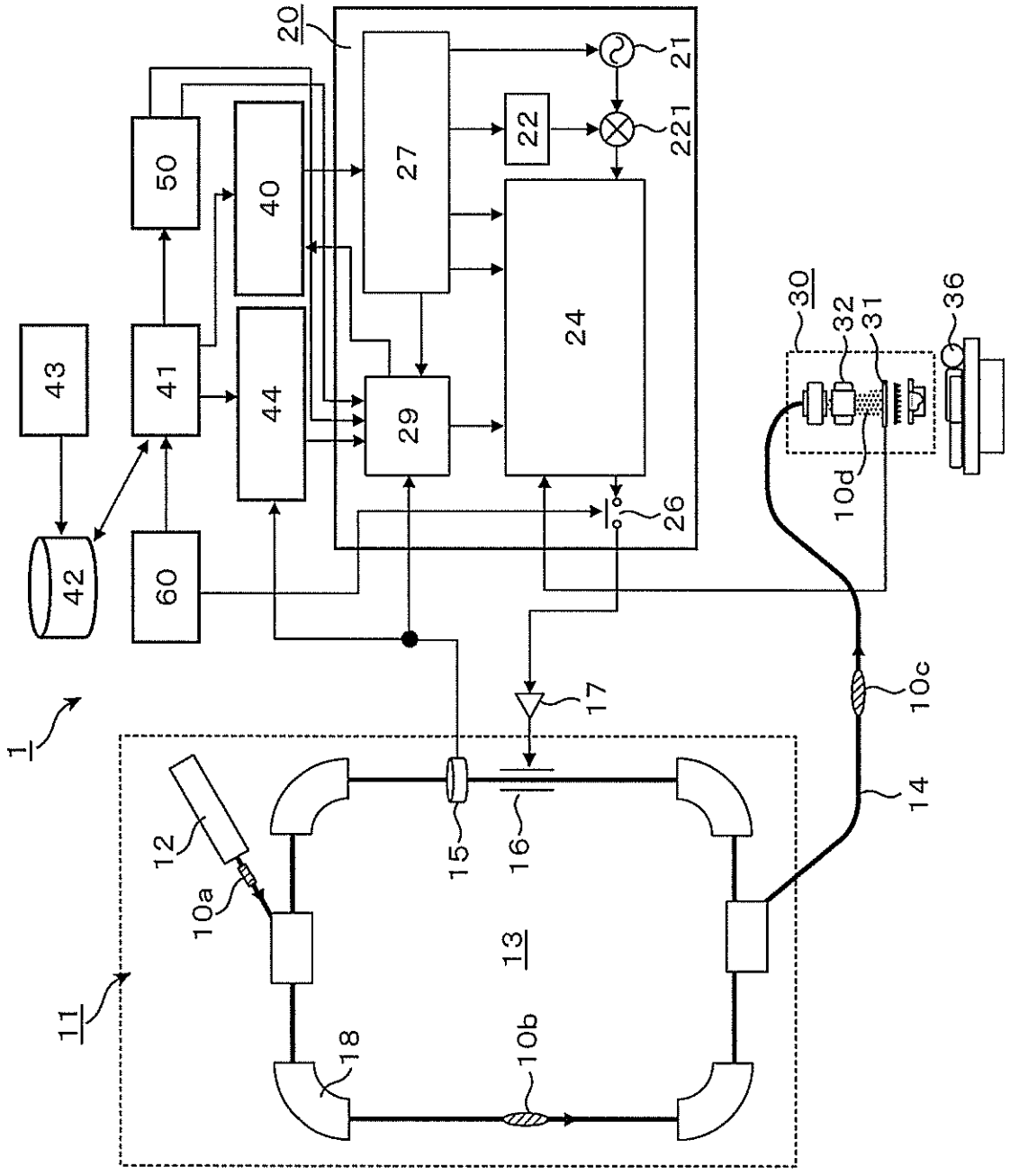

1
11
12
10a
13
15
16
17
18
10b
10c
14
10d
20
21
221
22
24
26
27
29
30
31
32
36
40
41
42
43
44
50
60

