
Away Market A:	Bid 30 @ 2.00	LMM:	Offer 70 @ 2.10
LMM:	Bid 40 @ 1.95	Away Market A:	Offer 50 @ 2.10
Away Market B:	Bid 10 @ 1.95	Away Market B:	Offer 90 @ **2.10** ←

[00150] As Order 910 is at the NBO and has time priority over the LMM quote, the continuous matching engine 52 matches 20 contracts of Market Buy Order I with Sell Order 910, completely depleting Sell Order 910 and removing it from the order book.

[00151] The order book momentarily looks like this:

Bids		Offers
Order I:	Buy **20** @ Market ←	
Order 012:	Buy 20 @ 1.95	
Order 678:	Buy 10 @ 1.90	

[00152] As Market Buy Order I still has 20 contracts available to trade and the LMM Offer is at the NBO, the continuous matching engine 52 automatically generates an order to Sell 20 at $2.10 on behalf of the LMM quote, and matches Market Buy Order I with the generated Sell Order. Market Buy Order I is completely matched. The LMM Offer still has 50 contracts available.

[00153] The order book looks like this:

Bids		Offers
Order 012:	Buy 20 @ 1.95	
Order 678:	Buy 10 @ 1.90	

[00154] The combined Quote Book looks like this:

Bids		Offers	
Away Market A:	Bid 30 @ 2.00	LMM:	Offer **50** @ 2.10 ←
LMM:	Bid 40 @ 1.95	Away Market A:	Offer 50 @ 2.10
Away Market B:	Bid 10 @ 1.95	Away Market B:	Offer 90 @ 2.10

[00155] While the invention has been discussed in terms of certain embodiments, it should be appreciated that the invention is not so limited. The embodiments are explained herein by way of example, and there are numerous modifications, variations and other embodiments that may be employed that would still be within the scope of the present invention.

CLAIMS

What is claimed is:

1. A method for crossing unpriced orders in a single-price auction in an issue on a posting market center, comprising:

providing a posting market center with an unpriced order book;

specifying a time at which a scheduled auction is to execute;

receiving unpriced buy and sell orders prior to the scheduled auction time and storing the received unpriced orders in the unpriced order book;

at the scheduled auction time, matching as many buy orders to sell orders as possible;

retrieving an indicator external to the posting market center to establish the best prices in the entire marketplace;

deriving a single auction price from the retrieved external indicator; and

executing trades in the issue between the matched buy and sell orders at the derived auction price.

2. The method of claim 1, wherein the retrieved external indicator is a national best bid and offer quote.

3. The method of claim 2, wherein the single auction price is derived by computing the midpoint of the retrieved national best bid and offer quote.

4. The method of claim 1, wherein the posting market center further includes a continuous matching process and wherein orders that are not matched during the

unpriced order auction process are released to the continuous matching process for execution.

5. The method of claim 4, wherein the continuing matching process operates concurrently with the unpriced order auction process.

6. The method of claim 1, wherein each buy order and each sell order specify a quantity of shares or contracts to be traded and further comprising adding the specified quantity of shares or contracts for each received unpriced buy order together to determine an aggregate buy volume and adding the specified quantity of shares or contracts for each received unpriced sell order together to determine an aggregate sell volume.

7. The method of claim 6, wherein, prior to matching as many buy orders to sell orders as possible, determining a maximum matchable quantity, which is the lesser of the aggregate buy volume and the aggregate sell volume; and

matching the received unpriced orders up to the determined maximum matchable quantity.

8. The method of claim 6, further comprising specifying a pre-auction period during which unpriced orders may be sent to the posting market center for possible inclusion in the unpriced order auction prior to the scheduled auction time.

9. The method of claim 8, further comprising evaluating unpriced orders received by the posting market center during the specified pre-auction period to determine if the received orders are eligible to participate in the scheduled auction;

wherein if a received unpriced order is eligible for participation in the auction, queuing the unpriced order on the posting market center in the unpriced order book; and

wherein if an issue has at least one queued unpriced order, subtracting the aggregate sell volume from the aggregate buy volume to compute an excess volume as an auction imbalance and publishing the computed auction imbalance to the marketplace.

10. The method of claim 9, wherein an excess of aggregate buy volume over aggregate sell volume constitutes a buy imbalance.

11. The method of claim 9, wherein an excess of aggregate sell volume over aggregate buy volume constitutes a sell imbalance.

12. The method of claim 9, wherein if an issue has at least one queued unpriced order, determining if unpriced orders exist on both sides of the unpriced order book; and

wherein if orders exist on both sides of the unpriced order book, determining the lesser of the aggregate buy volume and the aggregate sell volume as an indicative match volume and publishing the indicative match volume to the marketplace.

13. The method of claim 12, wherein unpriced orders eligible to participate in the scheduled auction are queued in the unpriced order book according to time priority;

wherein unpriced orders may be sent to the posting market center up until the scheduled auction time;

wherein unpriced orders queued in the unpriced order book may be canceled and modified up until the scheduled auction time;

wherein if any unpriced orders are canceled or modified, recalculating the indicative match volume and the auction imbalance; and

disseminating the updated indicative match volume and the auction imbalance to the marketplace.

14. The method of claim 9, wherein if an unpriced order is received for an issue that is not eligible to participate in the scheduled auction and wherein the issue is listed on a primary listing market center and wherein the primary listing market center is open for trading and the posting market center has a continuous matching process, releasing the received unpriced order to the continuous matching process.

15. The method of claim 9, wherein if an unpriced order is received for an issue that is not eligible to participate in the scheduled auction and wherein the issue is listed on a primary listing market center and wherein the primary listing market center is not yet open for trading, immediately routing the received unpriced order to the primary listing market center.

16. A method for crossing unpriced orders in a single-price auction for an issue on a posting market center, comprising:

providing a posting market center with an unpriced order book;

specifying a time at which a scheduled auction is to execute;

receiving unpriced buy and sell orders prior to the scheduled auction time and storing the received unpriced orders in the unpriced order book, wherein each buy order and each sell order specify a quantity of shares or contracts to be traded;

adding the specified quantity of shares or contracts for each received unpriced buy order together to determine an aggregate buy volume and adding the specified quantity of shares or contracts for each received unpriced sell order together to determine an aggregate sell volume;

determining a maximum matchable quantity, which is the lesser of the aggregate buy volume and the aggregate sell volume;

at the scheduled auction time, matching the received unpriced orders up to the determined maximum matchable quantity;

retrieving a first eligible national best bid and offer quote to establish the best prices in the entire marketplace;

deriving a single auction price from the retrieved national best bid and offer quote by computing the midpoint of the national best bid and offer quote; and

executing trades in the issue between the matched buy and sell orders at the derived auction price.

