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**Hoover et al.**

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(54) **BALLOT ADJUDICATION IN VOTING SYSTEMS UTILIZING BALLOT IMAGES**

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(73) Assignee: **Dominion Voting Systems, Inc.**, Denver, CO (US)

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This patent is subject to a terminal disclaimer.

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(22) Filed: **Nov. 12, 2014**

(65) **Prior Publication Data**

US 2015/0071501 A1 Mar. 12, 2015

**Related U.S. Application Data**

(63) Continuation of application No. 13/470,091, filed on May 11, 2012, now Pat. No. 8,913,787.

(51) **Int. Cl.**

| | |
|---|---|
| ***G06K 9/00*** | (2006.01) |
| ***G07C 13/00*** | (2006.01) |
| ***G06T 11/60*** | (2006.01) |

(52) **U.S. Cl.**
CPC ..... ***G06K 9/00442*** (2013.01); ***G06T 11/60*** (2013.01); ***G07C 13/00*** (2013.01); *G06T 2207/10004* (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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*Primary Examiner* — Nirav G Patel
(74) *Attorney, Agent, or Firm* — Holland & Hart LLP

(57) **ABSTRACT**

Methods, systems, and devices are described for adjudicating votes made on voter-marked paper ballots. Voter-marked paper ballots may be scanned to obtain optical image data of the voter-marked paper ballots. The optical image may be analyzed to determine the votes contained in the ballot for tabulation purposes. One or more votes on the ballot may be identified as requiring adjudication by an election official. Adjudication information, according to various embodiments, is appended to the optical images of the voter-marked paper ballots such that the image of the ballot and the image of the adjudication information may be viewed in an optical image. The optical image may be stored in a file format that allows the ballot image and the appended adjudication information to be viewed using readily available image viewers.

**19 Claims, 16 Drawing Sheets**

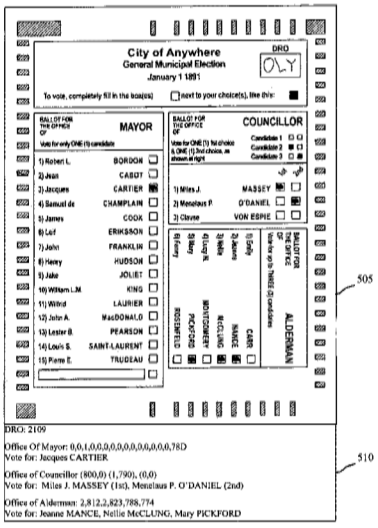



EXHIBIT
916

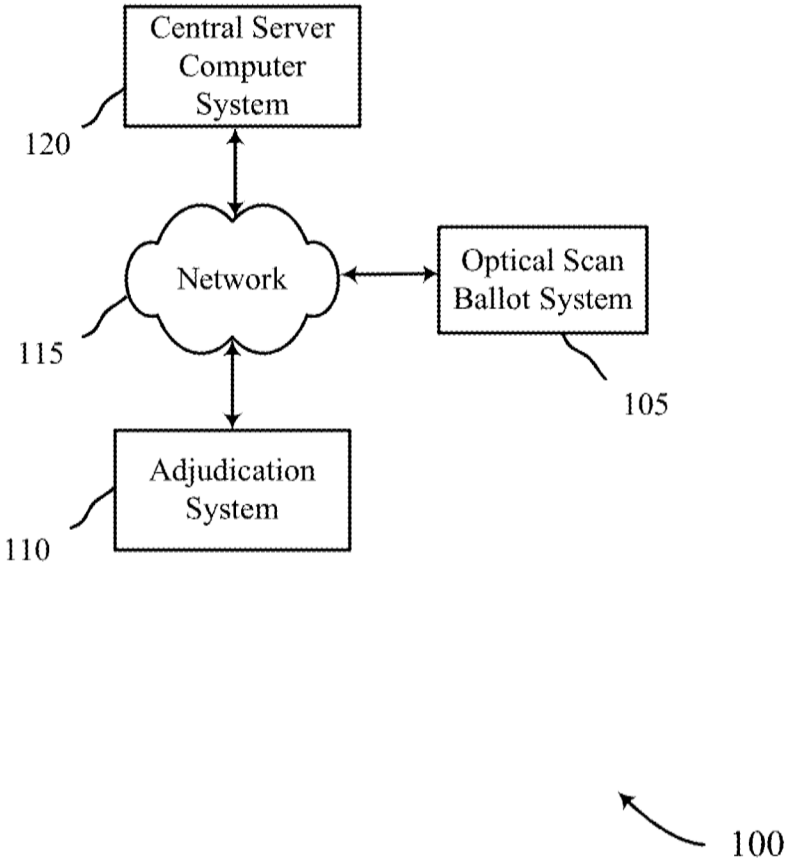

Central Server Computer System
120
Network
115
Optical Scan Ballot System
105
Adjudication System
110
100

