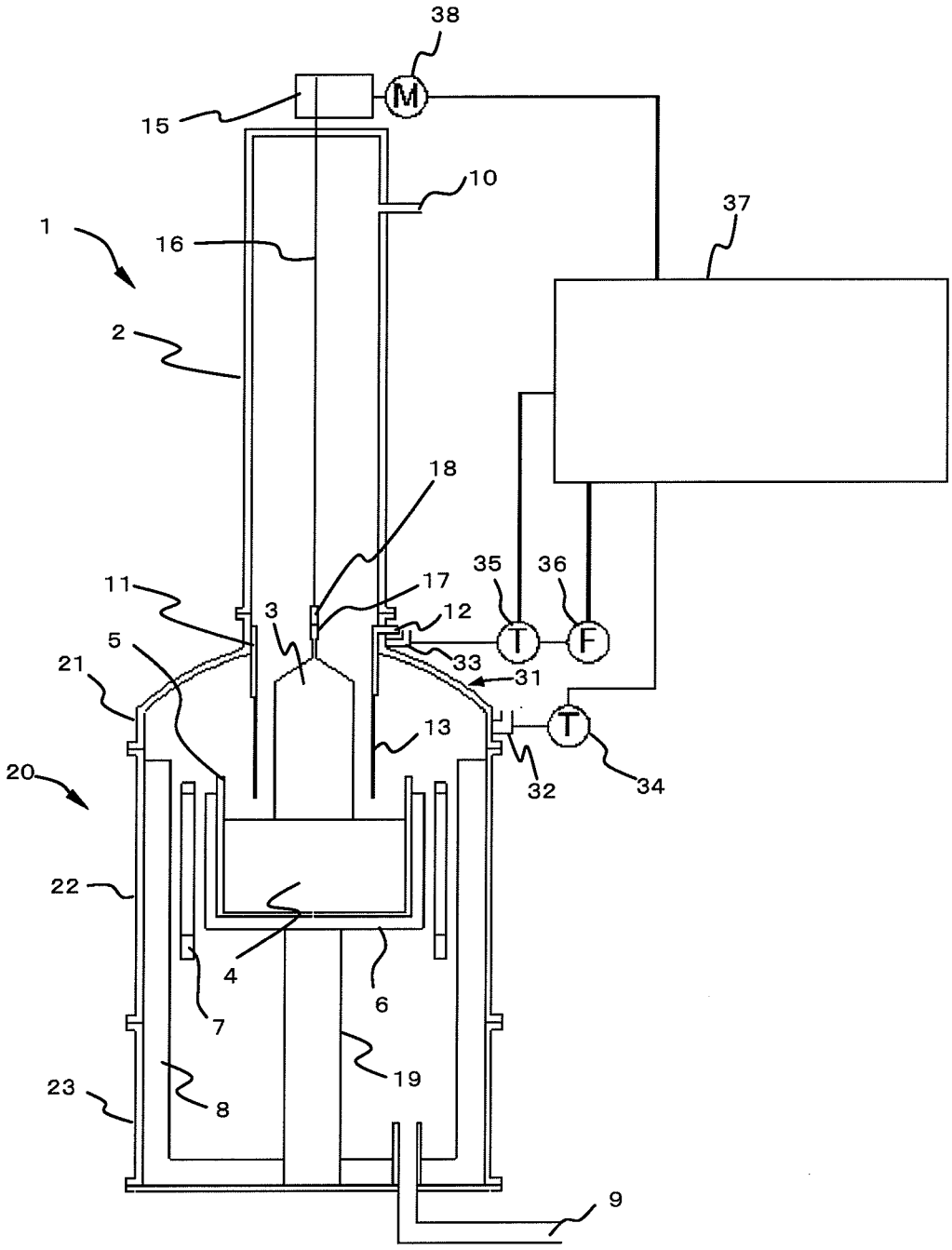
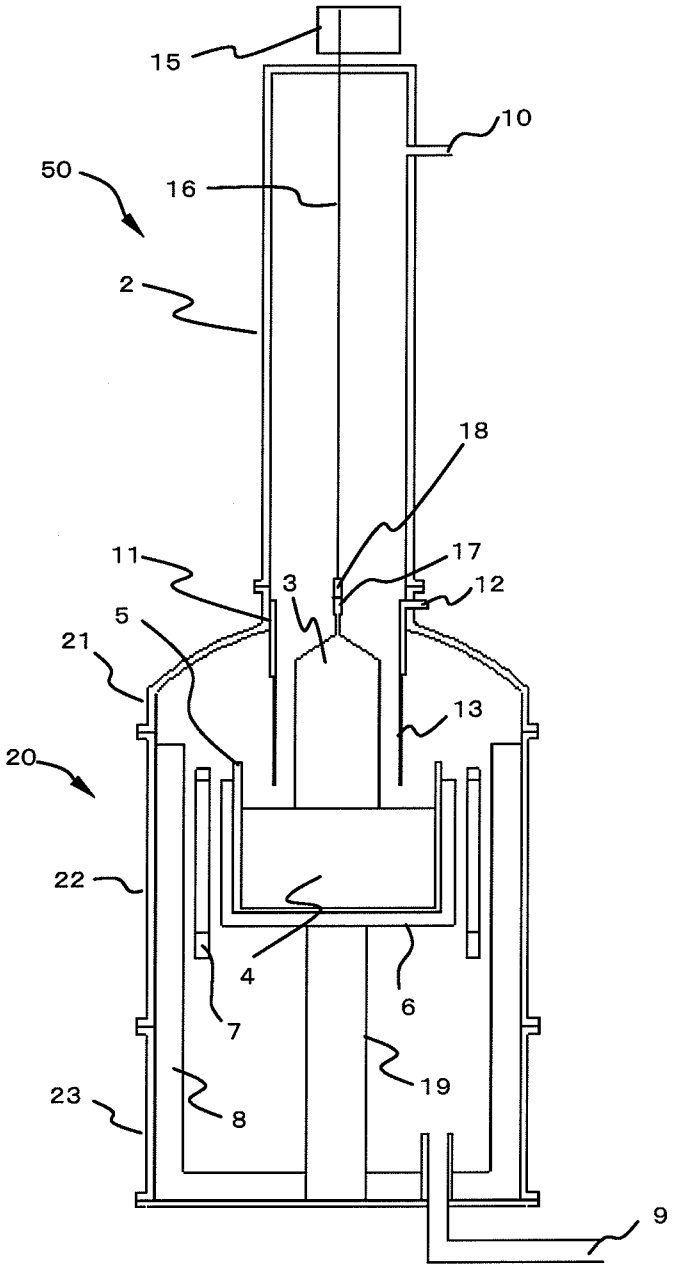