17. The method of claim 16, wherein the issue being auctioned has a primary listing market center and wherein if the primary listing market center for the issue being auctioned is open for trading, the first eligible national best bid and offer quote retrieved is the first quote published after the scheduled auction time.

18. The method of claim 16, wherein the issue being auctioned has a primary listing market center and wherein if the primary listing market center for the issue being auctioned is not yet open for trading, waiting a specified amount of time for the first national best bid and offer quote to be published; and

wherein, if the first national best bid and offer quote is not published within the specified amount of time, canceling the auction.

19. The method of claim 16, wherein if the evaluated national best bid and offer quote is crossed, discarding the crossed national best bid and offer quote; and

evaluating the next national best bid and quote.

20. The method of claim 16, wherein if the evaluated national best bid and offer quote is locked, setting the derived single auction price as the lock price of the national best bid and offer quote.

21. The method of claim 16, wherein if the evaluated national best bid and offer quote is locked, discarding the locked national best bid and offer quote; and

evaluating the next national best bid and quote.

22. The method of claim 16, wherein if the posting market center has market makers assigned to the issue in the auction and the market makers publish quotes in the issue, excluding the quotes published by the market makers from the scheduled auction.

23. The method of claim 16, wherein if the posting market center has market makers assigned to the issue in the auction and the market makers publish quotes in the issue, making unpriced orders that do not execute in the scheduled auction eligible for execution against contra-side market maker quotes.

24. A posting market center with the ability to cross unpriced orders in a single-price auction in an issue, comprising:

an unpriced order book;

an interface for receiving orders;

a posting market center memory for storing code for analyzing and processing orders and storing a parameter that specifies a time at which a scheduled auction is to execute;

a processor for interacting with the interface and executing the code for conducting an unpriced order auction, wherein the code, when executed:

receives unpriced buy and sell orders prior to the scheduled auction time and stores the received unpriced orders in the unpriced order book, wherein each buy order and each sell order specify a quantity of shares or contracts to be traded;

adds the specified quantity of shares or contracts for each received unpriced buy order together to determine an aggregate buy volume and adds the specified quantity of shares or contracts for each received unpriced sell order together to determine an aggregate sell volume;

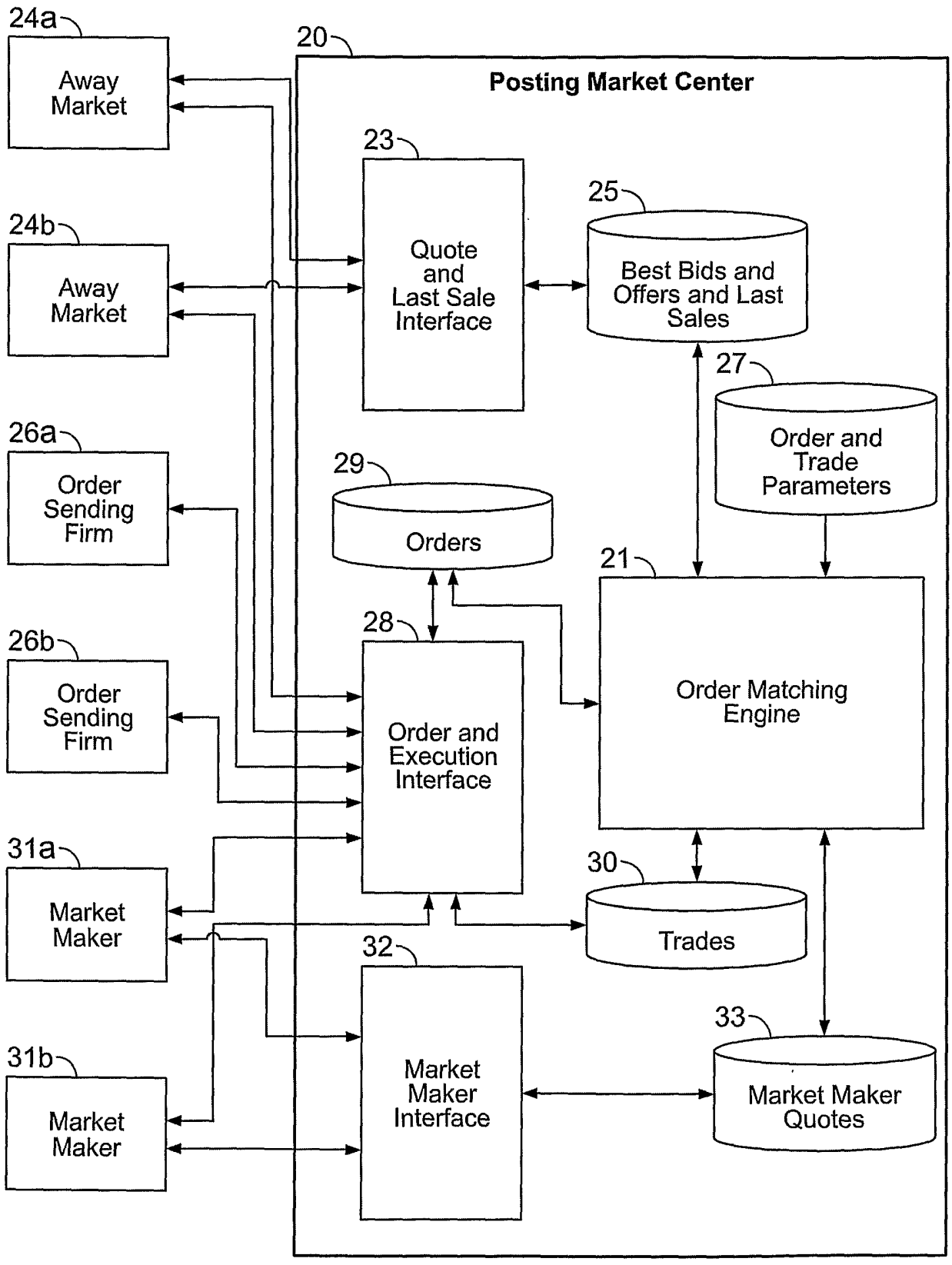
determines a maximum matchable quantity, which is the lesser of the aggregate buy volume and the aggregate sell volume;

at the scheduled auction time, matches the received unpriced orders up to the determined maximum matchable quantity;

retrieves a first eligible national best bid and offer quote to establish the best prices in the entire marketplace;

derives a single auction price from the retrieved national best bid and offer quote by computing the midpoint of the national best bid and offer quote; and

executes trades in the issue between the matched buy and sell orders at the derived auction price.