FIG.1

FIG.2A

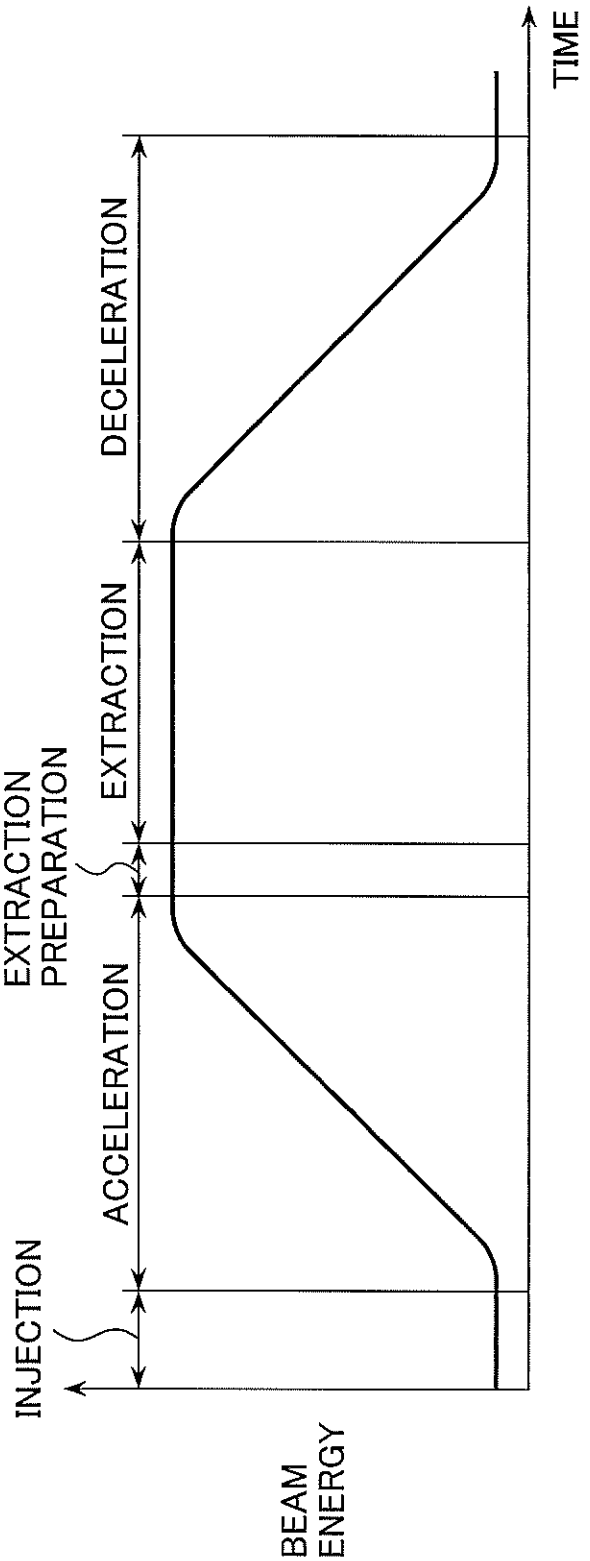

INJECTION
ACCELERATION
EXTRACTION PREPARATION
EXTRACTION
DECELERATION
TIME
BEAM ENERGY

FIG.2B

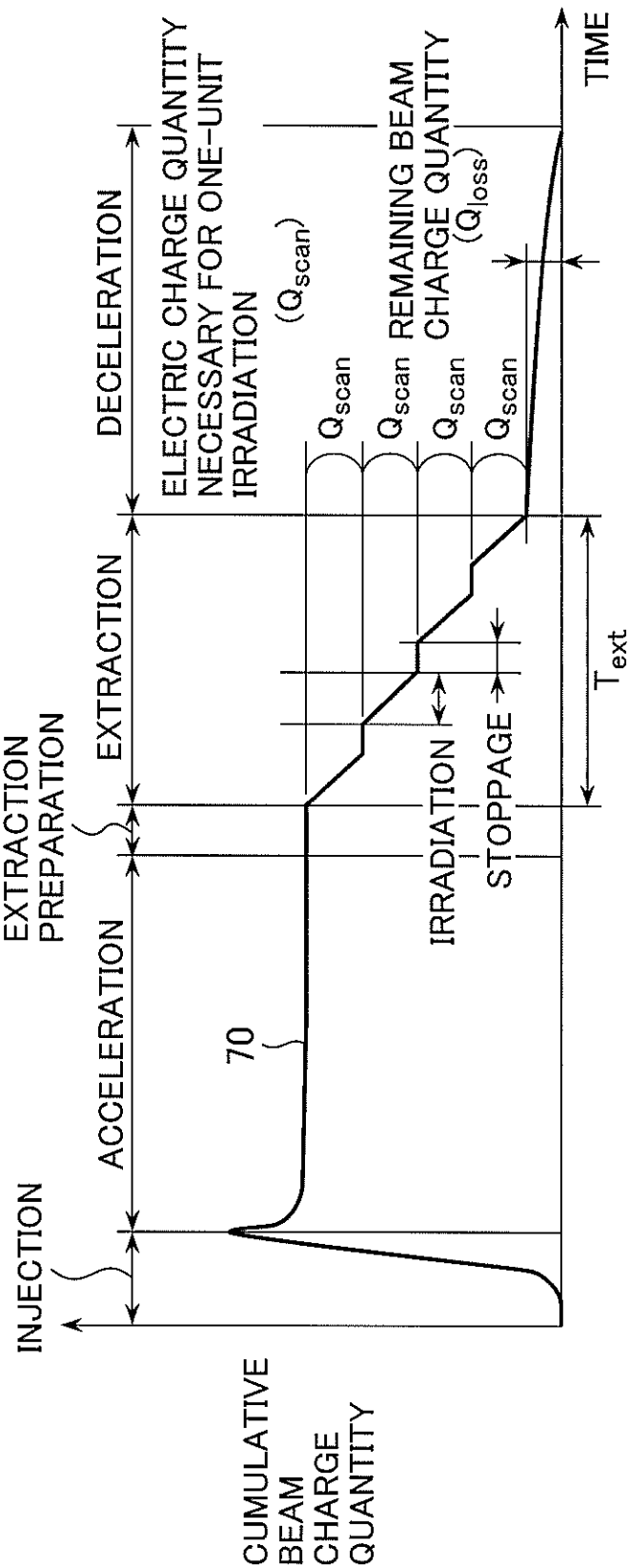

INJECTION
ACCELERATION
EXTRACTION PREPARATION
EXTRACTION
DECELERATION
ELECTRIC CHARGE QUANTITY NECESSARY FOR ONE-UNIT IRRADIATION
(Qscan)
Qscan
Qscan
Qscan
Qscan
REMAINING BEAM CHARGE QUANTITY
(Qloss)
IRRADIATION
STOPPAGE
Text
70
TIME
CUMULATIVE BEAM CHARGE QUANTITY