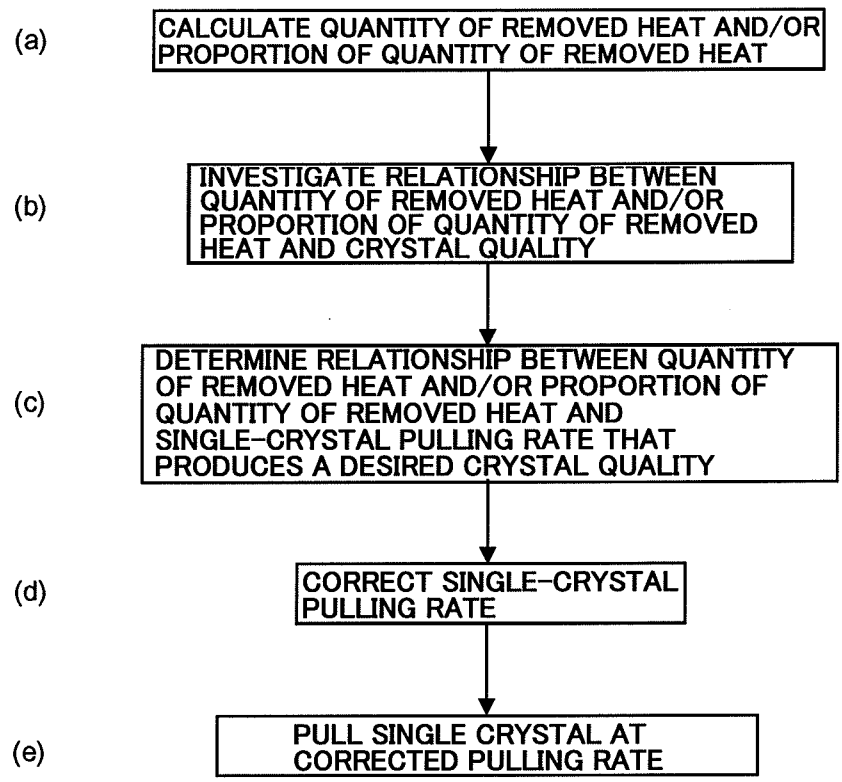
[Fig.1]