24a
Away Market
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Posting Market Center
23
Quote and Last Sale Interface
25
Best Bids and Offers and Last Sales
24b
Away Market
27
Order and Trade Parameters
26a
Order Sending Firm
29
Orders
21
Order Matching Engine
28
Order and Execution Interface
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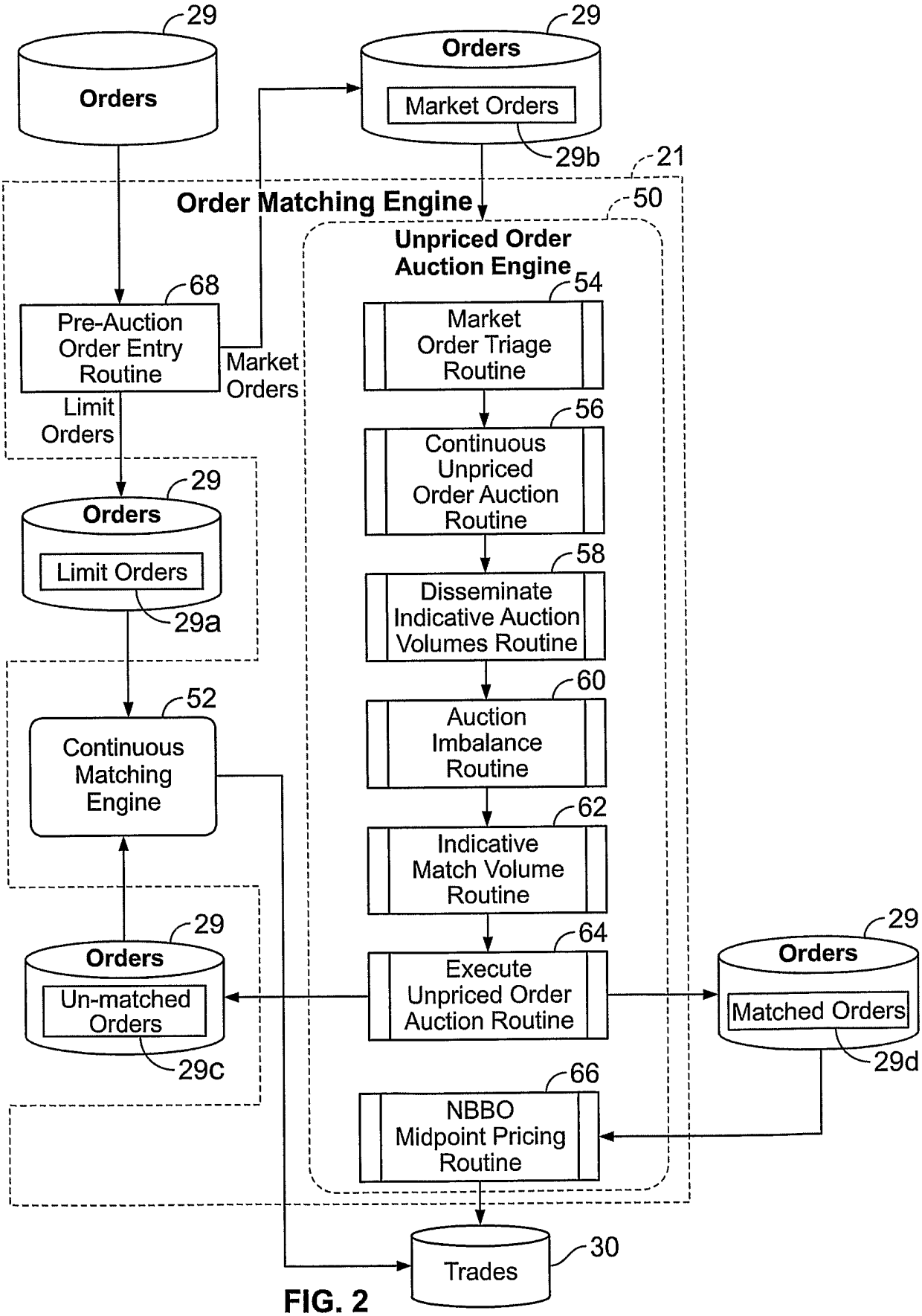
Market Maker
30
Trades
32
Market Maker Interface
33
Market Maker Quotes
31b
Market Maker

FIG. 1


29
Orders
29
Orders
Market Orders
29b
21
Order Matching Engine
50
Unpriced Order Auction Engine
68
Pre-Auction Order Entry Routine
Market Orders
Limit Orders
54
Market Order Triage Routine
56
Continuous Unpriced Order Auction Routine
58
Disseminate Indicative Auction Volumes Routine
60
Auction Imbalance Routine
62
Indicative Match Volume Routine
64
Execute Unpriced Order Auction Routine
66
NBBO Midpoint Pricing Routine
29
Orders
Limit Orders
29a
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Continuous Matching Engine
29
Orders
Un-matched Orders
29c
29
Orders
Matched Orders
29d
Trades
30