FIG. 1

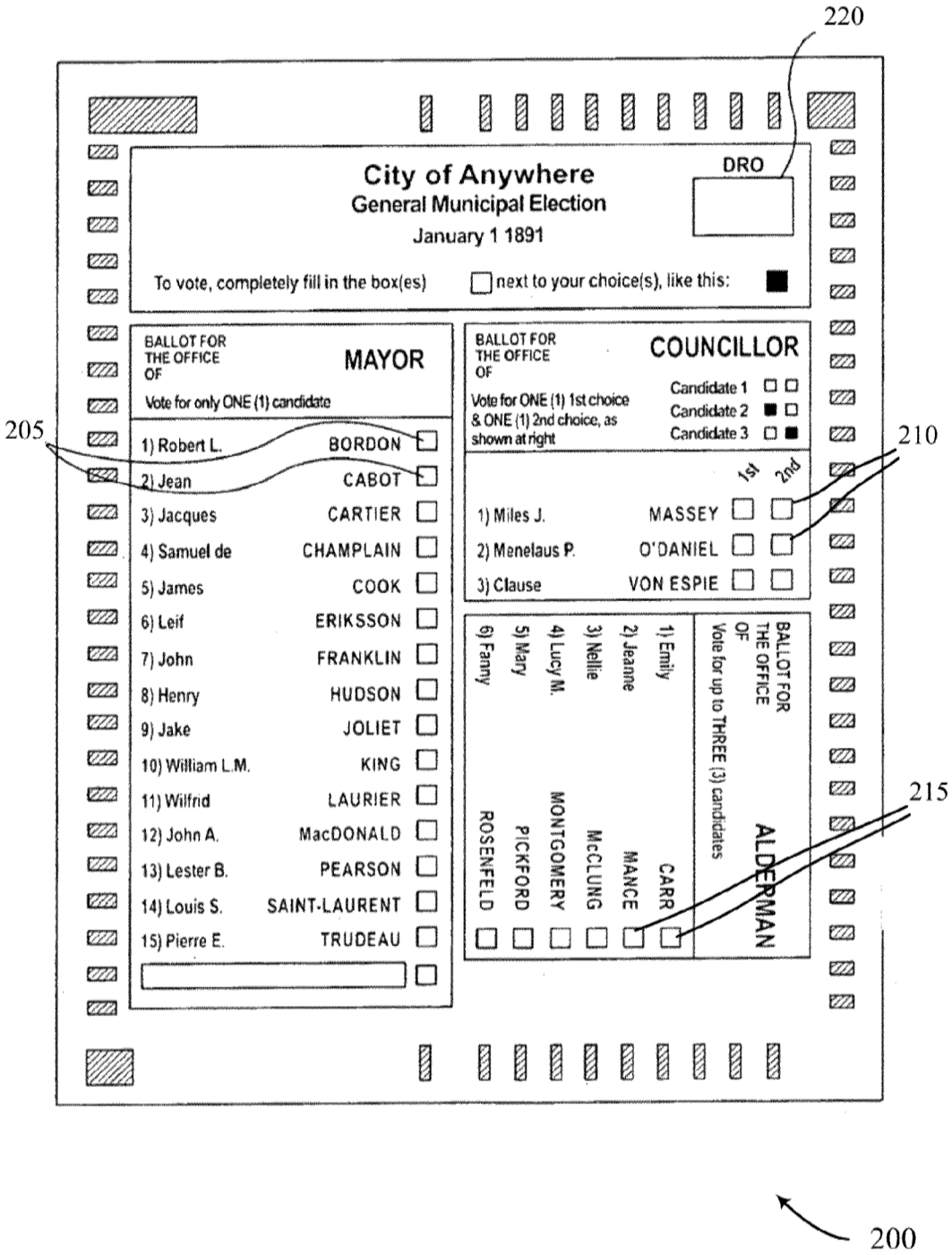
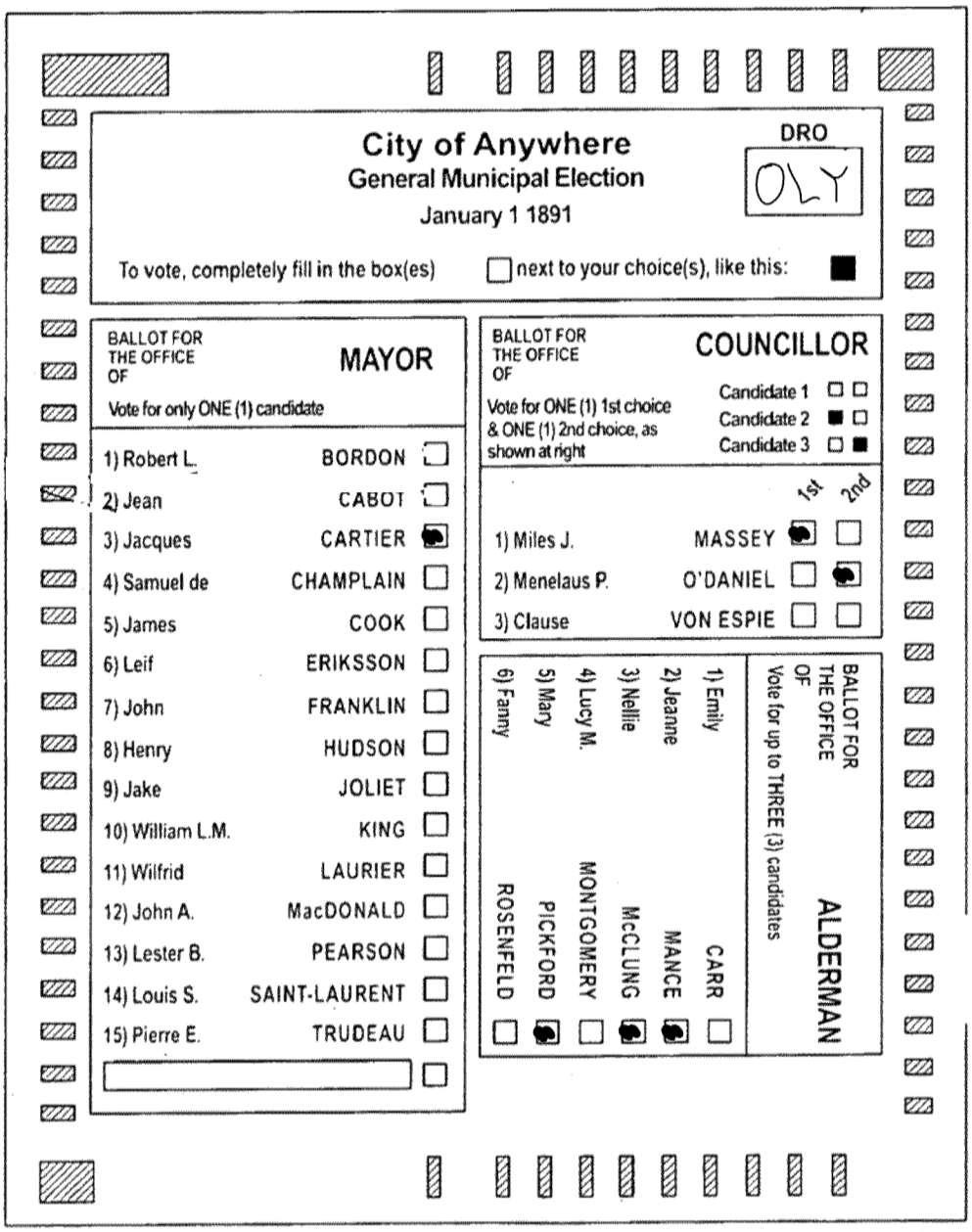

220
City of Anywhere
General Municipal Election
January 1 1891
DRO
To vote, completely fill in the box(es) next to your choice(s), like this:
BALLOT FOR THE OFFICE OF MAYOR
Vote for only ONE (1) candidate
1) Robert L. BORDON
2) Jean CABOT
3) Jacques CARTIER
4) Samuel de CHAMPLAIN
5) James COOK
6) Leif ERIKSSON
7) John FRANKLIN
8) Henry HUDSON
9) Jake JOLIET
10) William L.M. KING
11) Wilfrid LAURIER
12) John A. MacDONALD
13) Lester B. PEARSON
14) Louis S. SAINT-LAURENT
15) Pierre E. TRUDEAU
205
BALLOT FOR THE OFFICE OF COUNCILLOR
Vote for ONE (1) 1st choice & ONE (1) 2nd choice, as shown at right
Candidate 1
Candidate 2
Candidate 3
1st
2nd
1) Miles J. MASSEY
2) Menelaus P. O'DANIEL
3) Clause VON ESPIE
210
BALLOT FOR THE OFFICE OF ALDERMAN
Vote for up to THREE (3) candidates
1) Emily CARR
2) Jeanne MANCE
3) Nellie McCLUNG
4) Lucy M. MONTGOMERY
5) Mary PICKFORD
6) Fanny ROSENFELD
215
200

FIG. 2


City of Anywhere
General Municipal Election
January 1 1891
DRO
OLY
To vote, completely fill in the box(es) next to your choice(s), like this:
BALLOT FOR THE OFFICE OF
MAYOR
Vote for only ONE (1) candidate
1) Robert L. BORDON
2) Jean CABOT
3) Jacques CARTIER
4) Samuel de CHAMPLAIN
5) James COOK
6) Leif ERIKSSON
7) John FRANKLIN
8) Henry HUDSON
9) Jake JOLIET
10) William L.M. KING
11) Wilfrid LAURIER
12) John A. MacDONALD
13) Lester B. PEARSON
14) Louis S. SAINT-LAURENT
15) Pierre E. TRUDEAU
BALLOT FOR THE OFFICE OF
COUNCILLOR
Vote for ONE (1) 1st choice & ONE (1) 2nd choice, as shown at right
Candidate 1
Candidate 2
Candidate 3
1st
2nd
1) Miles J. MASSEY
2) Menelaus P. O'DANIEL
3) Clause VON ESPIE
BALLOT FOR THE OFFICE OF
ALDERMAN
Vote for up to THREE (3) candidates
1) Emily CARR
2) Jeanne MANCE
3) Nellie McCLUNG
4) Lucy M. MONTGOMERY
5) Mary PICKFORD
6) Fanny ROSENFELD

