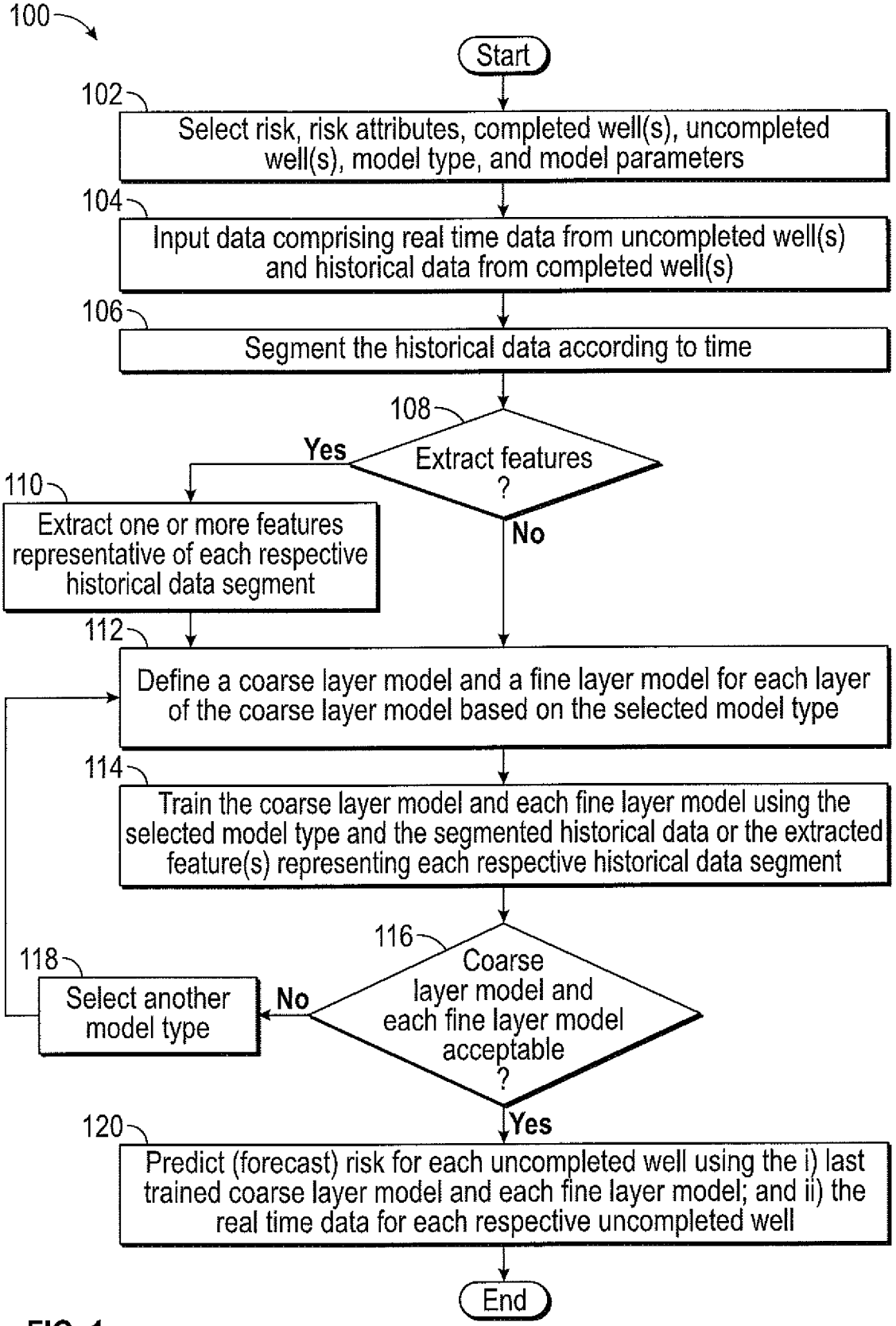
100
Start
102
Select risk, risk attributes, completed well(s), uncompleted well(s), model type, and model parameters
104
Input data comprising real time data from uncompleted well(s) and historical data from completed well(s)
106
Segment the historical data according to time
108
Extract features ?
Yes
No
110
Extract one or more features representative of each respective historical data segment
112
Define a coarse layer model and a fine layer model for each layer of the coarse layer model based on the selected model type
114
Train the coarse layer model and each fine layer model using the selected model type and the segmented historical data or the extracted feature(s) representing each respective historical data segment
116
Coarse layer model and each fine layer model acceptable ?
No
118
Select another model type
Yes
120
Predict (forecast) risk for each uncompleted well using the i) last trained coarse layer model and each fine layer model; and ii) the real time data for each respective uncompleted well
End