FIG. 2

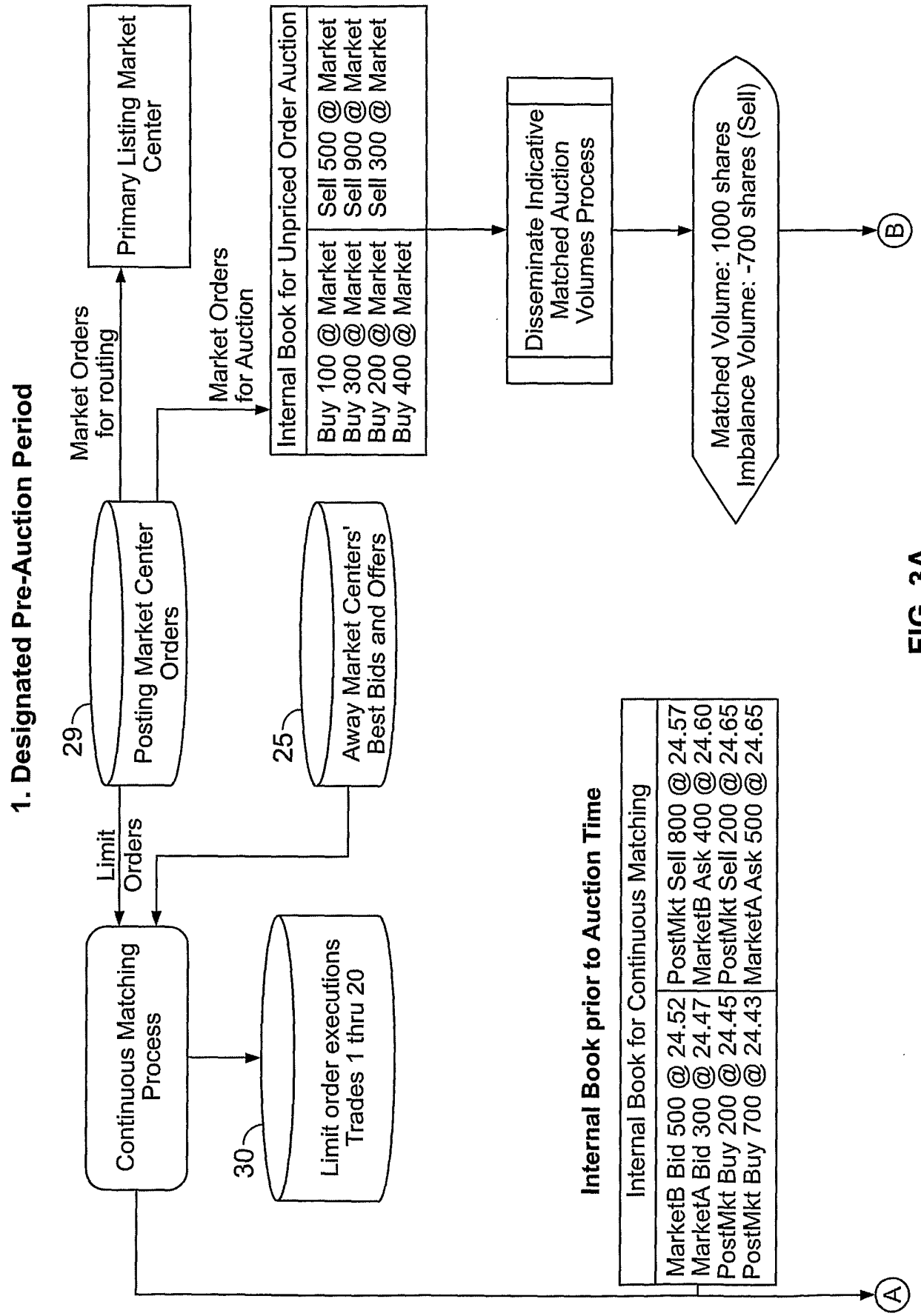
1. Designated Pre-Auction Period
Primary Listing Market Center
Market Orders for routing
Market Orders for Auction
Internal Book for Unpriced Order Auction
Buy 100 @ Market
Buy 300 @ Market
Buy 200 @ Market
Buy 400 @ Market
Sell 500 @ Market
Sell 900 @ Market
Sell 300 @ Market
Disseminate Indicative Matched Auction Volumes Process
Matched Volume: 1000 shares
Imbalance Volume: -700 shares (Sell)
B
29
Posting Market Center Orders
25
Away Market Centers' Best Bids and Offers
Limit Orders
Continuous Matching Process
30
Limit order executions Trades 1 thru 20
Internal Book prior to Auction Time
Internal Book for Continuous Matching
MarketB Bid 500 @ 24.52
MarketA Bid 300 @ 24.47
PostMkt Buy 200 @ 24.45
PostMkt Buy 700 @ 24.43
PostMkt Sell 800 @ 24.57
MarketB Ask 400 @ 24.60
PostMkt Sell 200 @ 24.65
MarketA Ask 500 @ 24.65
A

FIG. 3A

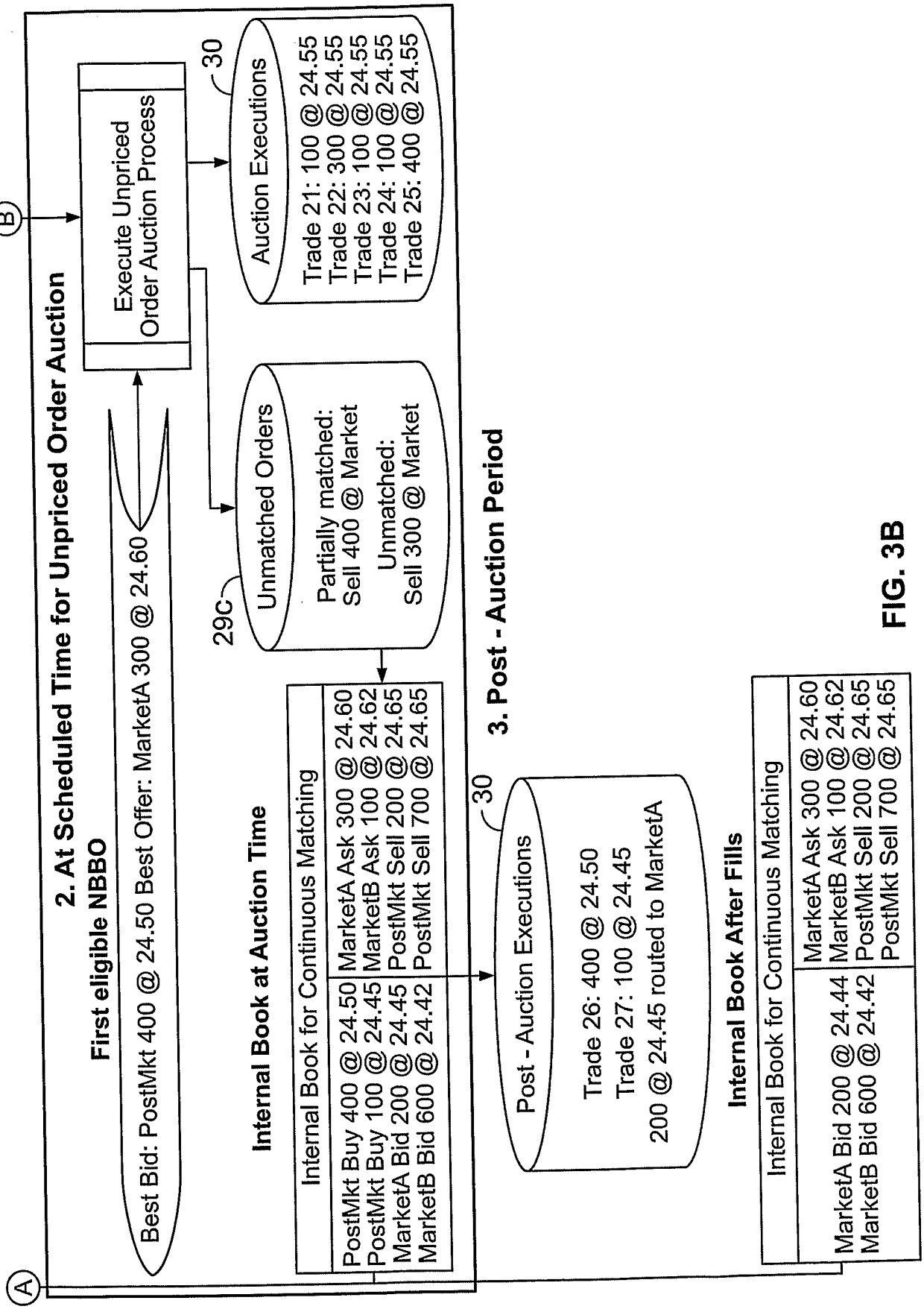
A
B
2. At Scheduled Time for Unpriced Order Auction
First eligible NBBO
Best Bid: PostMkt 400 @ 24.50 Best Offer: MarketA 300 @ 24.60
Execute Unpriced Order Auction Process
30
Auction Executions
Trade 21: 100 @ 24.55
Trade 22: 300 @ 24.55
Trade 23: 100 @ 24.55
Trade 24: 100 @ 24.55
Trade 25: 400 @ 24.55
29c
Unmatched Orders
Partially matched:
Sell 400 @ Market
Unmatched:
Sell 300 @ Market
Internal Book at Auction Time
Internal Book for Continuous Matching
PostMkt Buy 400 @ 24.50
PostMkt Buy 100 @ 24.45
MarketA Bid 200 @ 24.45
MarketB Bid 600 @ 24.42
MarketA Ask 300 @ 24.60
MarketB Ask 100 @ 24.62
PostMkt Sell 200 @ 24.65
PostMkt Sell 700 @ 24.65
3. Post - Auction Period
30
Post - Auction Executions
Trade 26: 400 @ 24.50
Trade 27: 100 @ 24.45
200 @ 24.45 routed to MarketA
Internal Book After Fills
Internal Book for Continuous Matching
MarketA Bid 200 @ 24.44
MarketB Bid 600 @ 24.42
MarketA Ask 300 @ 24.60
MarketB Ask 100 @ 24.62
PostMkt Sell 200 @ 24.65
PostMkt Sell 700 @ 24.65