300

FIG. 3

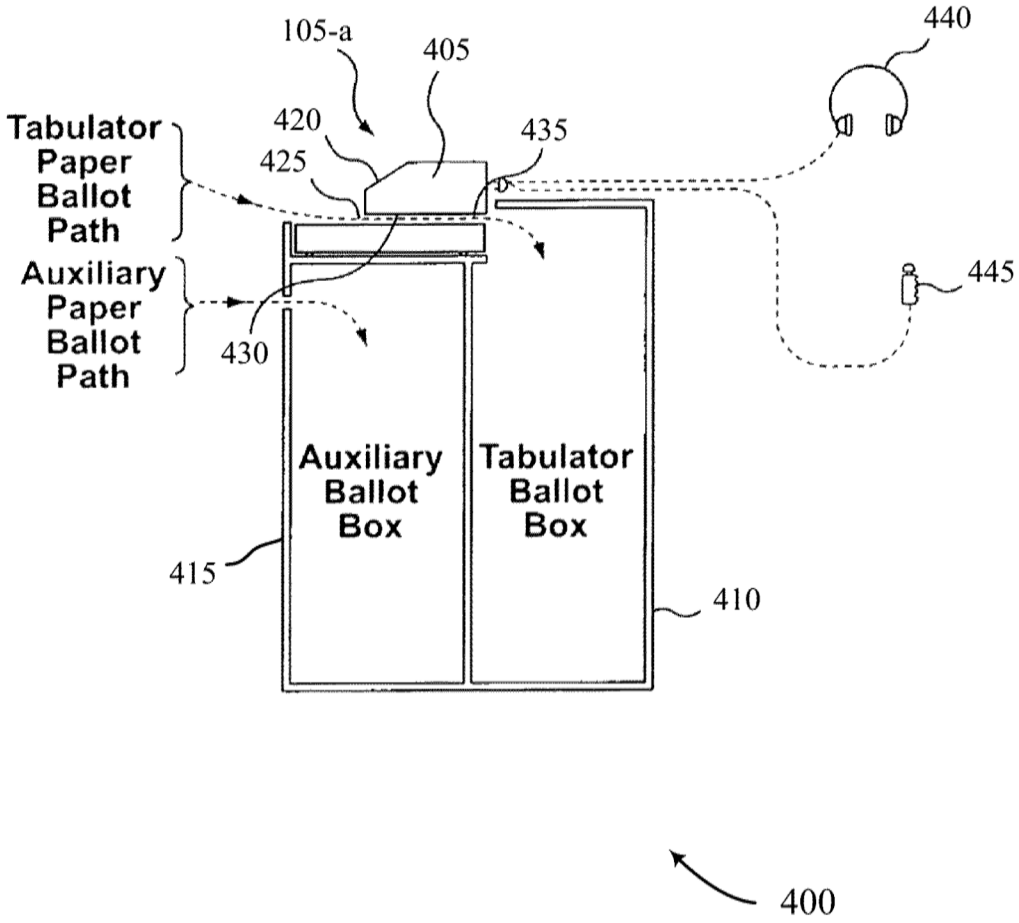
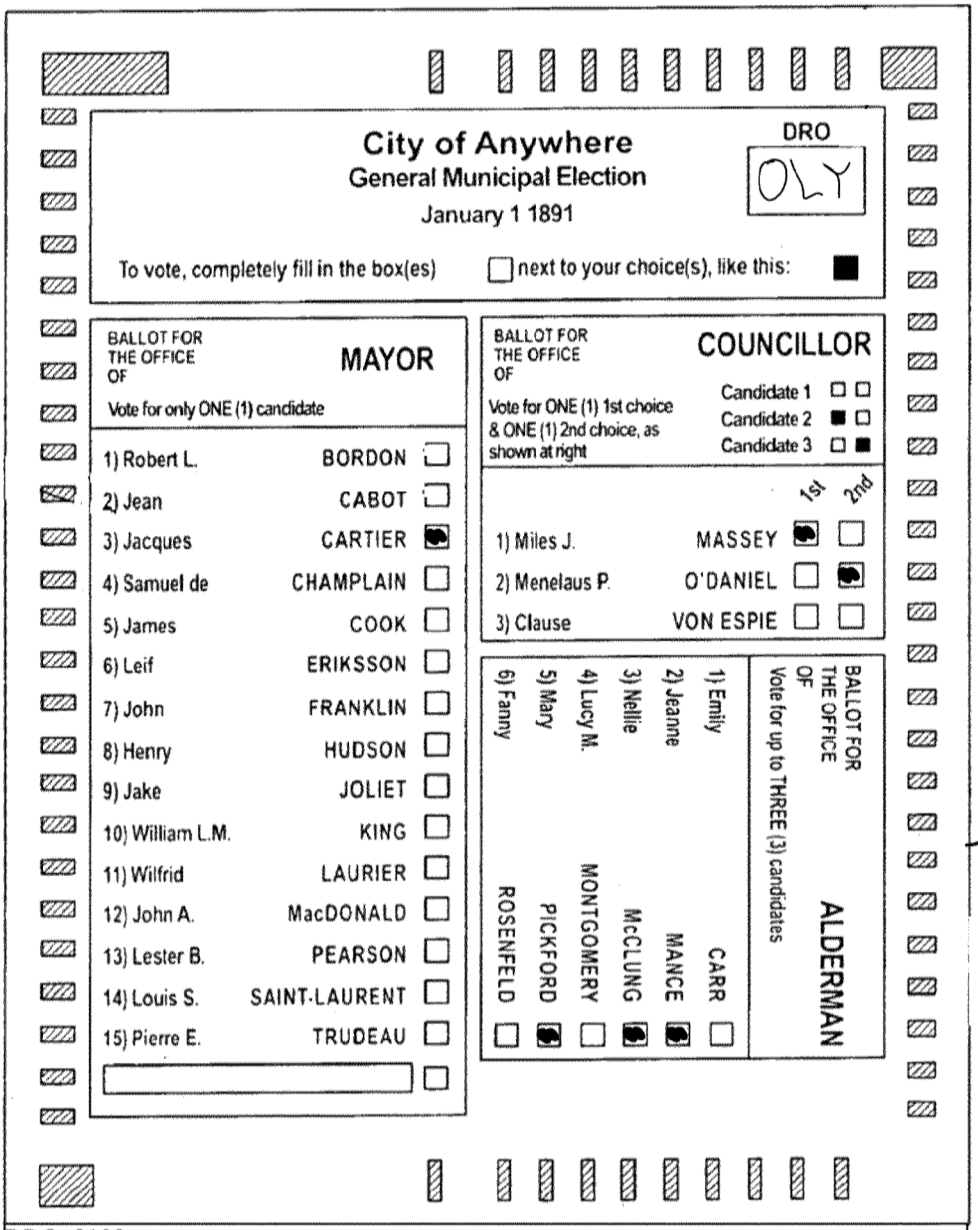

105-a
405
440
420
435
425
Tabulator Paper Ballot Path
Auxiliary Paper Ballot Path
445
430
Auxiliary Ballot Box
Tabulator Ballot Box
415
410
400

FIG. 4




505

DRO: 2109

Office Of Mayor: 0,0,1,0,0,0,0,0,0,0,0,0,0,0,78D
Vote for: Jacques CARTIER

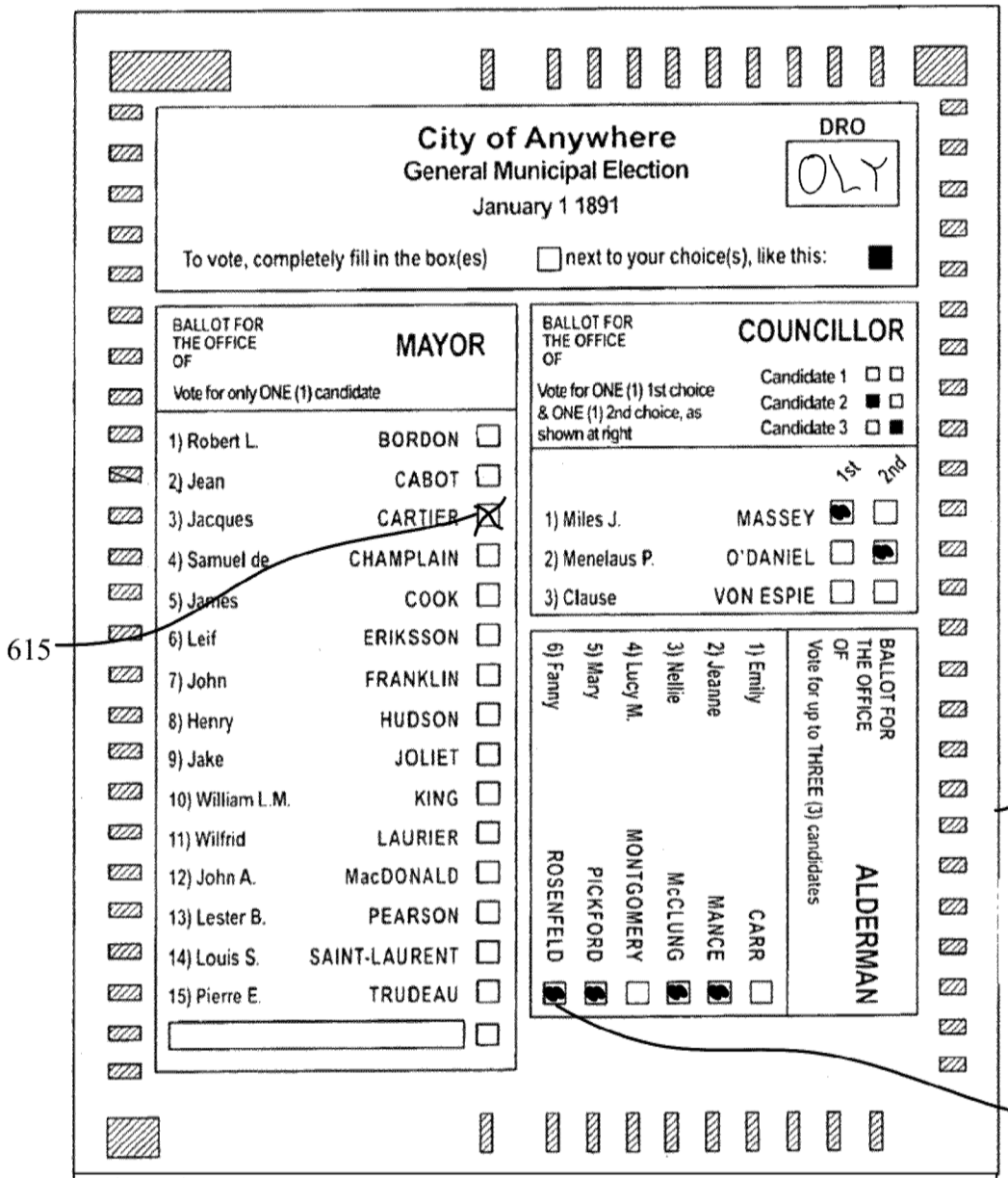
Office of Councillor (800,0) (1,790), (0,0)
Vote for: Miles J. MASSEY (1st), Menelaus P. O'DANIEL (2nd)