FIG. 1

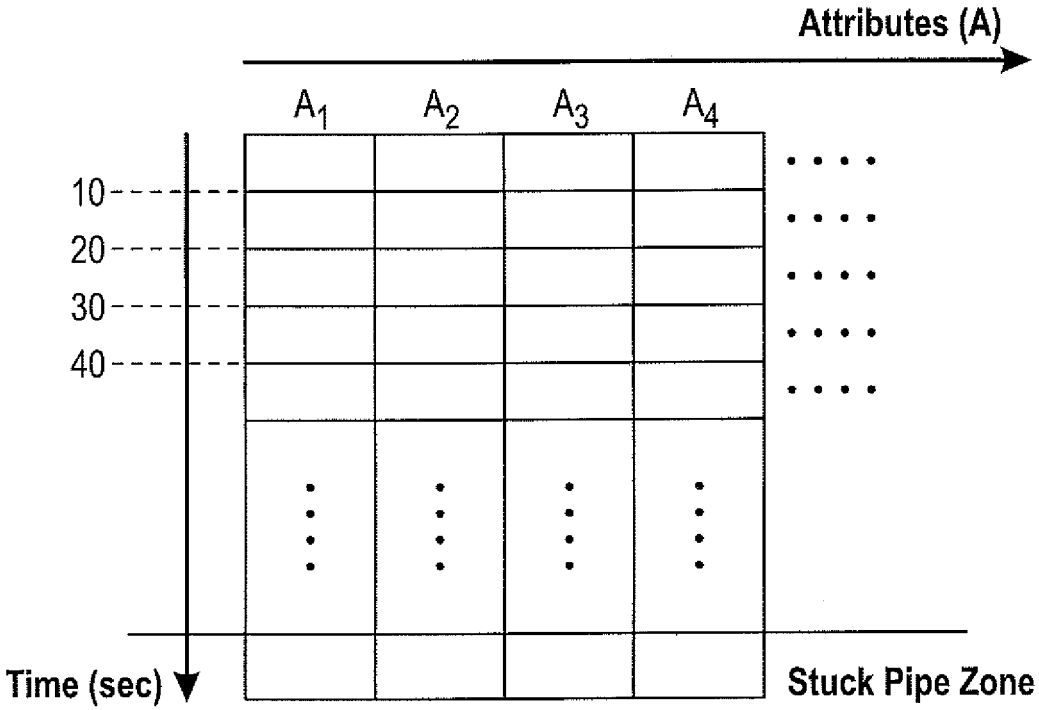

FIG. 2

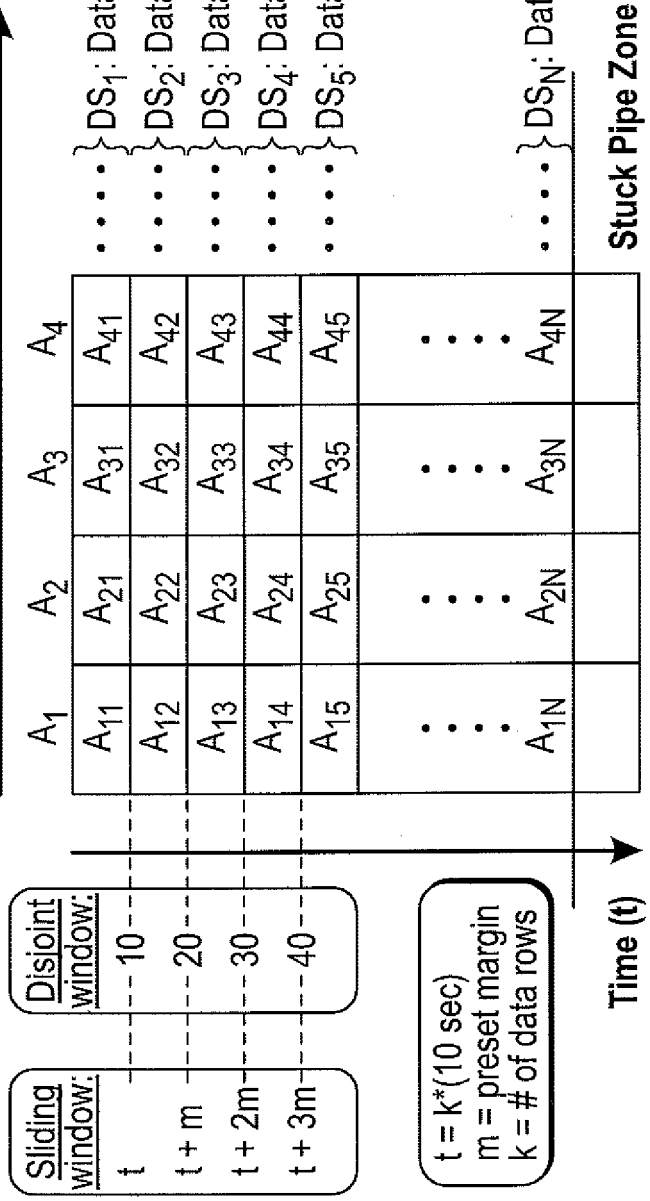
Attributes (A)
A1
A2
A3
A4
A11
A21
A31
A41
A12
A22
A32
A42
A13
A23
A33
A43
A14
A24
A34
A44
A15
A25
A35
A45
A1N
A2N
A3N
A4N
DS1: Data segment 1
DS2: Data segment 2
DS3: Data segment 3
DS4: Data segment 4
DS5: Data segment 5
DSN: Data segment N
Stuck Pipe Zone
Time (t)
Sliding window:
t
t + m
t + 2m
t + 3m
Disjoint window:
10
20
30
40
t = k*(10 sec)
m = preset margin