FIG. 3B

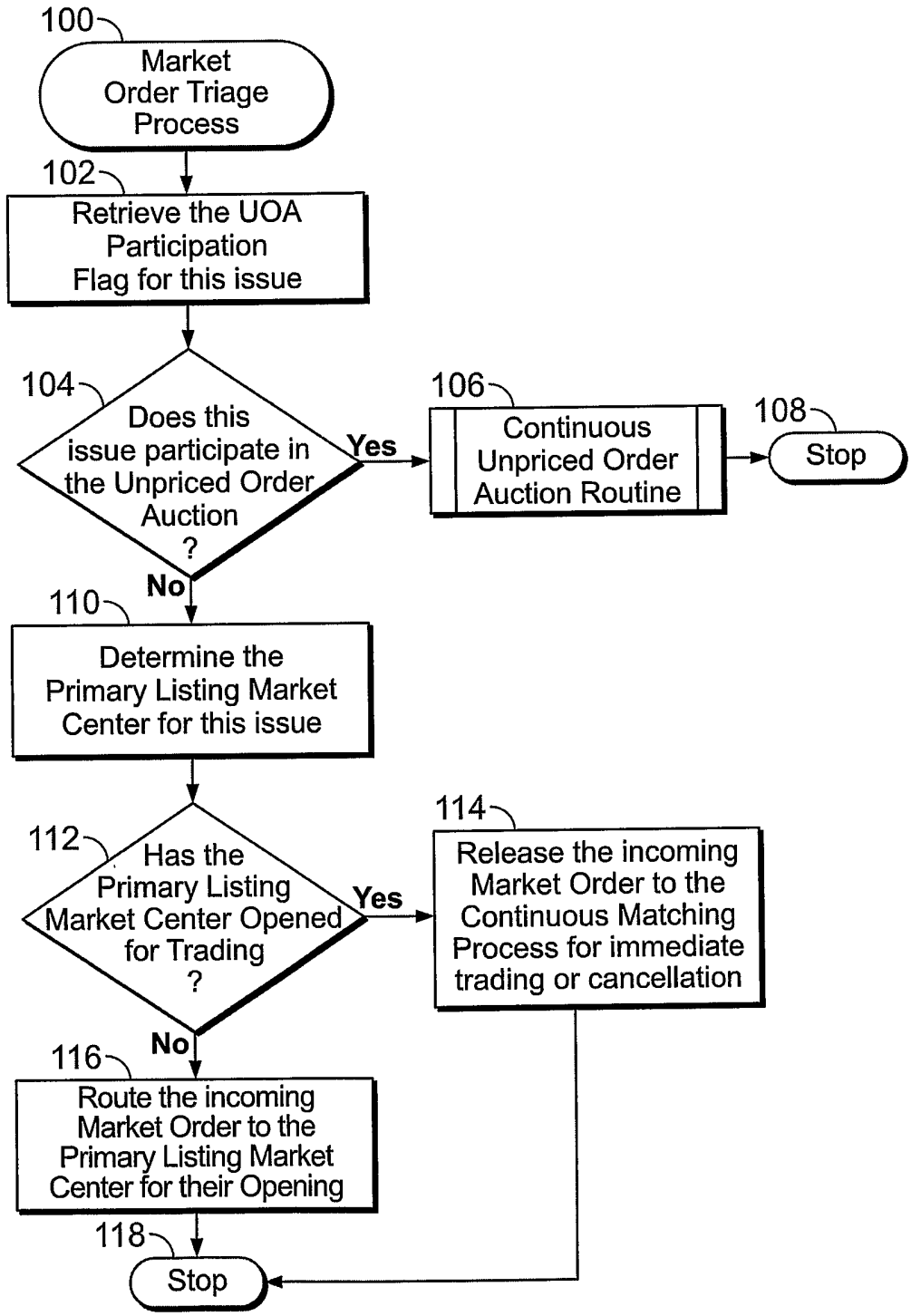
100
Market Order Triage Process
102
Retrieve the UOA Participation Flag for this issue
104
Does this issue participate in the Unpriced Order Auction ?
Yes
106
Continuous Unpriced Order Auction Routine
108
Stop
No
110
Determine the Primary Listing Market Center for this issue
112
Has the Primary Listing Market Center Opened for Trading ?
Yes
114
Release the incoming Market Order to the Continuous Matching Process for immediate trading or cancellation
No
116
Route the incoming Market Order to the Primary Listing Market Center for their Opening
118
Stop