FIG.3

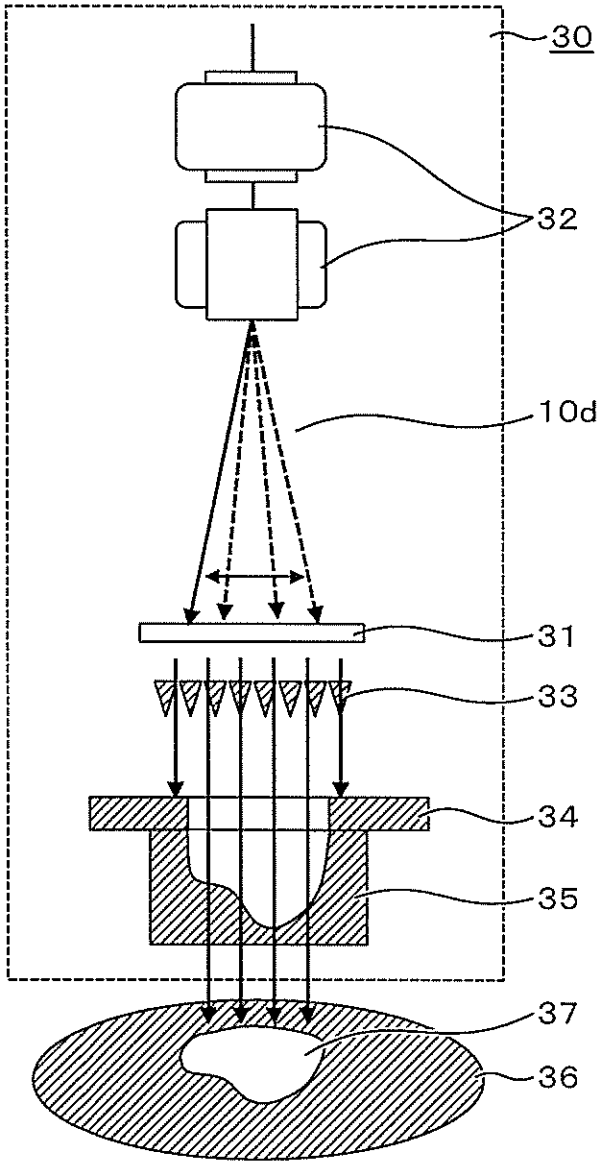


FIG.4A

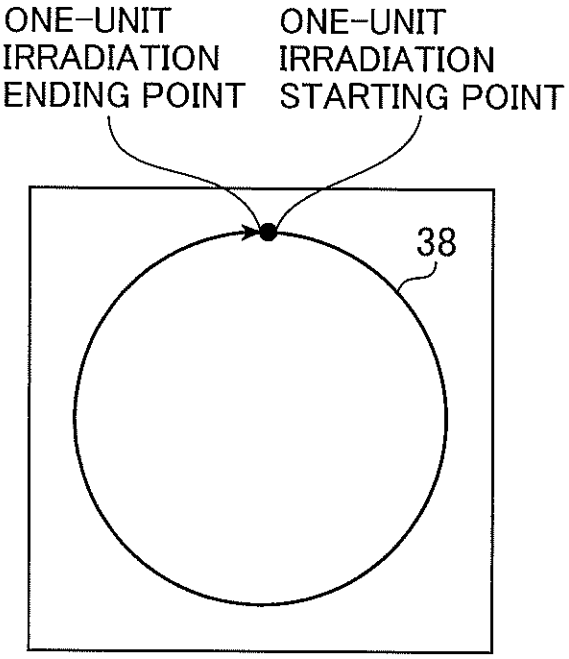


FIG.4B

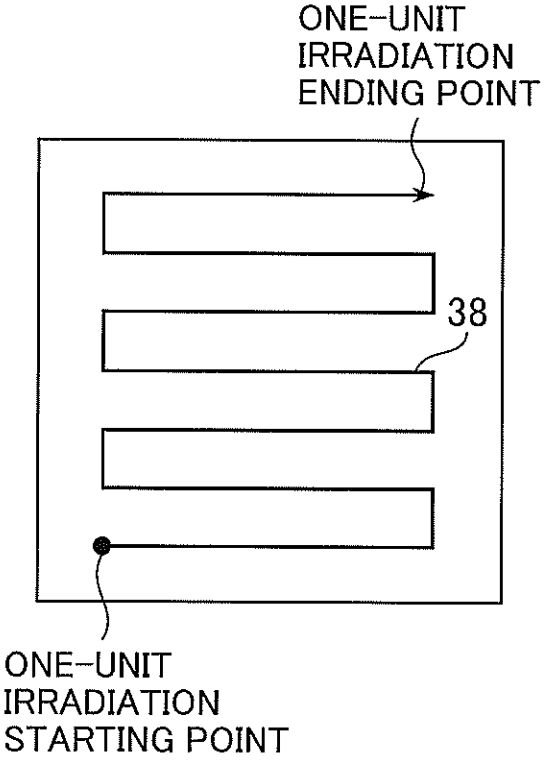


FIG.4C

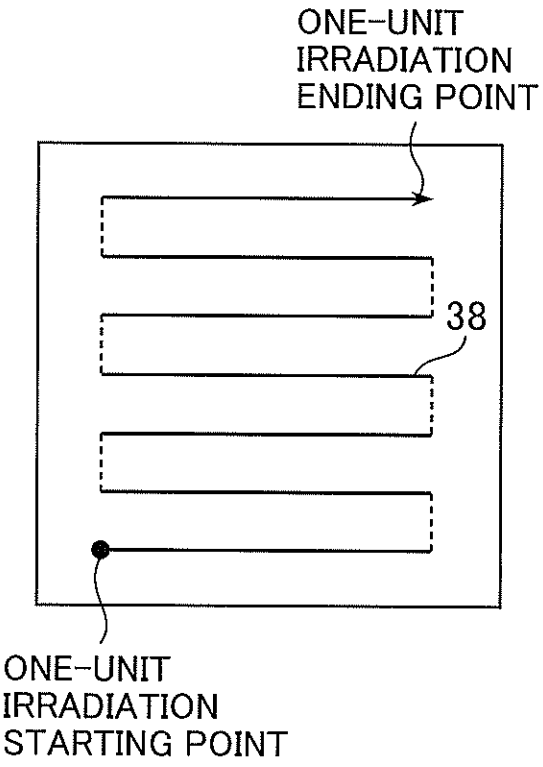


FIG.5

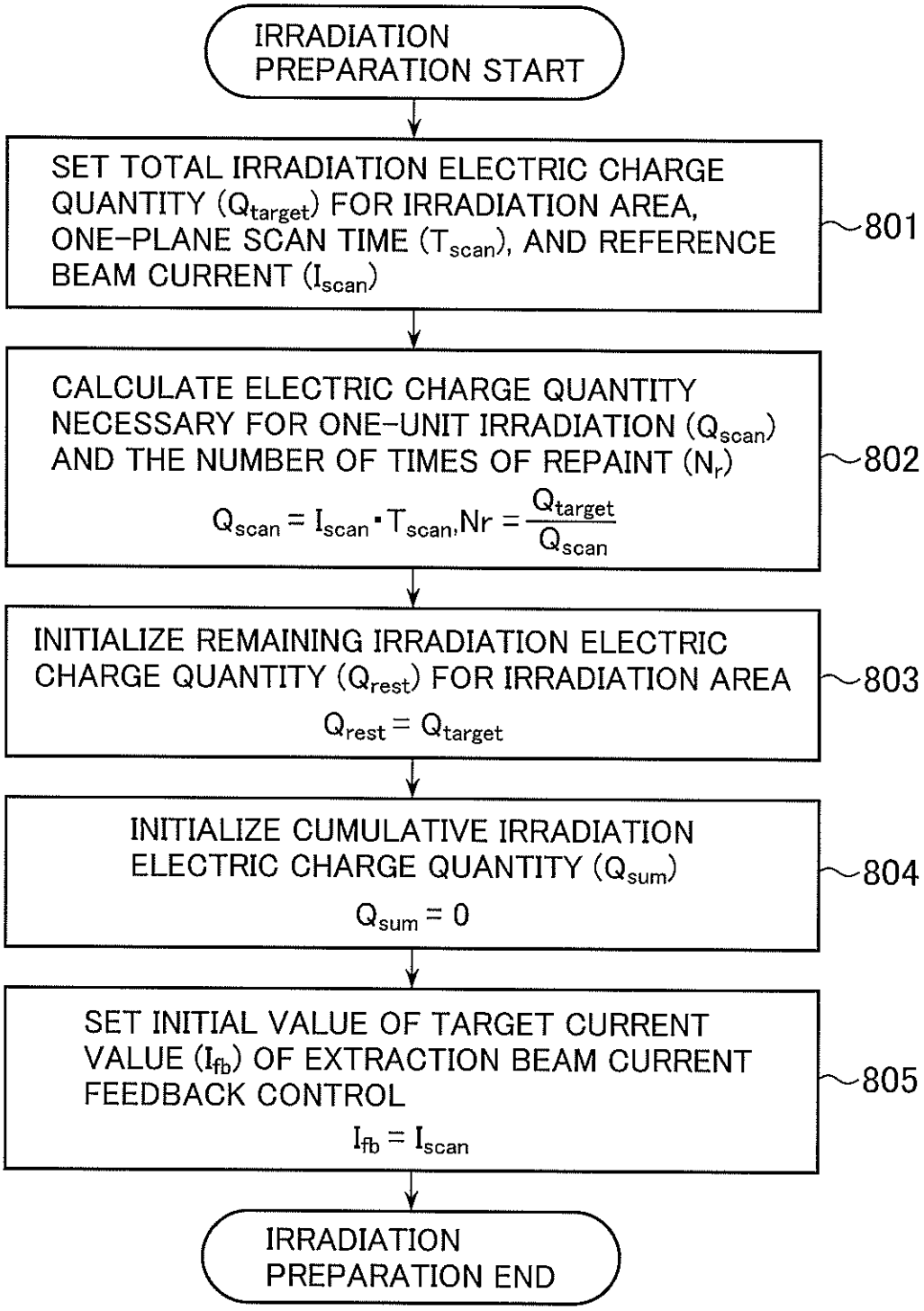

IRRADIATION PREPARATION START
SET TOTAL IRRADIATION ELECTRIC CHARGE QUANTITY (Q_{target}) FOR IRRADIATION AREA, ONE-PLANE SCAN TIME (T_{scan}), AND REFERENCE BEAM CURRENT (I_{scan})
801
CALCULATE ELECTRIC CHARGE QUANTITY NECESSARY FOR ONE-UNIT IRRADIATION (Q_{scan}) AND THE NUMBER OF TIMES OF REPAINT (N_r)
$Q_{scan} = I_{scan} \cdot T_{scan}, Nr = \frac{Q_{target}}{Q_{scan}}$
802
INITIALIZE REMAINING IRRADIATION ELECTRIC CHARGE QUANTITY (Q_{rest}) FOR IRRADIATION AREA
$Q_{rest} = Q_{target}$
803
INITIALIZE CUMULATIVE IRRADIATION ELECTRIC CHARGE QUANTITY (Q_{sum})
$Q_{sum} = 0$
804
SET INITIAL VALUE OF TARGET CURRENT VALUE (I_{fb}) OF EXTRACTION BEAM CURRENT FEEDBACK CONTROL
$I_{fb} = I_{scan}$
805
IRRADIATION PREPARATION END