k = # of data rows

FIG. 3

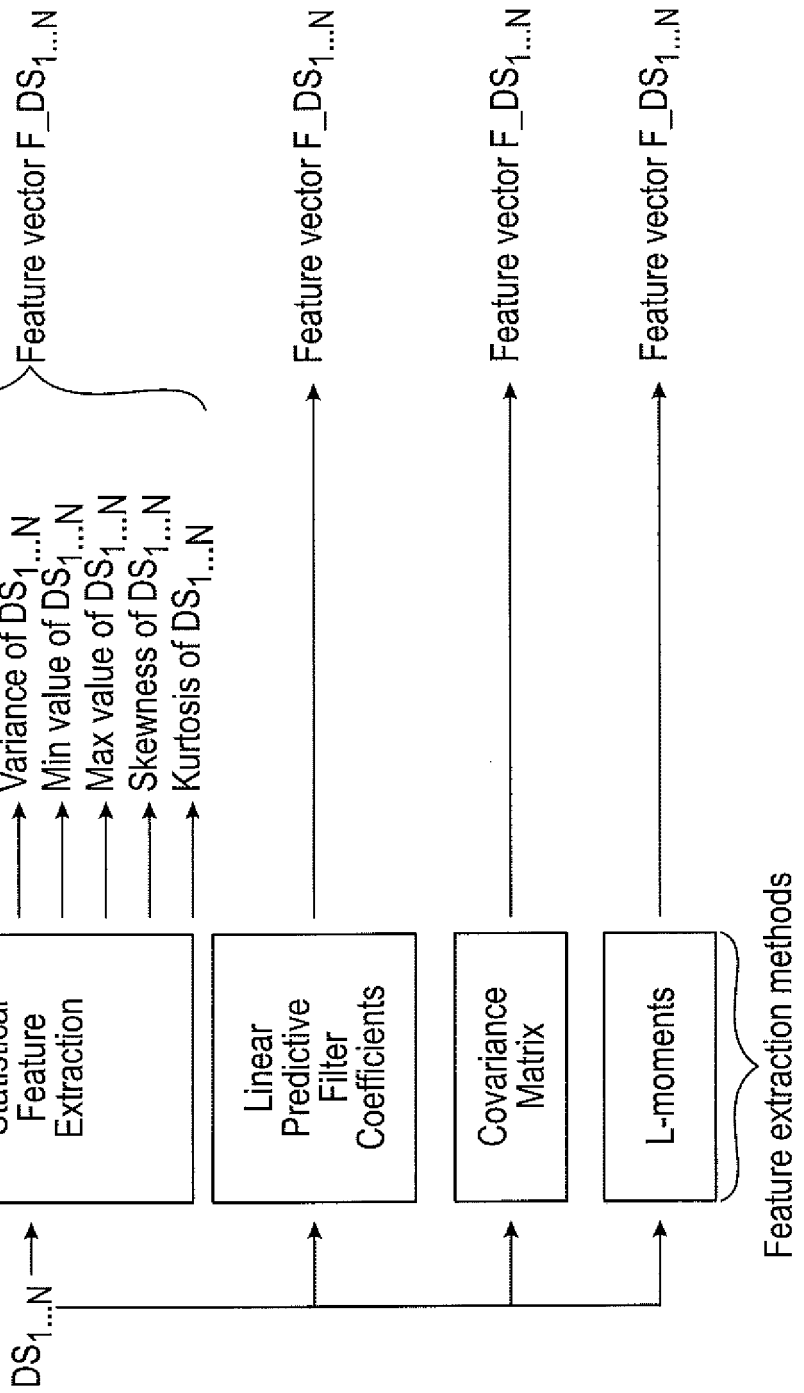
1st Derivative of DS1...N
2nd Derivative of DS1...N
Mean value of DS1...N
Variance of DS1...N
Min value of DS1...N
Max value of DS1...N
Skewness of DS1...N
Kurtosis of DS1...N
Feature vector F_DS1...N
Statistical Feature Extraction
Linear Predictive Filter Coefficients
Feature vector F_DS1...N
Covariance Matrix
Feature vector F_DS1...N
L-moments
Feature vector F_DS1...N
Feature extraction methods
DS1...N