38
M
15
10
37
1
16
2
18
35
36
11
17
3
12
T
F
5
21
33
31
T
13
20
32
34
22
4
6
7
19
23
8
9

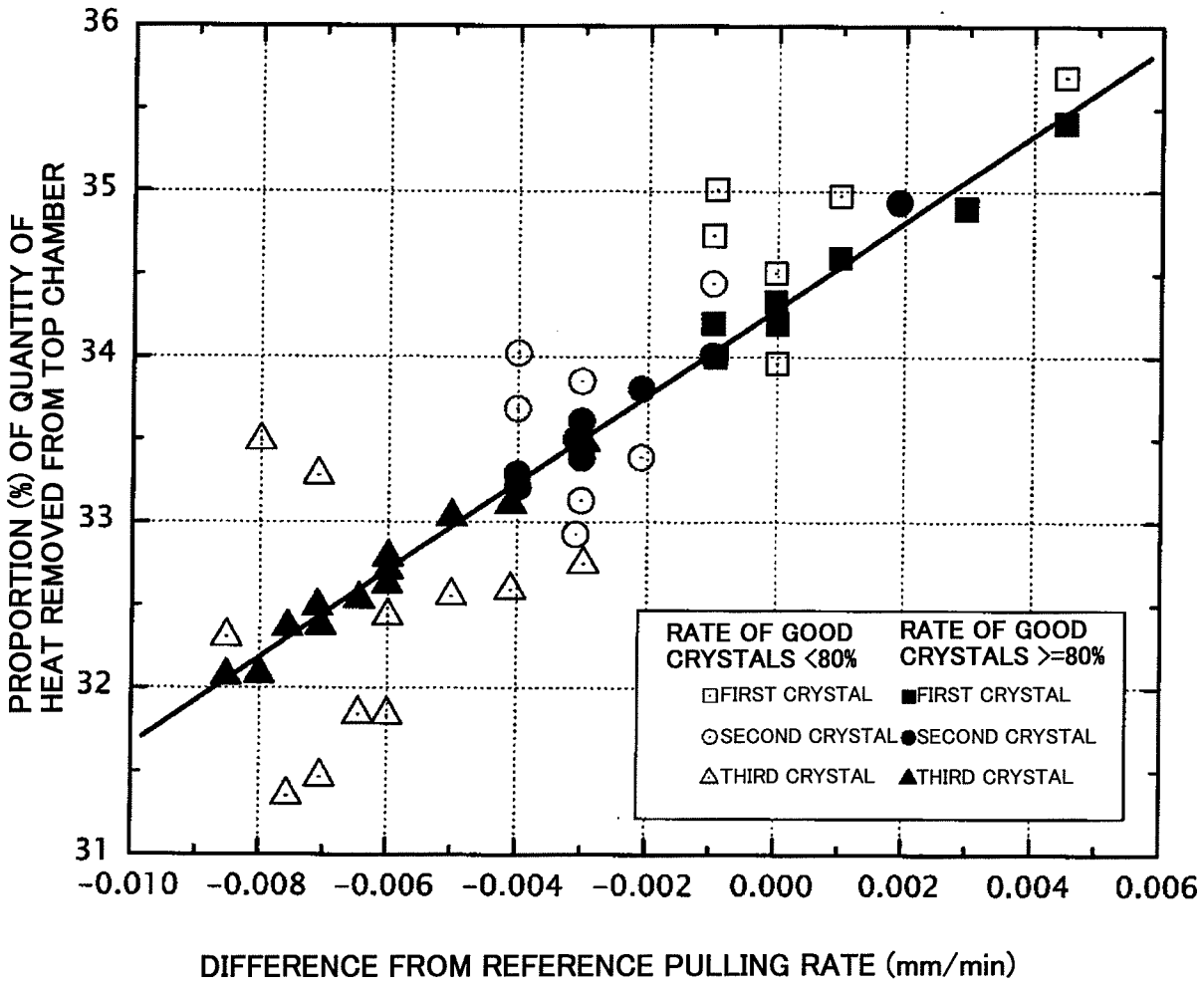
[Fig.2]