FIG.6

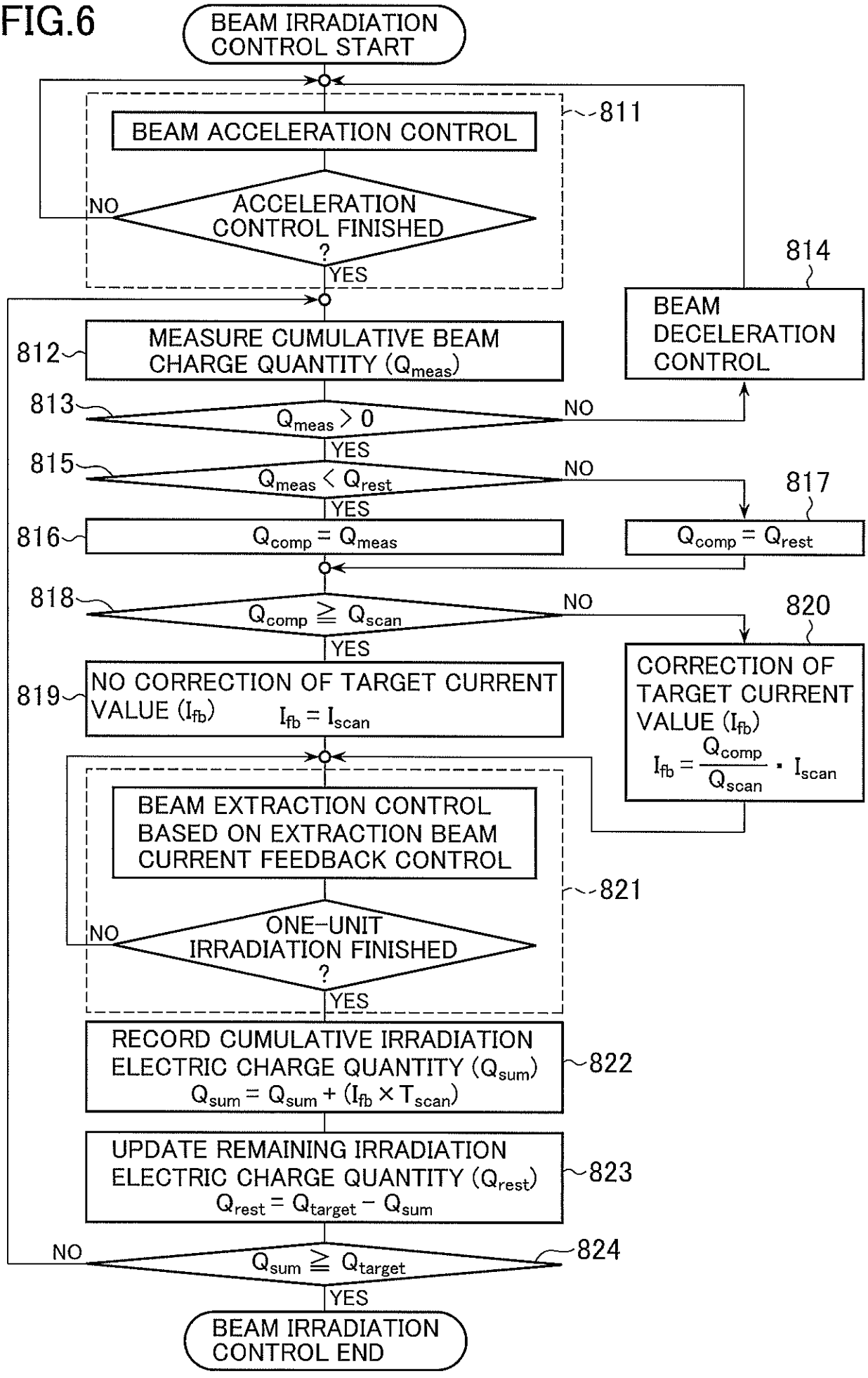

BEAM IRRADIATION CONTROL START
811
BEAM ACCELERATION CONTROL
NO
ACCELERATION CONTROL FINISHED ?
YES
814
BEAM DECELERATION CONTROL
812
MEASURE CUMULATIVE BEAM CHARGE QUANTITY (Q_{meas})
813
$Q_{meas} > 0$
NO
YES
815
$Q_{meas} < Q_{rest}$
NO
YES
817
$Q_{comp} = Q_{rest}$
816
$Q_{comp} = Q_{meas}$
818
$Q_{comp} \geqq Q_{scan}$
NO
YES
820
CORRECTION OF TARGET CURRENT VALUE (I_{fb})
$I_{fb} = \frac{Q_{comp}}{Q_{scan}} \cdot I_{scan}$
819
NO CORRECTION OF TARGET CURRENT VALUE (I_{fb})
$I_{fb} = I_{scan}$
BEAM EXTRACTION CONTROL BASED ON EXTRACTION BEAM CURRENT FEEDBACK CONTROL
821
NO
ONE-UNIT IRRADIATION FINISHED ?
YES
RECORD CUMULATIVE IRRADIATION ELECTRIC CHARGE QUANTITY (Q_{sum})
$Q_{sum} = Q_{sum} + (I_{fb} \times T_{scan})$
822
UPDATE REMAINING IRRADIATION ELECTRIC CHARGE QUANTITY (Q_{rest})
$Q_{rest} = Q_{target} - Q_{sum}$
823
NO
$Q_{sum} \geqq Q_{target}$
824
YES
BEAM IRRADIATION CONTROL END