Office of Alderman: 2,812,2,823,788,774
Vote for: Jeanne MANCE, Nellie McCLUNG, Mary PICKFORD

510

500

FIG. 5




DRO: 2109

Office Of Mayor: 0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,78D
Vote for: AMBIGUOUS

Office of Councillor (800,0) (1,790), (0,0)
Vote for: Miles J. MASSEY (1st), Menelaus P. O'DANIEL (2nd)

Office of Alderman: 2,812,2,823,788,774
Vote for: OVER-VOTE

610

600

FIG. 6

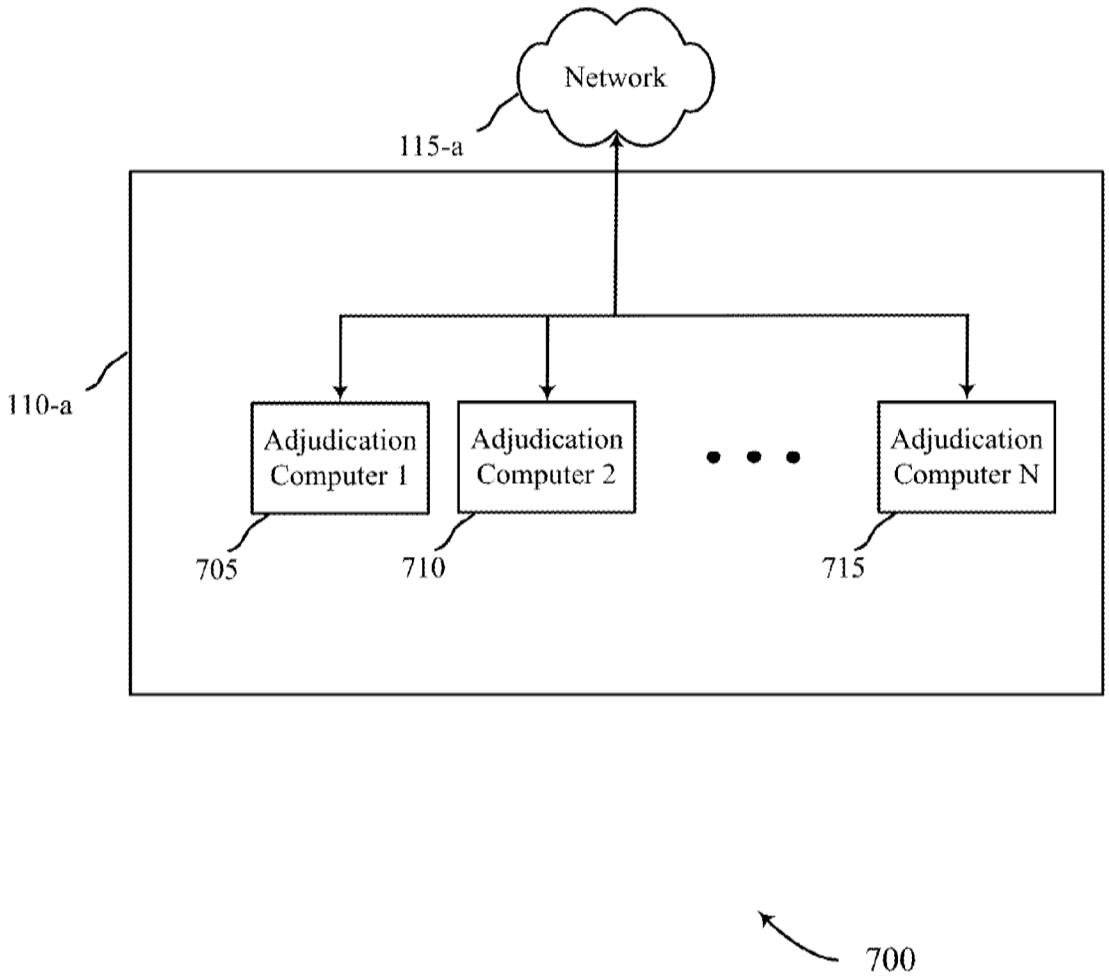

Network
115-a
110-a
Adjudication Computer 1
Adjudication Computer 2
Adjudication Computer N
705
710
715
700

FIG. 7

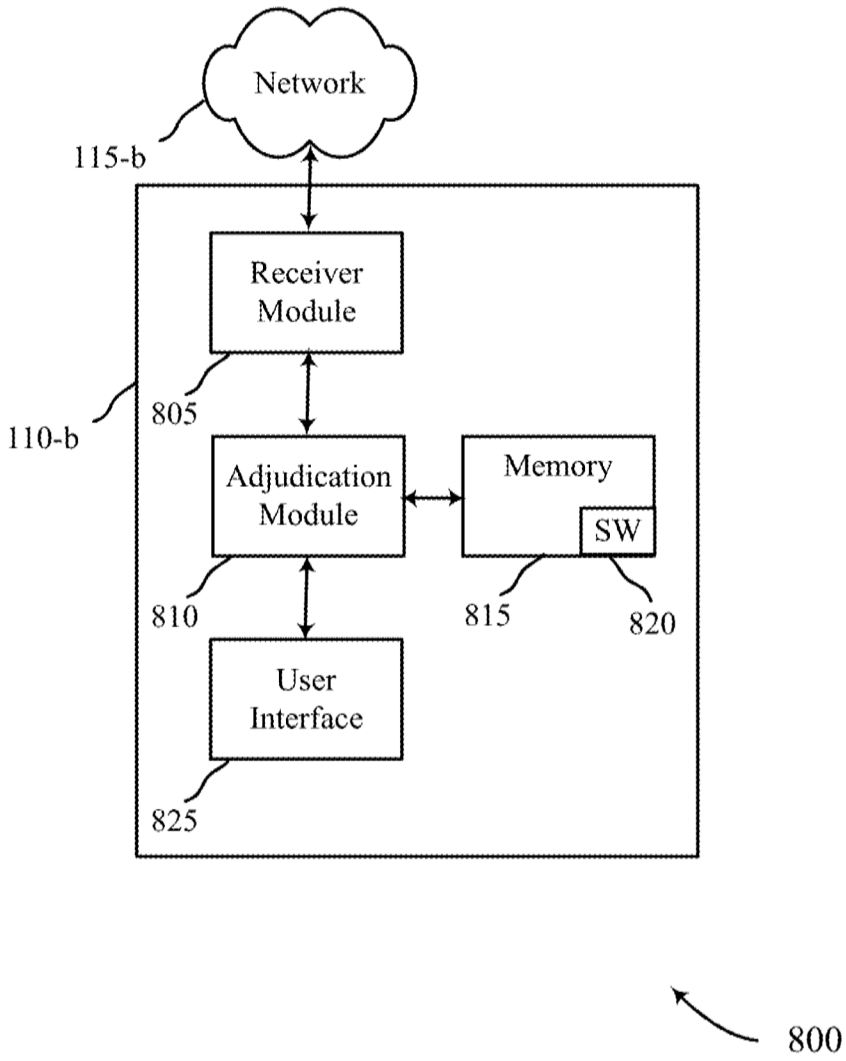
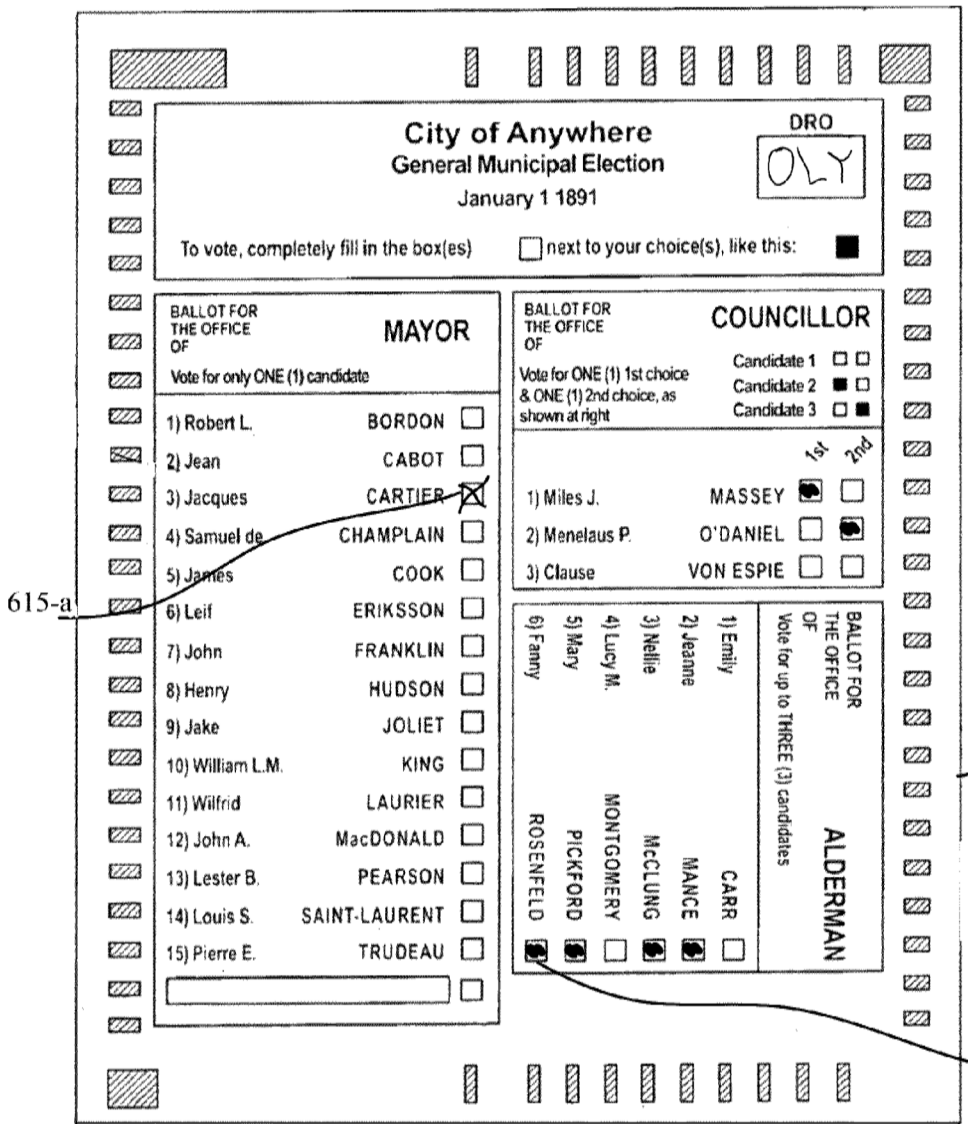