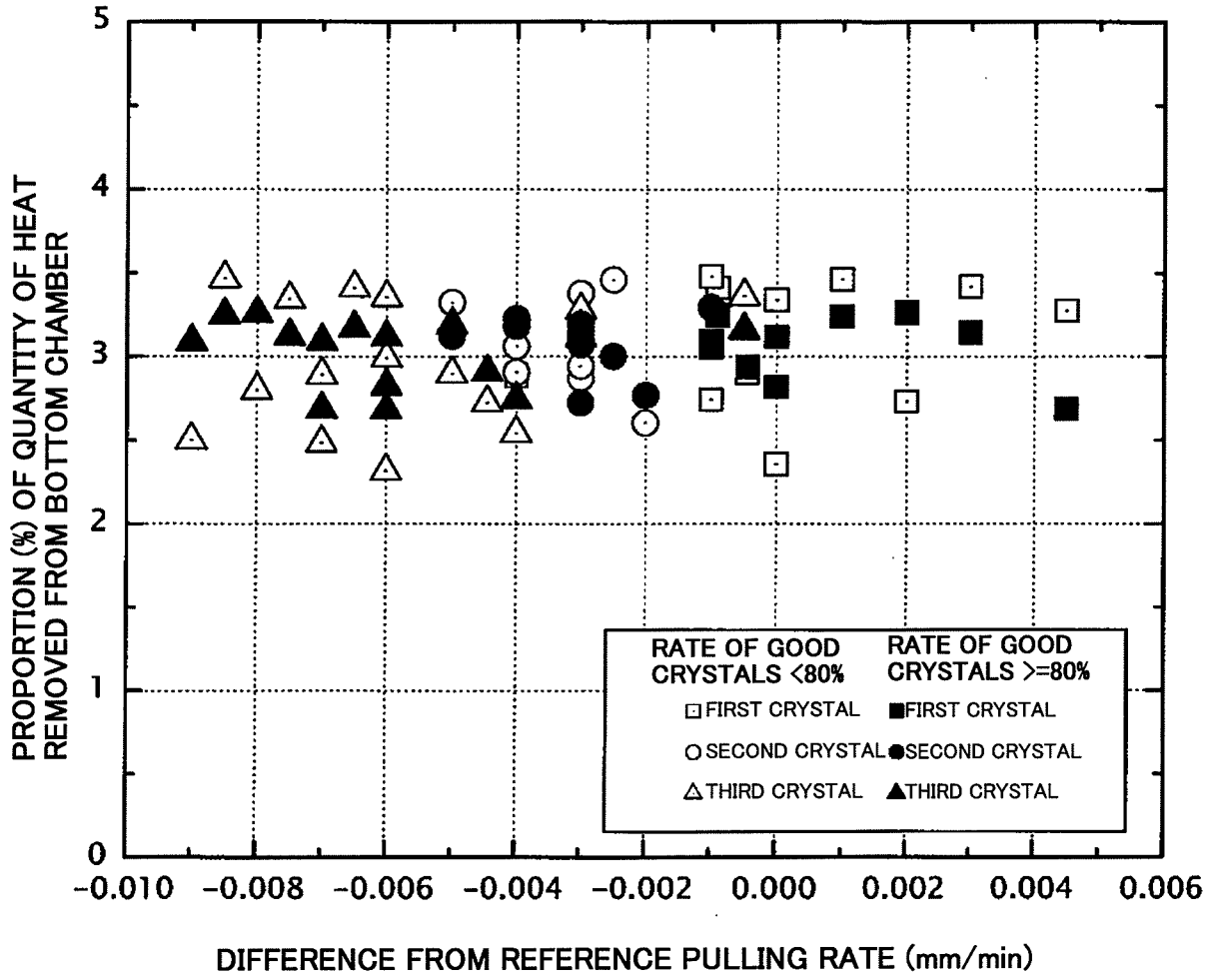
[Fig.3]