FIG.7

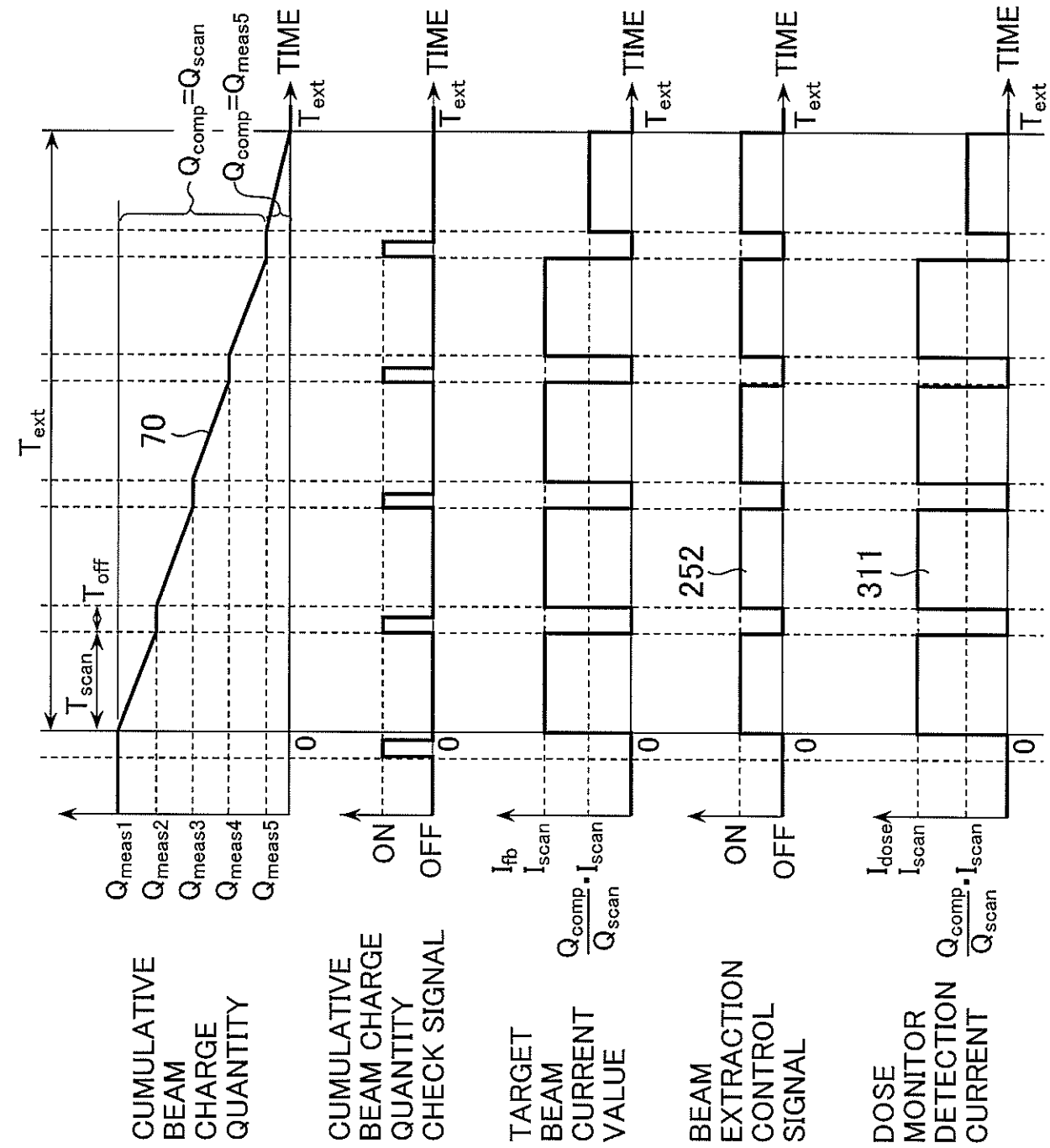

(a)
CUMULATIVE BEAM CHARGE QUANTITY
Q_{meas1}
Q_{meas2}
Q_{meas3}
Q_{meas4}
Q_{meas5}
$Q_{comp}=Q_{scan}$
$Q_{comp}=Q_{meas5}$
T_{ext}
T_{scan}
T_{off}
70
TIME
0
(b)
CUMULATIVE BEAM CHARGE QUANTITY CHECK SIGNAL
ON
OFF
T_{ext}
TIME
0
(c)
TARGET BEAM CURRENT VALUE
I_{fb}
I_{scan}
$\frac{Q_{comp}}{Q_{scan}} \cdot I_{scan}$
T_{ext}
TIME
0
(d)
BEAM EXTRACTION CONTROL SIGNAL
ON
OFF
252
T_{ext}
TIME
0
(e)
DOSE MONITOR DETECTION CURRENT
I_{dose}
I_{scan}
$\frac{Q_{comp}}{Q_{scan}} \cdot I_{scan}$
311
T_{ext}
TIME
0