FIG. 4

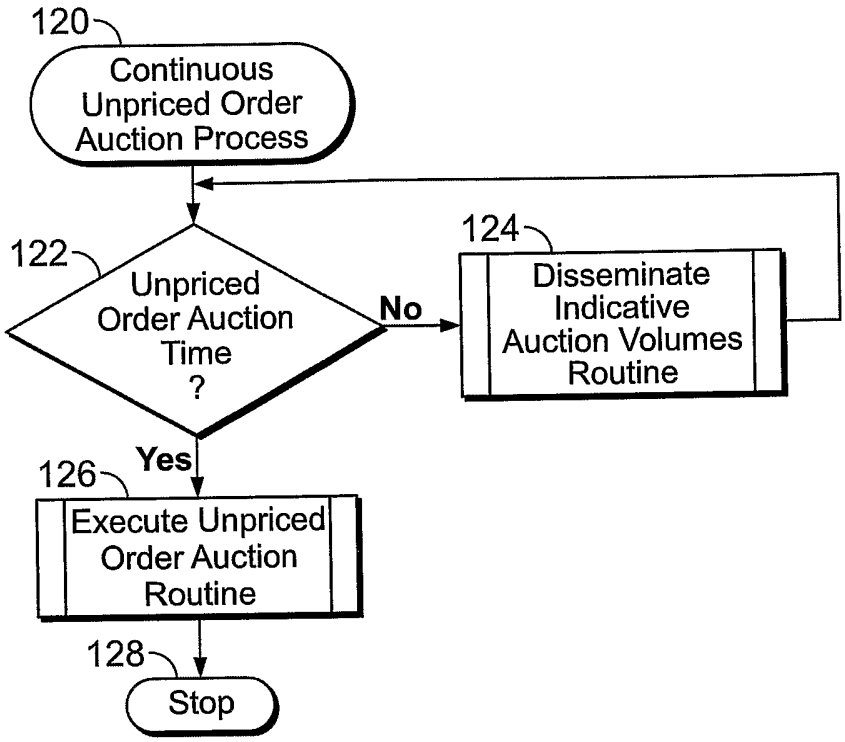
120
Continuous Unpriced Order Auction Process
122
Unpriced Order Auction Time ?
No
124
Disseminate Indicative Auction Volumes Routine
Yes
126
Execute Unpriced Order Auction Routine
128
Stop

FIG. 5

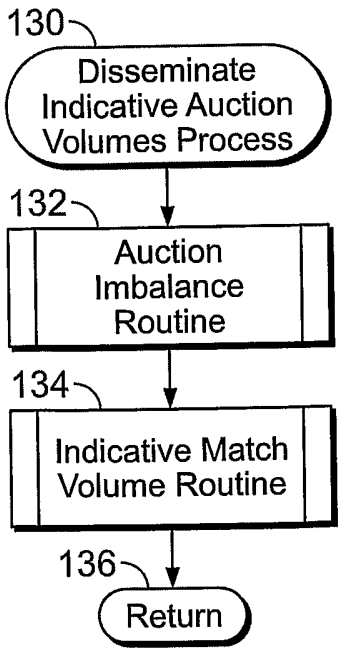
130
Disseminate Indicative Auction Volumes Process
132
Auction Imbalance Routine
134
Indicative Match Volume Routine
136
Return

FIG. 6

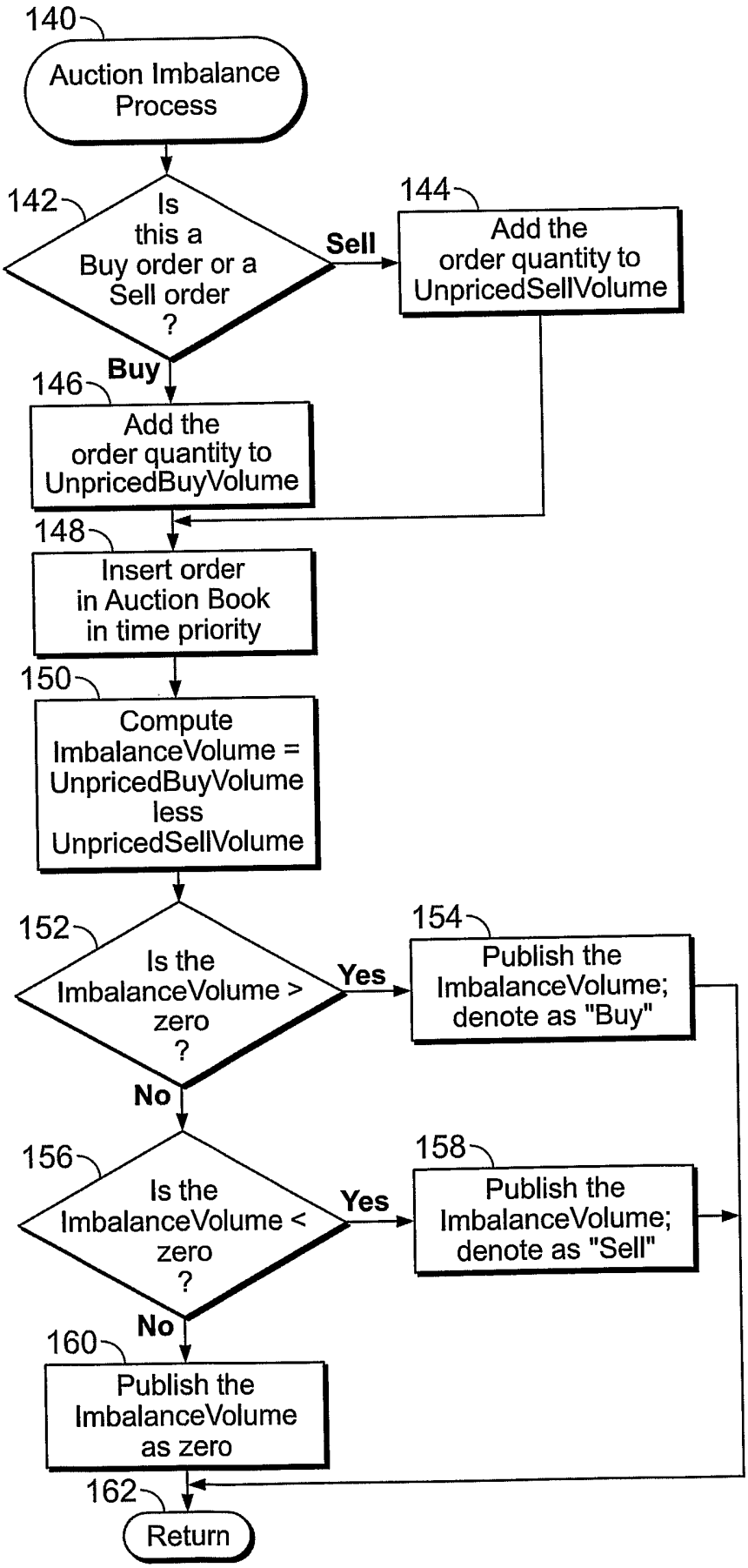
140
Auction Imbalance Process
142
Is this a Buy order or a Sell order ?
Sell
144
Add the order quantity to UnpricedSellVolume
Buy
146
Add the order quantity to UnpricedBuyVolume
148
Insert order in Auction Book in time priority
150
Compute ImbalanceVolume = UnpricedBuyVolume less UnpricedSellVolume
152
Is the ImbalanceVolume > zero ?
Yes
154
Publish the ImbalanceVolume; denote as "Buy"
No
156
Is the ImbalanceVolume < zero ?
Yes
158
Publish the ImbalanceVolume; denote as "Sell"
No
160
Publish the ImbalanceVolume as zero
162
Return