Network
115-b
Receiver Module
805
110-b
Adjudication Module
Memory
SW
810
815
820
User Interface
825
800

FIG. 8




DRO: 2109

Office Of Mayor: 0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,78D
Vote for: AMBIGUOUS

610-a

Office of Councillor (800,0) (1,790), (0,0)
Vote for: Miles J. MASSEY (1st), Menelaus P. O'DANIEL (2nd)

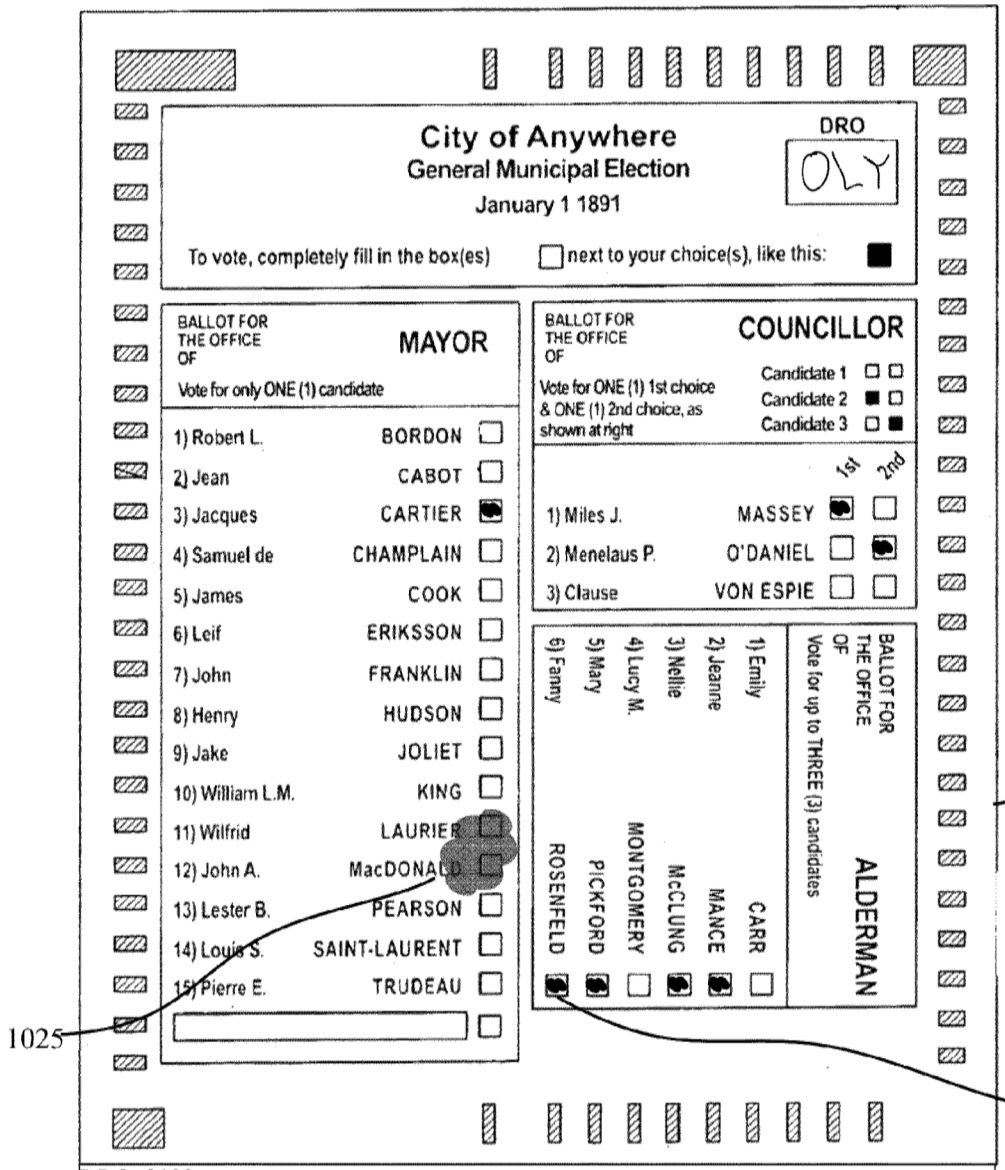
Office of Alderman: 2,812,2,823,788,774
Vote for: OVER-VOTE

Adjudication Session on Batch – 1, Ballot – 1, by
User – Admin from Machine ADJUDICATION1
Office of Mayor
01/02/1891 12:59:31 PM Office of Mayor
Choice 3 > Marginal Mark: Mark ADDED
01/02/1891 12:59:36 PM Contest
ADJUDICATED

905

900

FIG. 9




DRO: 2109

Office Of Mayor: 0,0,1,0,0,0,0,0,0,0,0,0,0,0,78D
Vote for: OVER-VOTE

1010

Office of Councillor (800,0) (1,790), (0,0)
Vote for: Miles J. MASSEY (1st), Menelaus P. O'DANIEL (2nd)

Office of Alderman: 2,812,2,823,788,774
Vote for: OVER-VOTE

Adjudication Session on Batch – 1, Ballot – 1, by
User – Admin from Machine ADJUDICATION1
Office of Mayor
01/02/1891 12:59:31 PM Office of Mayor
Choice 3 > Stray Mark: Mark removed
01/02/1891 12:59:36 PM Contest
ADJUDICATED