FIG.8

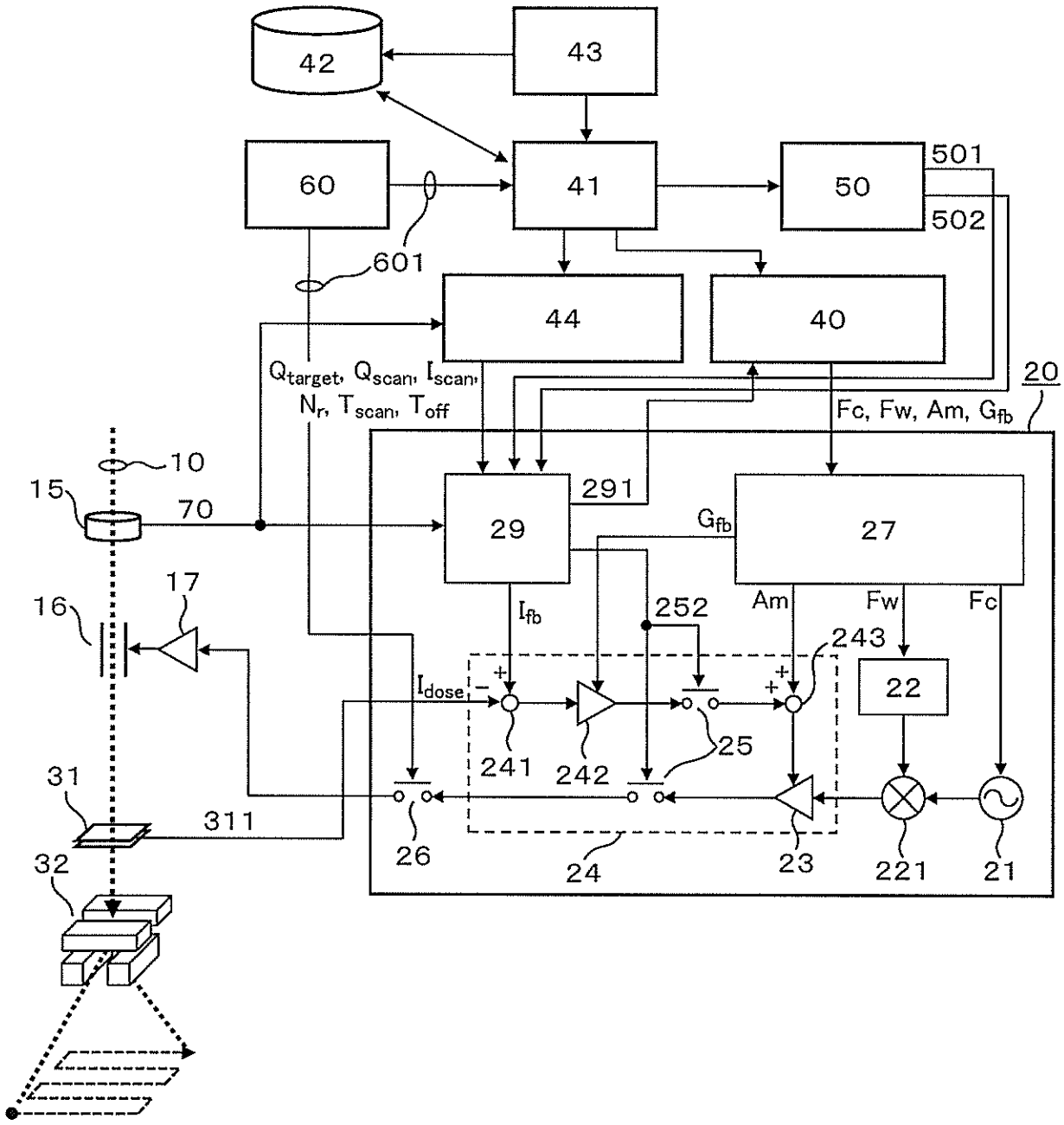

42
43
60
41
50
501
502
601
44
40
Q_{target}, Q_{scan}, I_{scan},
N_r, T_{scan}, T_{off}
Fc, Fw, Am, G_{fb}
20
10
15
70
29
291