FIG. 7

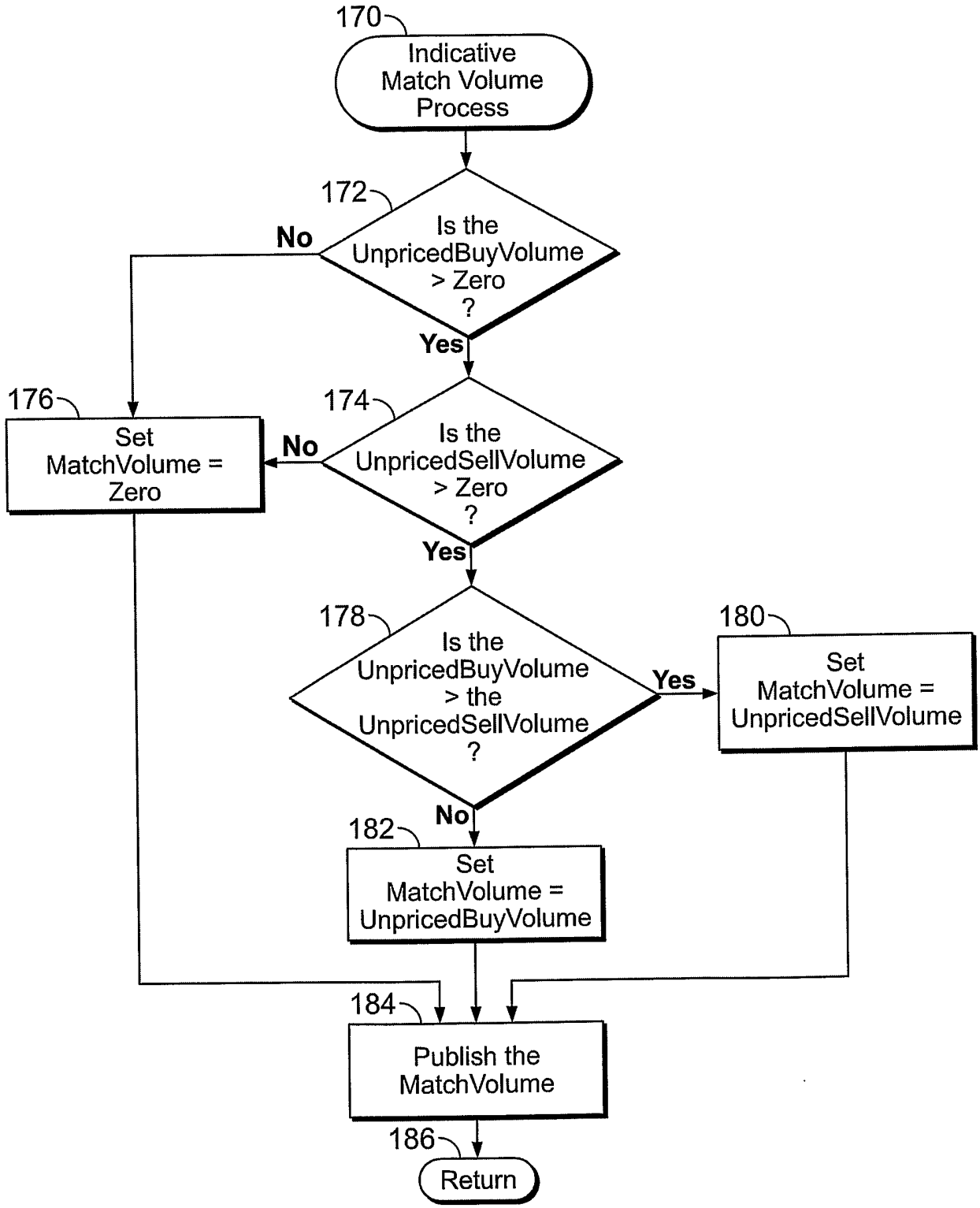
170
Indicative Match Volume Process
172
Is the UnpricedBuyVolume > Zero ?
No
Yes
174
Is the UnpricedSellVolume > Zero ?
No
Yes
176
Set MatchVolume = Zero
178
Is the UnpricedBuyVolume > the UnpricedSellVolume ?
Yes
180
Set MatchVolume = UnpricedSellVolume
No
182
Set MatchVolume = UnpricedBuyVolume
184
Publish the MatchVolume
186
Return