1015

1000

FIG. 10

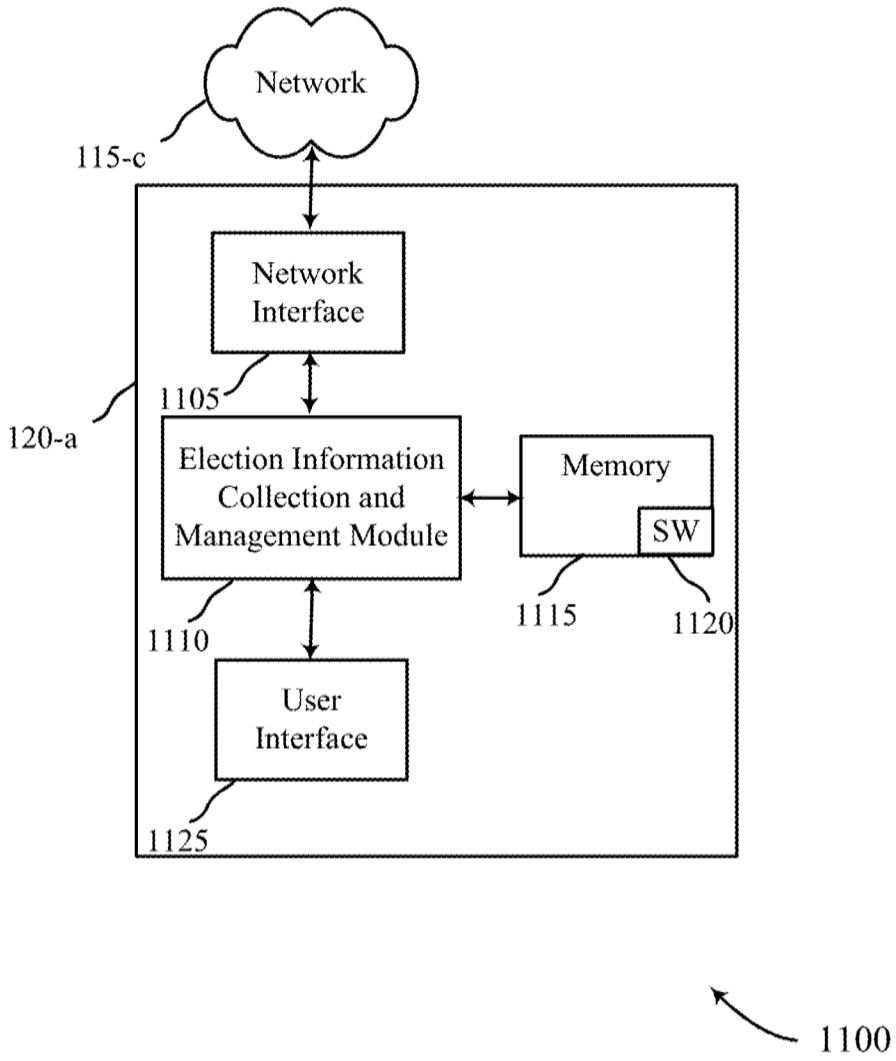

Network
115-c
Network Interface
1105
120-a
Election Information Collection and Management Module
Memory
SW
1110
1115
1120
User Interface
1125
1100