FIG. 4

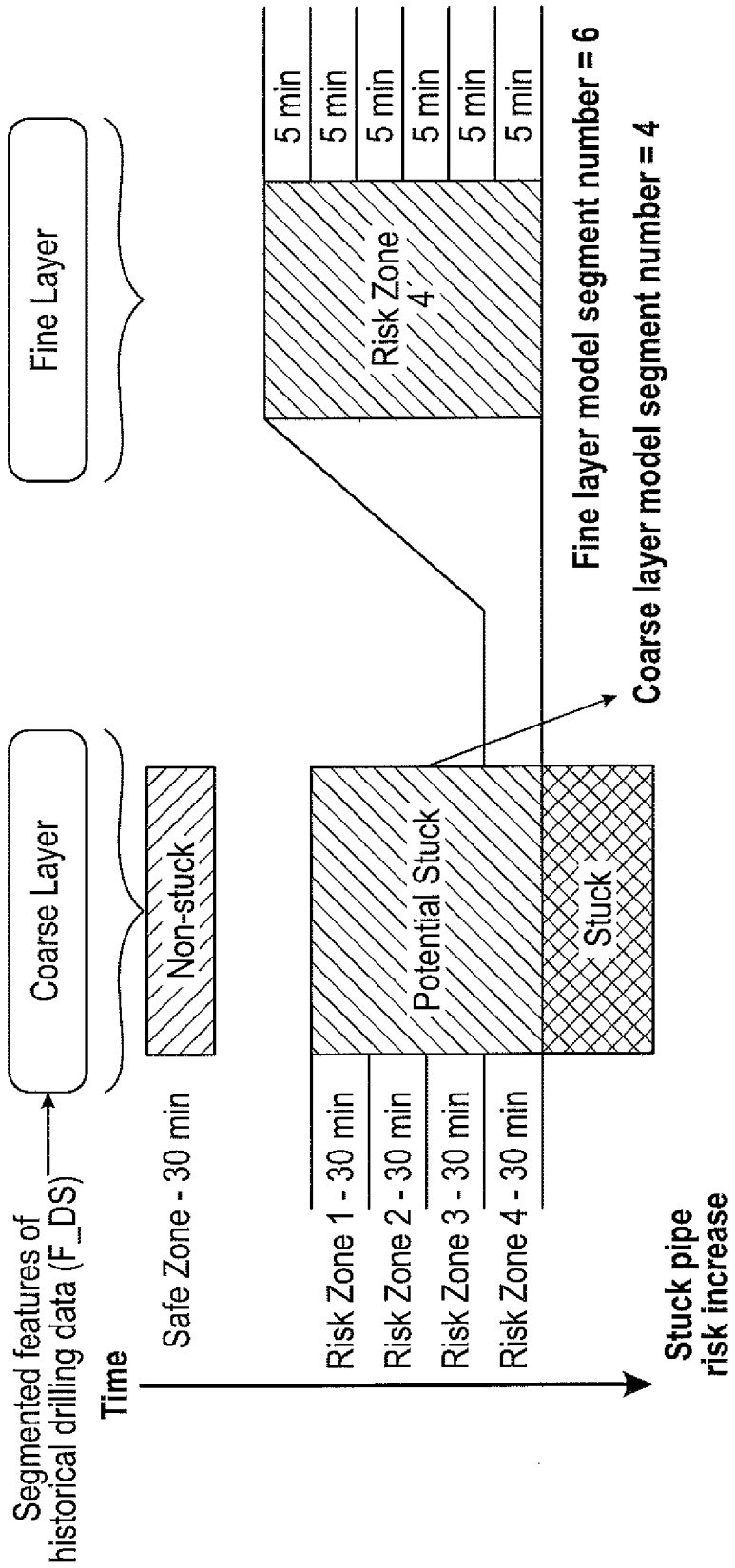
Segmented features of historical drilling data (F_DS)
Time
Coarse Layer
Fine Layer
Safe Zone - 30 min
Non-stuck
Risk Zone 1 - 30 min
Risk Zone 2 - 30 min
Risk Zone 3 - 30 min
Risk Zone 4 - 30 min
Potential Stuck
Stuck
5 min
5 min
5 min
5 min
5 min
5 min
Risk Zone 4'
Fine layer model segment number = 6
Coarse layer model segment number = 4
Stuck pipe risk increase