G_{fb}
27
17
16
I_{fb}
252
Am
Fw
Fc
243
I_{dose}
22
241
242
25
31
311
26
24
23
221
21
32

FIG.9

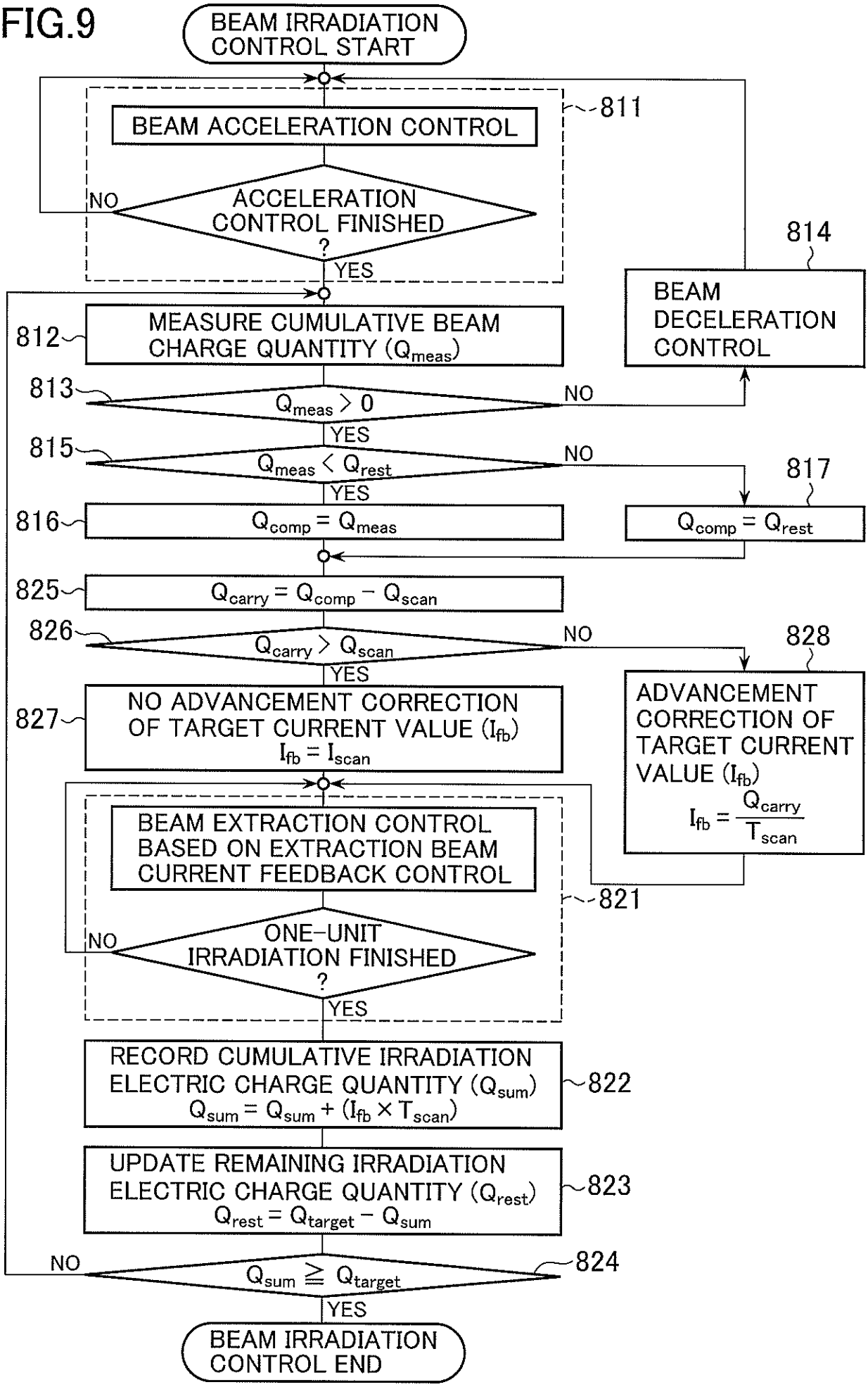
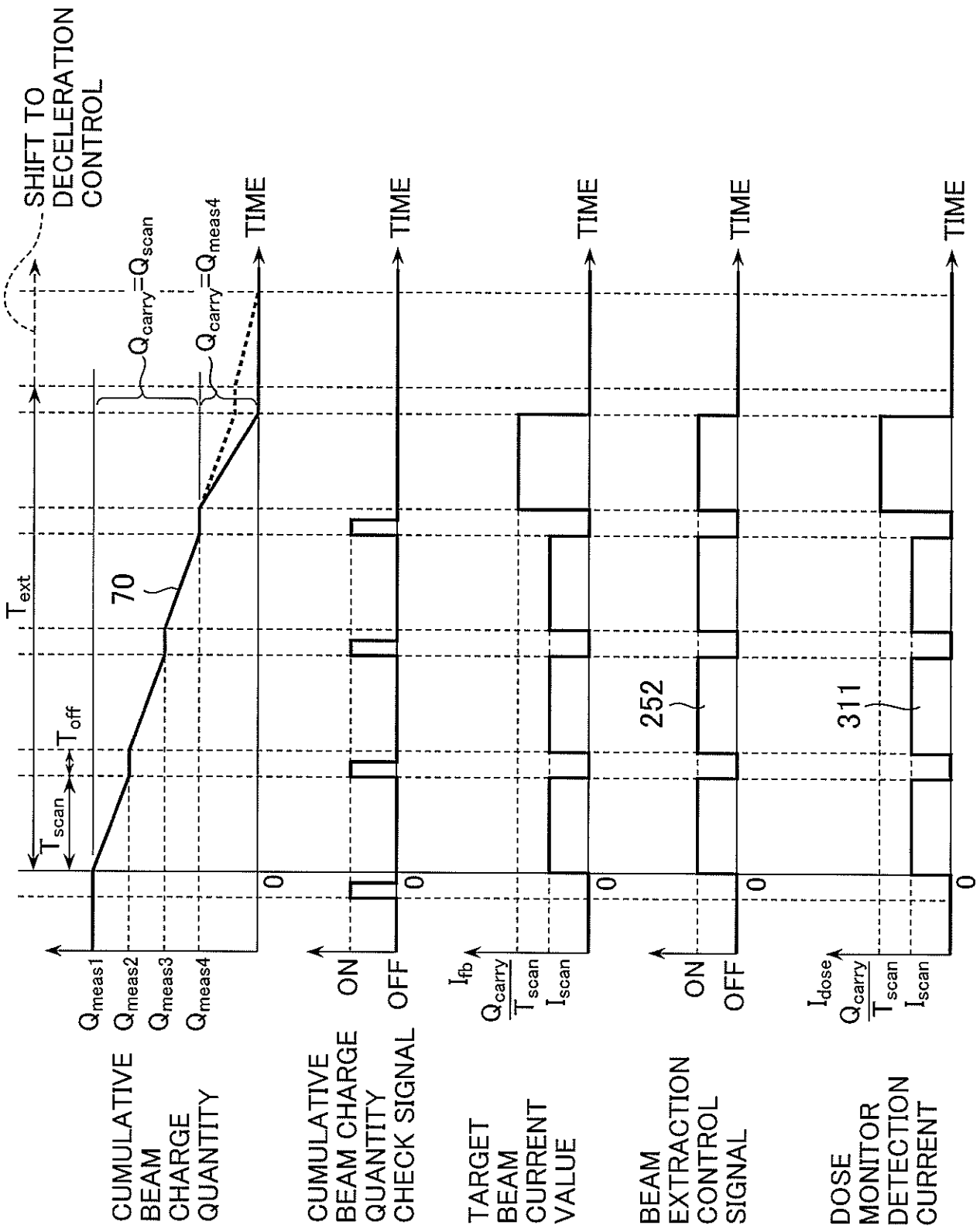