FIG. 11

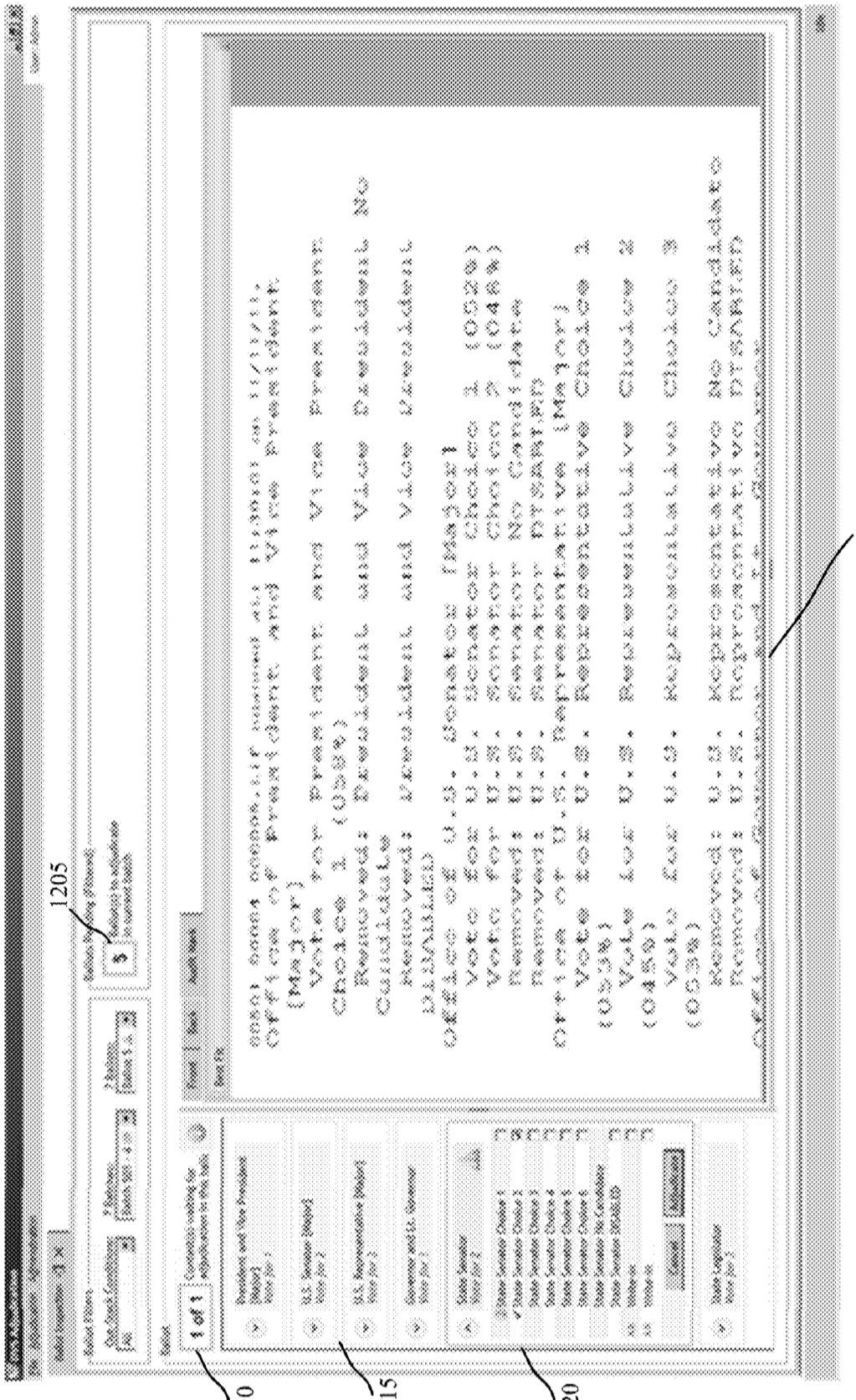



FIG. 12

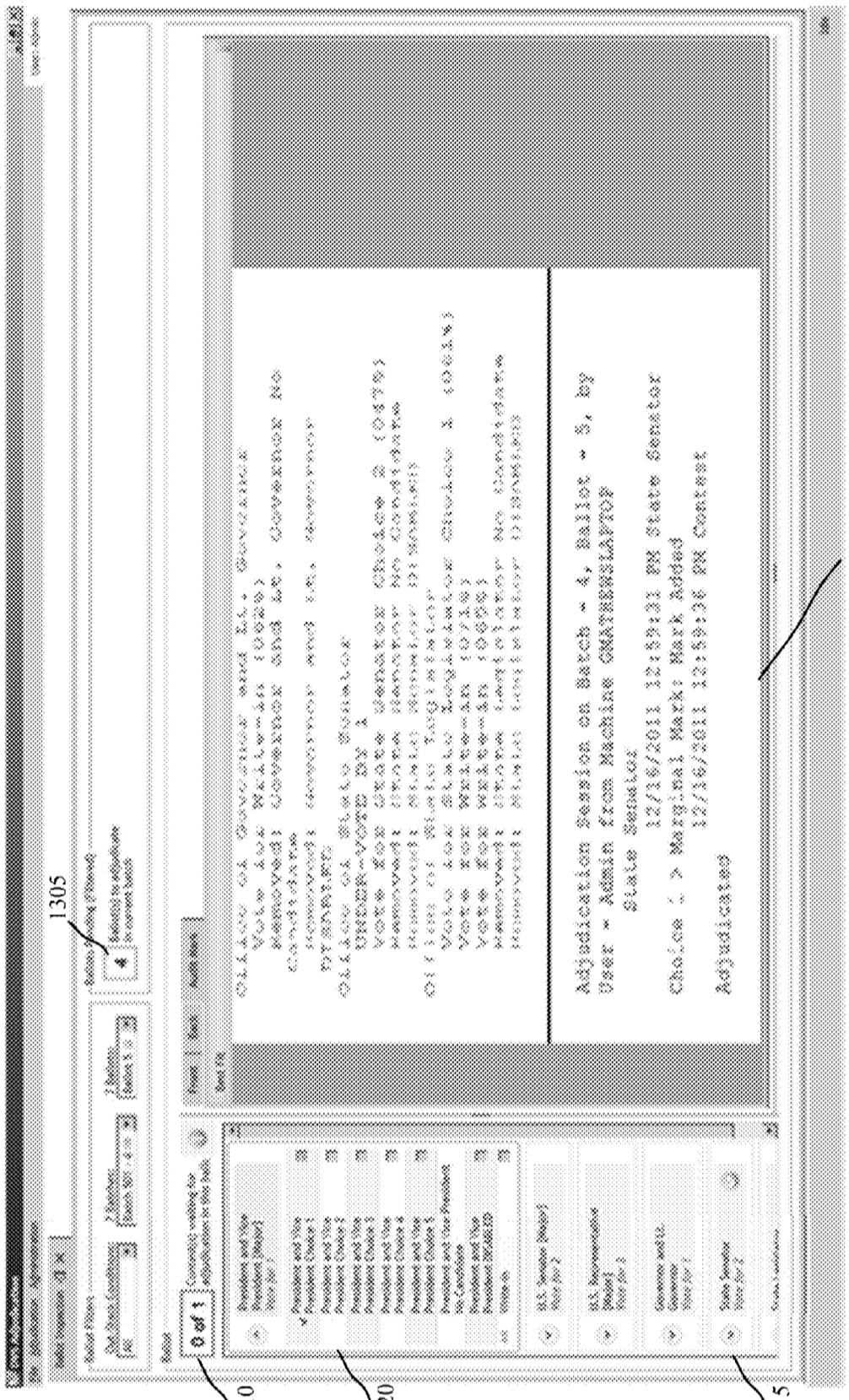

1305
1310
1320
1315
1325
1300
Adjudication Session on Batch - 4, Ballot - 5, by
User - Admin from Machine CMATHEWSLAPTOP
State Senator
12/16/2011 12:59:31 PM State Senator
Choice 2 > Marginal Mark: Mark Added
12/16/2011 12:58:36 PM Contest
Adjudicated

FIG. 13

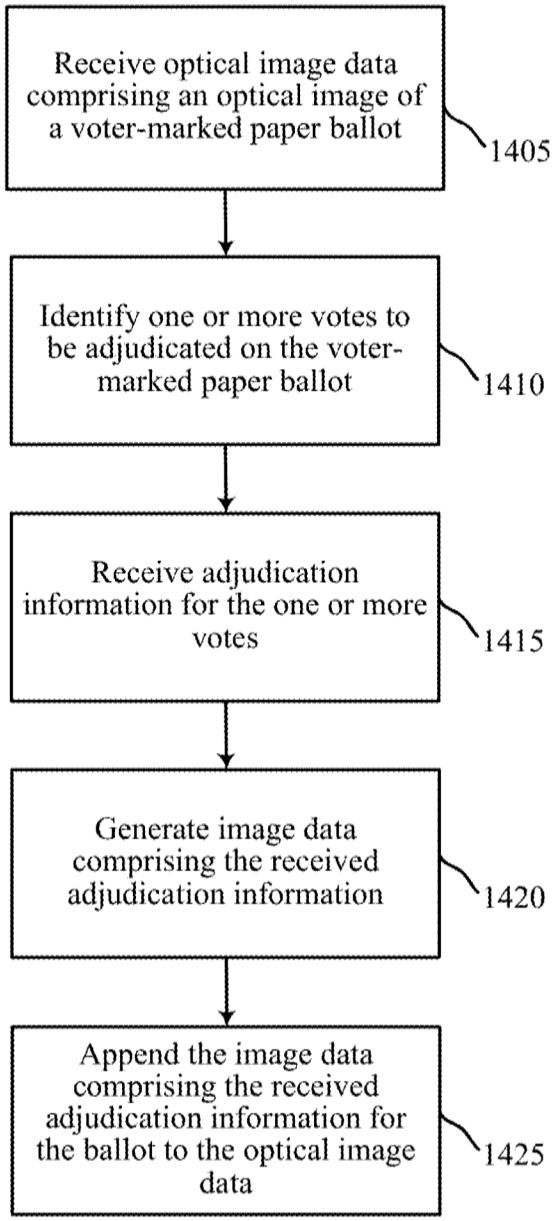

Receive optical image data comprising an optical image of a voter-marked paper ballot
1405
Identify one or more votes to be adjudicated on the voter-marked paper ballot
1410
Receive adjudication information for the one or more votes
1415
Generate image data comprising the received adjudication information
1420
Append the image data comprising the received adjudication information for the ballot to the optical image data
1425
1400

FIG. 14

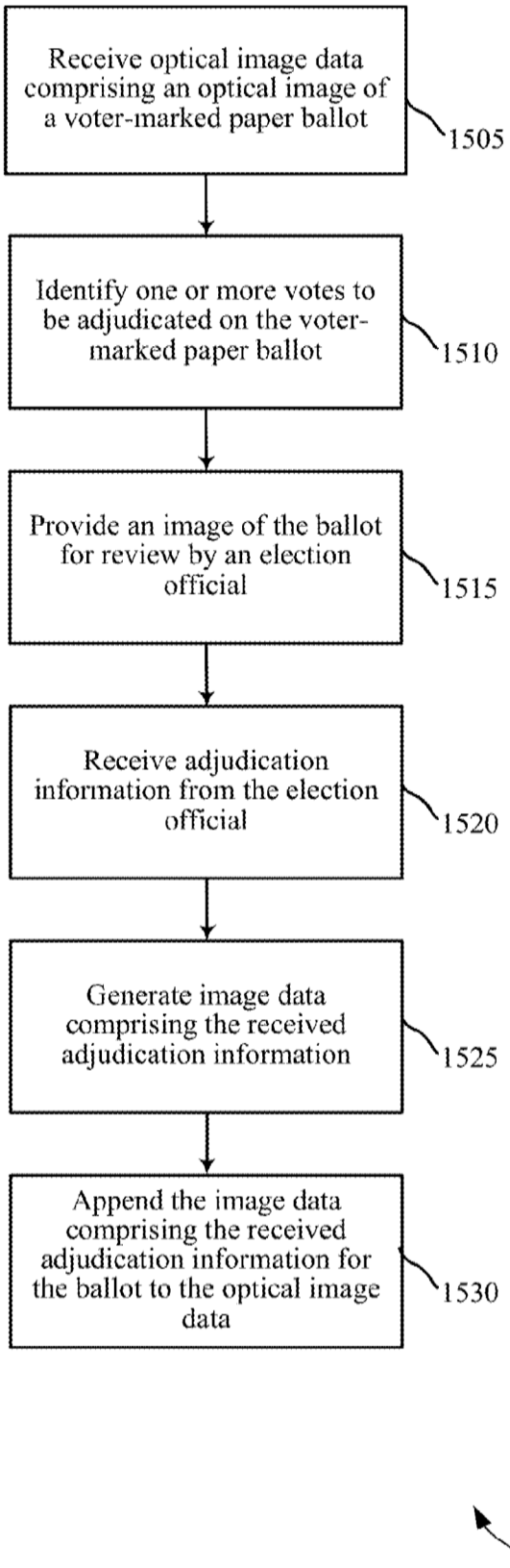

Receive optical image data comprising an optical image of a voter-marked paper ballot
1505
Identify one or more votes to be adjudicated on the voter-marked paper ballot
1510
Provide an image of the ballot for review by an election official
1515
Receive adjudication information from the election official
1520
Generate image data comprising the received adjudication information
1525
Append the image data comprising the received adjudication information for the ballot to the optical image data
1530
1500