FIG. 5

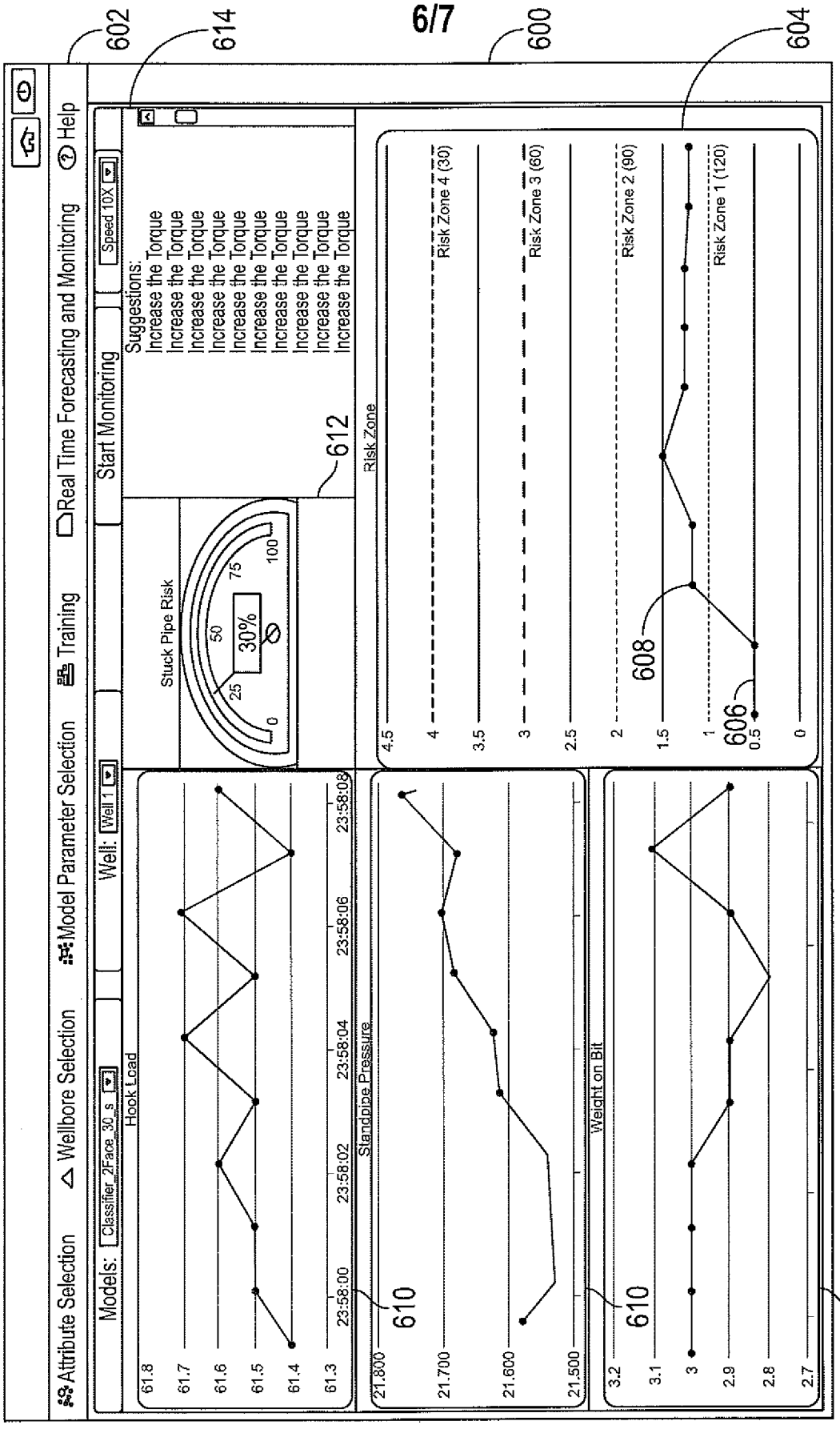
602
614
600
604
Attribute Selection
Wellbore Selection
Model Parameter Selection
Training
Real Time Forecasting and Monitoring
Help
Models:
Classifier_2Face_30_s
Well:
Well 1
Start Monitoring
Speed 10X
Suggestions:
Increase the Torque
Stuck Pipe Risk
30%
612
Risk Zone
Risk Zone 4 (30)
Risk Zone 3 (60)
Risk Zone 2 (90)
Risk Zone 1 (120)
608
606
Hook Load
Standpipe Pressure
Weight on Bit
610