(a)
CALCULATE QUANTITY OF REMOVED HEAT AND/OR PROPORTION OF QUANTITY OF REMOVED HEAT
(b)
INVESTIGATE RELATIONSHIP BETWEEN QUANTITY OF REMOVED HEAT AND/OR PROPORTION OF QUANTITY OF REMOVED HEAT AND CRYSTAL QUALITY
(c)
DETERMINE RELATIONSHIP BETWEEN QUANTITY OF REMOVED HEAT AND/OR PROPORTION OF QUANTITY OF REMOVED HEAT AND SINGLE-CRYSTAL PULLING RATE THAT PRODUCES A DESIRED CRYSTAL QUALITY
(d)
CORRECT SINGLE-CRYSTAL PULLING RATE
(e)
PULL SINGLE CRYSTAL AT CORRECTED PULLING RATE

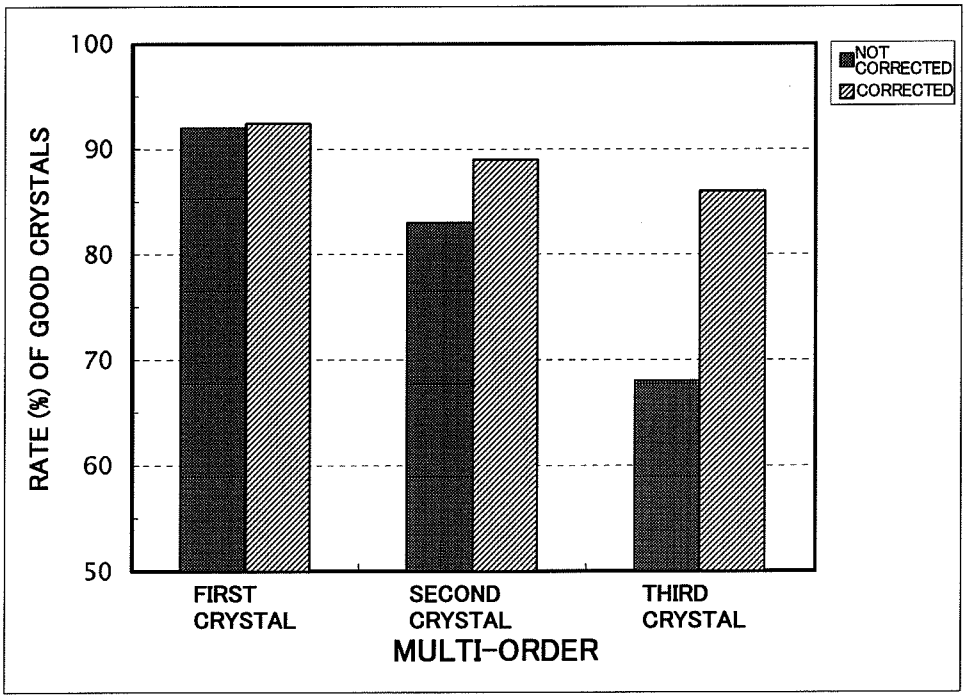
[Fig.4]


PROPORTION (%) OF QUANTITY OF HEAT REMOVED FROM TOP CHAMBER
36
35
34
33
32
31
-0.010
-0.008
-0.006
-0.004
-0.002
0.000
0.002
0.004
0.006
DIFFERENCE FROM REFERENCE PULLING RATE (mm/min)
RATE OF GOOD CRYSTALS <80%
RATE OF GOOD CRYSTALS >=80%
FIRST CRYSTAL
FIRST CRYSTAL
SECOND CRYSTAL
SECOND CRYSTAL
THIRD CRYSTAL
THIRD CRYSTAL

[Fig.5]


PROPORTION (%) OF QUANTITY OF HEAT REMOVED FROM BOTTOM CHAMBER
5
4
3
2
1
0
-0.010
-0.008
-0.006
-0.004
-0.002
0.000
0.002
0.004
0.006
DIFFERENCE FROM REFERENCE PULLING RATE (mm/min)
RATE OF GOOD CRYSTALS <80%
RATE OF GOOD CRYSTALS >=80%
FIRST CRYSTAL
FIRST CRYSTAL
SECOND CRYSTAL
SECOND CRYSTAL
THIRD CRYSTAL
THIRD CRYSTAL

[Fig.6]


RATE (%) OF GOOD CRYSTALS
100
90
80
70
60
50
NOT CORRECTED
CORRECTED
FIRST CRYSTAL
SECOND CRYSTAL
THIRD CRYSTAL
MULTI-ORDER