FIG. 8

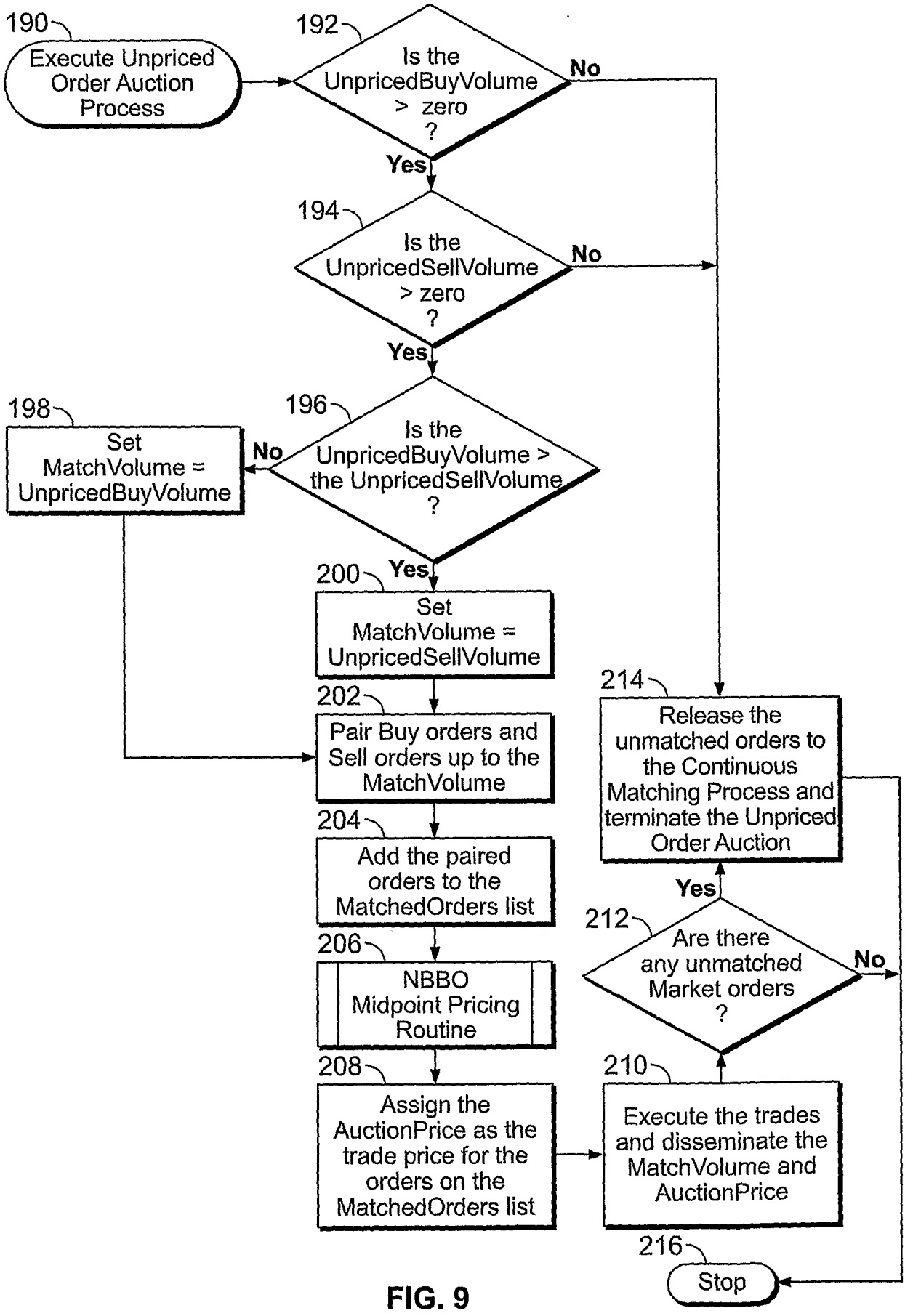
190
Execute Unpriced Order Auction Process
192
Is the UnpricedBuyVolume > zero ?
No
Yes
194
Is the UnpricedSellVolume > zero ?
No
Yes
196
Is the UnpricedBuyVolume > the UnpricedSellVolume ?
No
Yes
198
Set MatchVolume = UnpricedBuyVolume
200
Set MatchVolume = UnpricedSellVolume
202
Pair Buy orders and Sell orders up to the MatchVolume
204
Add the paired orders to the MatchedOrders list
206
NBBO Midpoint Pricing Routine
208
Assign the AuctionPrice as the trade price for the orders on the MatchedOrders list
210
Execute the trades and disseminate the MatchVolume and AuctionPrice
212
Are there any unmatched Market orders ?
Yes
No
214
Release the unmatched orders to the Continuous Matching Process and terminate the Unpriced Order Auction
216
Stop

FIG. 9

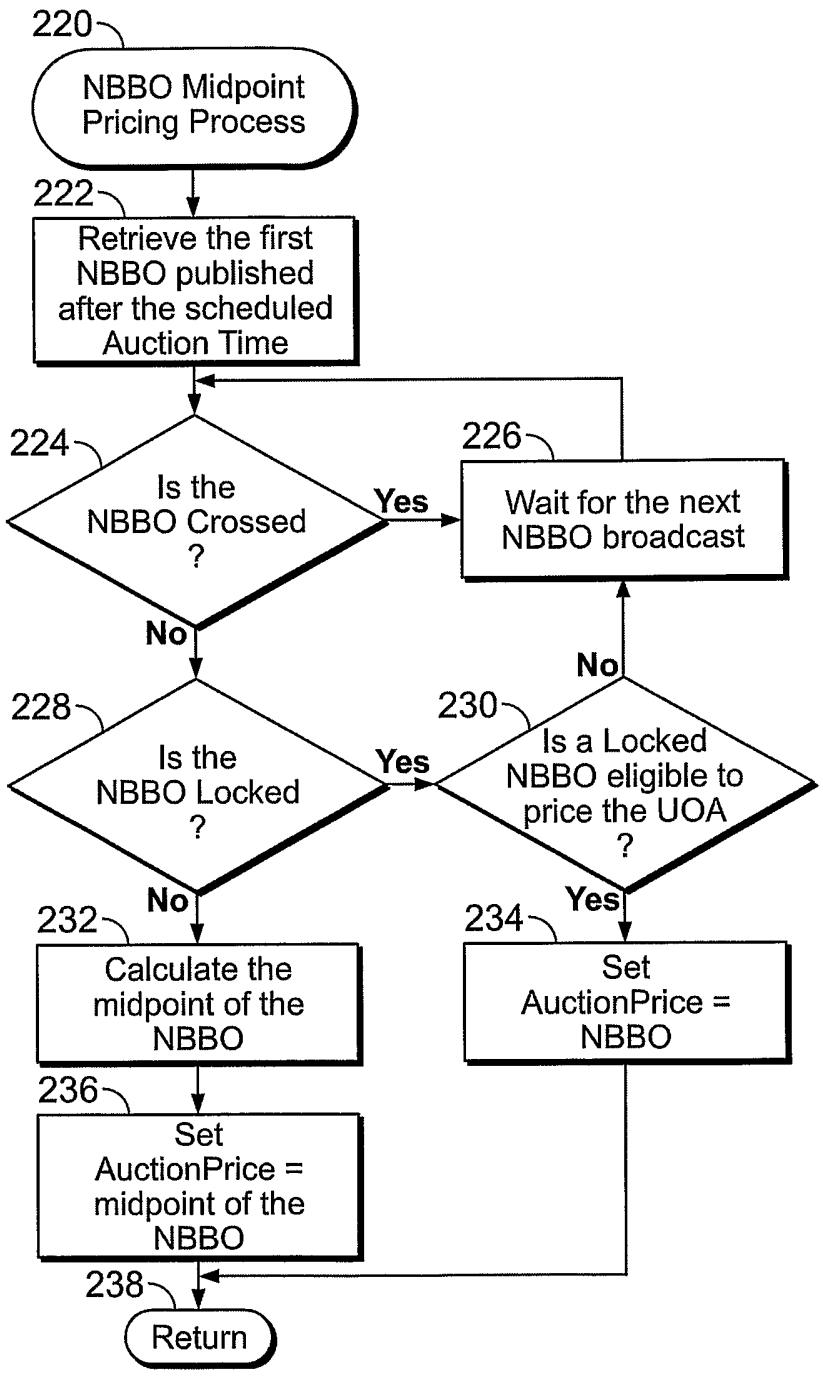
220
NBBO Midpoint Pricing Process
222
Retrieve the first NBBO published after the scheduled Auction Time
224
Is the NBBO Crossed ?
Yes
226
Wait for the next NBBO broadcast
No
228
Is the NBBO Locked ?
Yes
230
Is a Locked NBBO eligible to price the UOA ?
No
No
Yes
232
Calculate the midpoint of the NBBO
234
Set AuctionPrice = NBBO
236
Set AuctionPrice = midpoint of the NBBO
238
Return

FIG. 10