BEAM IRRADIATION CONTROL START
811
BEAM ACCELERATION CONTROL
NO
ACCELERATION CONTROL FINISHED ?
YES
814
BEAM DECELERATION CONTROL
812
MEASURE CUMULATIVE BEAM CHARGE QUANTITY (Q_{meas})
813
$Q_{meas} > 0$
NO
YES
815
$Q_{meas} < Q_{rest}$
NO
YES
817
$Q_{comp} = Q_{rest}$
816
$Q_{comp} = Q_{meas}$
825
$Q_{carry} = Q_{comp} - Q_{scan}$
826
$Q_{carry} > Q_{scan}$
NO
YES
828
ADVANCEMENT CORRECTION OF TARGET CURRENT VALUE (I_{fb})
$I_{fb} = \frac{Q_{carry}}{T_{scan}}$
827
NO ADVANCEMENT CORRECTION OF TARGET CURRENT VALUE (I_{fb})
$I_{fb} = I_{scan}$
BEAM EXTRACTION CONTROL BASED ON EXTRACTION BEAM CURRENT FEEDBACK CONTROL
821
NO
ONE-UNIT IRRADIATION FINISHED ?
YES
RECORD CUMULATIVE IRRADIATION ELECTRIC CHARGE QUANTITY (Q_{sum})
$Q_{sum} = Q_{sum} + (I_{fb} \times T_{scan})$
822
UPDATE REMAINING IRRADIATION ELECTRIC CHARGE QUANTITY (Q_{rest})
$Q_{rest} = Q_{target} - Q_{sum}$
823
NO
$Q_{sum} \geqq Q_{target}$
824
YES
BEAM IRRADIATION CONTROL END

FIG.10


(a)
CUMULATIVE BEAM CHARGE QUANTITY
SHIFT TO DECELERATION CONTROL
T_{ext}
T_{scan}
T_{off}
$Q_{carry}=Q_{scan}$
$Q_{carry}=Q_{meas4}$
70
Q_{meas1}
Q_{meas2}
Q_{meas3}
Q_{meas4}
TIME
0
(b)
CUMULATIVE BEAM CHARGE QUANTITY CHECK SIGNAL
ON
OFF
TIME
0
(c)
TARGET BEAM CURRENT VALUE
I_{fb}
$\frac{Q_{carry}}{T_{scan}}$
I_{scan}
TIME
0
(d)
BEAM EXTRACTION CONTROL SIGNAL
252
ON
OFF
TIME
0
(e)
DOSE MONITOR DETECTION CURRENT
311
I_{dose}
$\frac{Q_{carry}}{T_{scan}}$
I_{scan}
TIME
0