FIG. 6

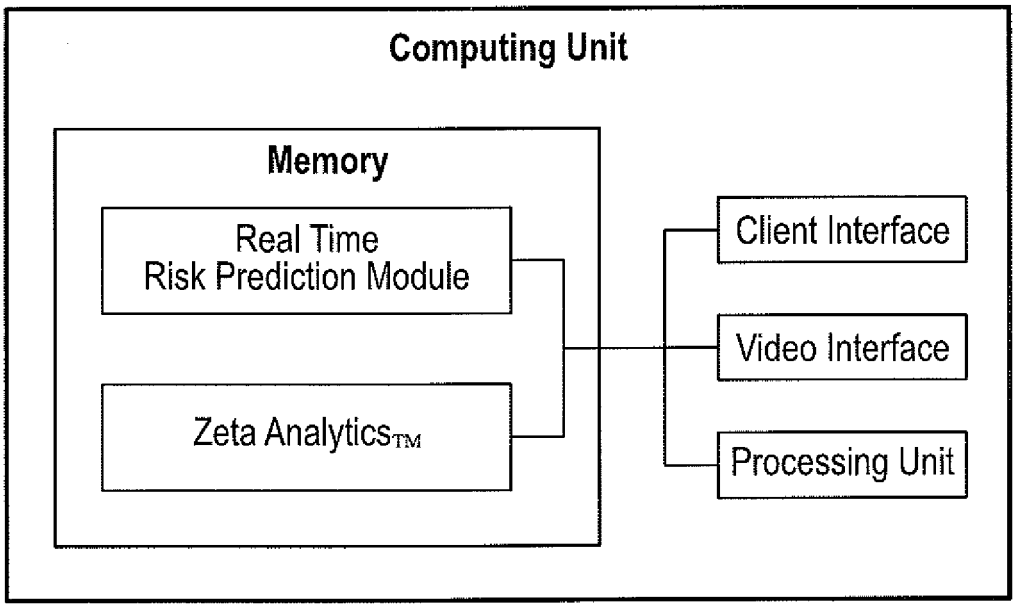
Computing Unit
Memory
Real Time
Risk Prediction Module
Zeta Analytics™
Client Interface
Video Interface
Processing Unit

FIG. 7