FIG. 15

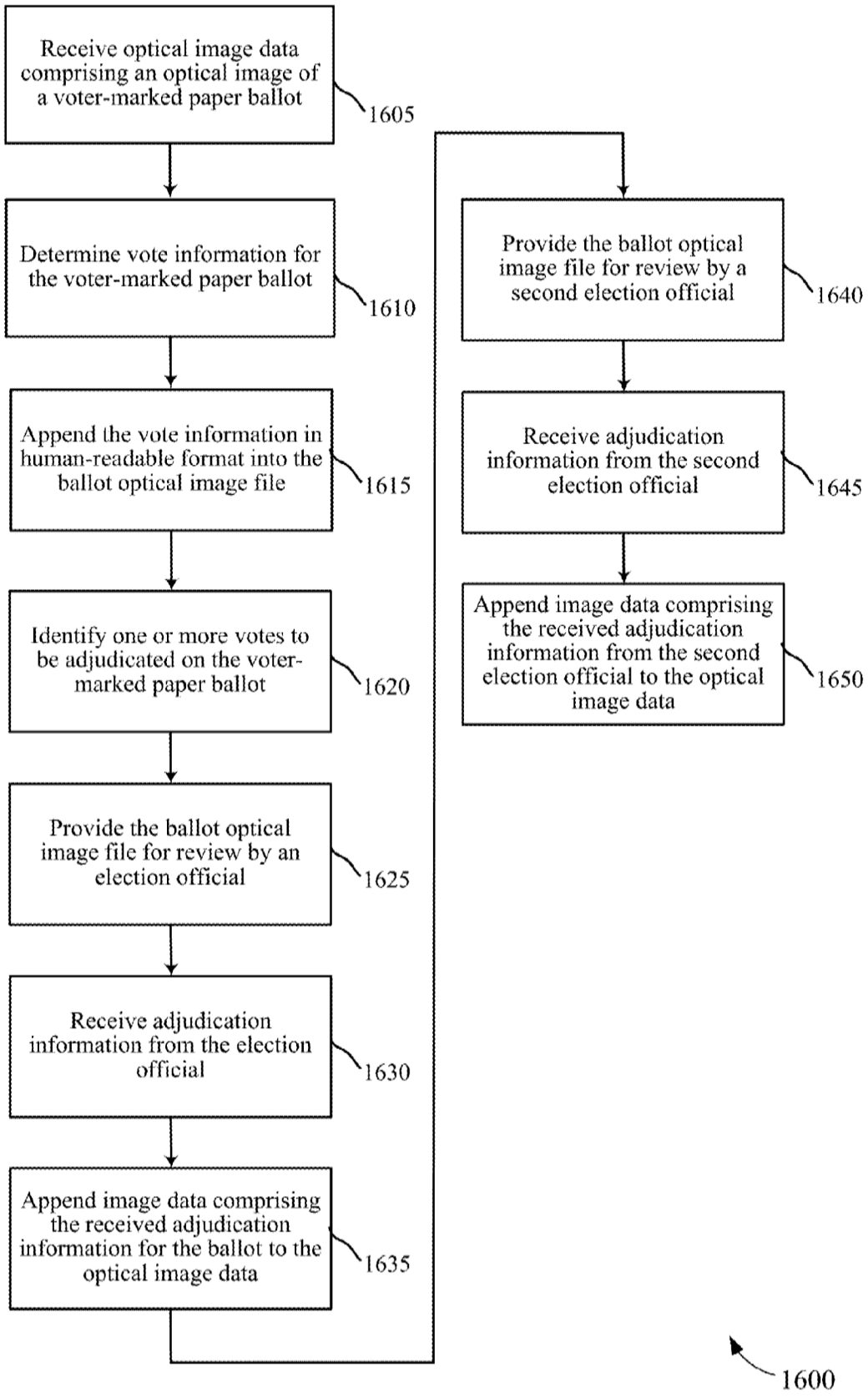

Receive optical image data comprising an optical image of a voter-marked paper ballot
1605
Determine vote information for the voter-marked paper ballot
1610
Append the vote information in human-readable format into the ballot optical image file
1615
Identify one or more votes to be adjudicated on the voter-marked paper ballot
1620
Provide the ballot optical image file for review by an election official
1625
Receive adjudication information from the election official
1630
Append image data comprising the received adjudication information for the ballot to the optical image data
1635
Provide the ballot optical image file for review by a second election official
1640
Receive adjudication information from the second election official
1645
Append image data comprising the received adjudication information from the second election official to the optical image data
1650
1600

FIG. 16

# BALLOT ADJUDICATION IN VOTING SYSTEMS UTILIZING BALLOT IMAGES

## CROSS REFERENCES

This application is a continuation of U.S. patent application Ser. No. 13/470,091, filed May 11, 2012, entitled, "BALLOT ADJUDICATION IN VOTING SYSTEMS UTILIZING BALLOT IMAGES," which is incorporated by reference in its entirety for all purposes.

## BACKGROUND

The present invention relates to voting systems in general and, in particular, to methods and systems for adjudicating ballots utilizing ballot images.

Electronic tabulation of voter-marked paper ballots has been used in elections for some time. Such systems may provide efficient vote tabulation if ballots are received without any errors, modifications, or write-in candidates included on the ballot. Electronic tabulation systems for voter-marked ballots may include optical scanners that scan the voter-marked ballots. Such ballots may have a target area that is evaluated by a computer that receives an image of the scanned ballot to determine if a vote is cast for a particular election, such as a bubble or square next to a candidate's name on a ballot. Electronic tabulation systems may also receive ballots generated from direct-recording electronic (DRE) voting machines, in which a voter may electronically enter votes without a voter-marked paper ballot.

In some instances optical scan systems may not be able to determine with high confidence that a particular vote has been cast. For example, a voter may partially fill in a target area next to a candidate name, may place a mark next to the target area rather than filling in the target area, and/or soil the ballot in some fashion (e.g., coffee stain).

Furthermore, in many jurisdictions voter intent is used as a basis for evaluating and adjudicating ballots for purposes of tabulating votes. Thus, if a voter improperly completed a ballot with a mark outside of a target area, a review of the ballot may indicate that the voter intended to cast a certain vote, and thus the ballot should be properly tabulated to include the intended vote. Similarly, a voter may mark an area for a particular candidate, and afterward realize that they made an error or change their mind. The voter may cross out the vote and mark a different area for a different candidate, and make a note such as, for example, writing "not this one" next to the crossed-out mark. An electronic scanning and tabulation system may not tabulate such a vote properly, while a human review of the ballot may readily reveal that the voter did intend to vote for the different candidate. Such instances may consume a significant amount of resources at the polling place or later, when the votes recorded on the ballots are being tabulated.

Furthermore, many jurisdictions have a number of voters that vote through a mail-in ballot, and in some elections the voting may be done exclusively through mail-in ballots. Such mail-in ballots may have an increased likelihood of votes requiring adjudication, as the voter is not able to simply ask for a new ballot if they improperly mark or otherwise soil their original ballot. Furthermore, voters may complete mail-in ballots at their home, which may increase the likelihood that a ballot will be soiled with food or drink stains, which may lead to incorrect vote tabulation by an optical scan tabulation system.

## SUMMARY

Methods, systems, and devices are described for adjudicating votes made on voter-marked paper ballots. Voter-marked paper ballots may be optically scanned to obtain optical image data of the voter-marked paper ballots. The optical image data may be analyzed to determine the votes contained in the ballot for tabulation purposes. One or more votes on the ballot, or the ballot as a whole, may be identified as requiring adjudication by an election official. Adjudication information, according to various embodiments, is appended to the optical images of the voter-marked paper ballots such that the image of the ballot and the image of the adjudication information may be viewed in an optical image. The optical image may be stored in a file format that allows the ballot image and the appended adjudication information to be viewed using readily available image viewers.

In one set of embodiments, methods for ballot adjudication of a voter-marked paper ballot are provided that include receiving optical image data comprising an optical image of a voter-marked paper ballot, identifying one or more votes recorded on the voter-marked paper ballot to be adjudicated, receiving adjudication information for the ballot, generating image data comprising the received adjudication information for the ballot, and appending the image data comprising the received adjudication information for the ballot to the optical image data.

In other embodiments, a system for adjudication of voter-marked paper ballots is provided. The systems, according to various embodiments, may comprise a receiver module configured to receive ballot optical image data comprising an optical image of a voter-marked paper ballot, and an adjudication module configured to receive adjudication information for the ballot, generate image data comprising the received adjudication information for the ballot and append the image data for the ballot to the optical image data. The adjudication module may be configured to receive an indication that the ballot requires adjudication when a mark within a target area of the ballot is determined to be ambiguous. In some embodiments, the adjudication module is further configured to provide an image of the ballot for review by an election official and receive the adjudication information from the election official. In some embodiments, multiple election officials may adjudicate a ballot, with each adjudication having corresponding image data comprising the received adjudication information for the ballot that is appended to the image data for the ballot.



## BRIEF DESCRIPTION OF THE DRAWINGS

A further understanding of the nature and advantages of the present disclosure may be realized by reference to the following drawings. In the appended figures, similar components or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label by a dash and a second label that distinguishes among the similar components. If only the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label.

FIG. **1** is a block diagram of a ballot scanning, tabulation, and adjudication system including components configured according to various embodiments.

FIG. **2** is an image of a paper ballot according to various embodiments.

FIG. **3** is an image of a voter-marked paper ballot according to various embodiments.

FIG. **4** is an illustration of an optical scan ballot system according to various embodiments.