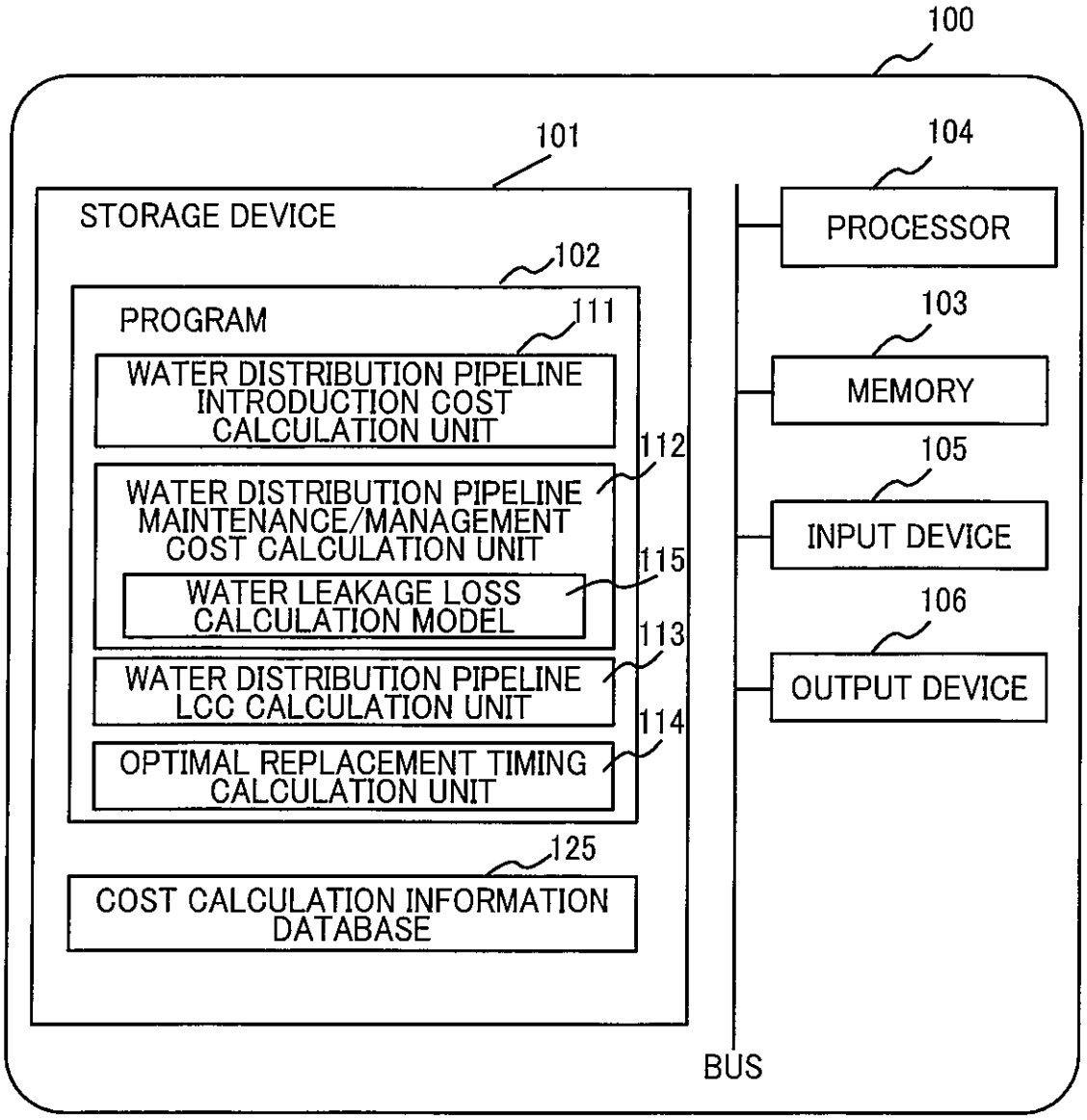

100
101
STORAGE DEVICE
102
PROGRAM
111
WATER DISTRIBUTION PIPELINE INTRODUCTION COST CALCULATION UNIT
112
WATER DISTRIBUTION PIPELINE MAINTENANCE/MANAGEMENT COST CALCULATION UNIT
115
WATER LEAKAGE LOSS CALCULATION MODEL
113
WATER DISTRIBUTION PIPELINE LCC CALCULATION UNIT
114
OPTIMAL REPLACEMENT TIMING CALCULATION UNIT
125
COST CALCULATION INFORMATION DATABASE
104
PROCESSOR
103
MEMORY
105
INPUT DEVICE
106
OUTPUT DEVICE
BUS

FIG. 1

125

COST CALCULATION INFORMATION DATABASE

PIPELINE NUMBER	PIPELINE LENGTH (m)	DIAMETER (mm)	PIPE TYPE	TIME OF USE (YEAR(S))	NUMBER OF REPAIRS	INFORMATION ON GROUND	INSPECTION CYCLE FOR WATER LEAKAGE (YEAR(S))	SPECIFICATIONS	UNAVOIDABLE WATER LEAKAGE AMOUNT	OPTIMAL REPLACEMENT TIMING	...
1	3500	200	DIP	40	1 (35TH YEAR)	GOOD	3				...
2	2000	250	DIP	30	2 (25TH AND 30TH YEAR)	GOOD	3				...
3	1500	100	SP	25	0	GOOD	4				...
.	.	.	.	.	.	.	.				...

FIG. 2

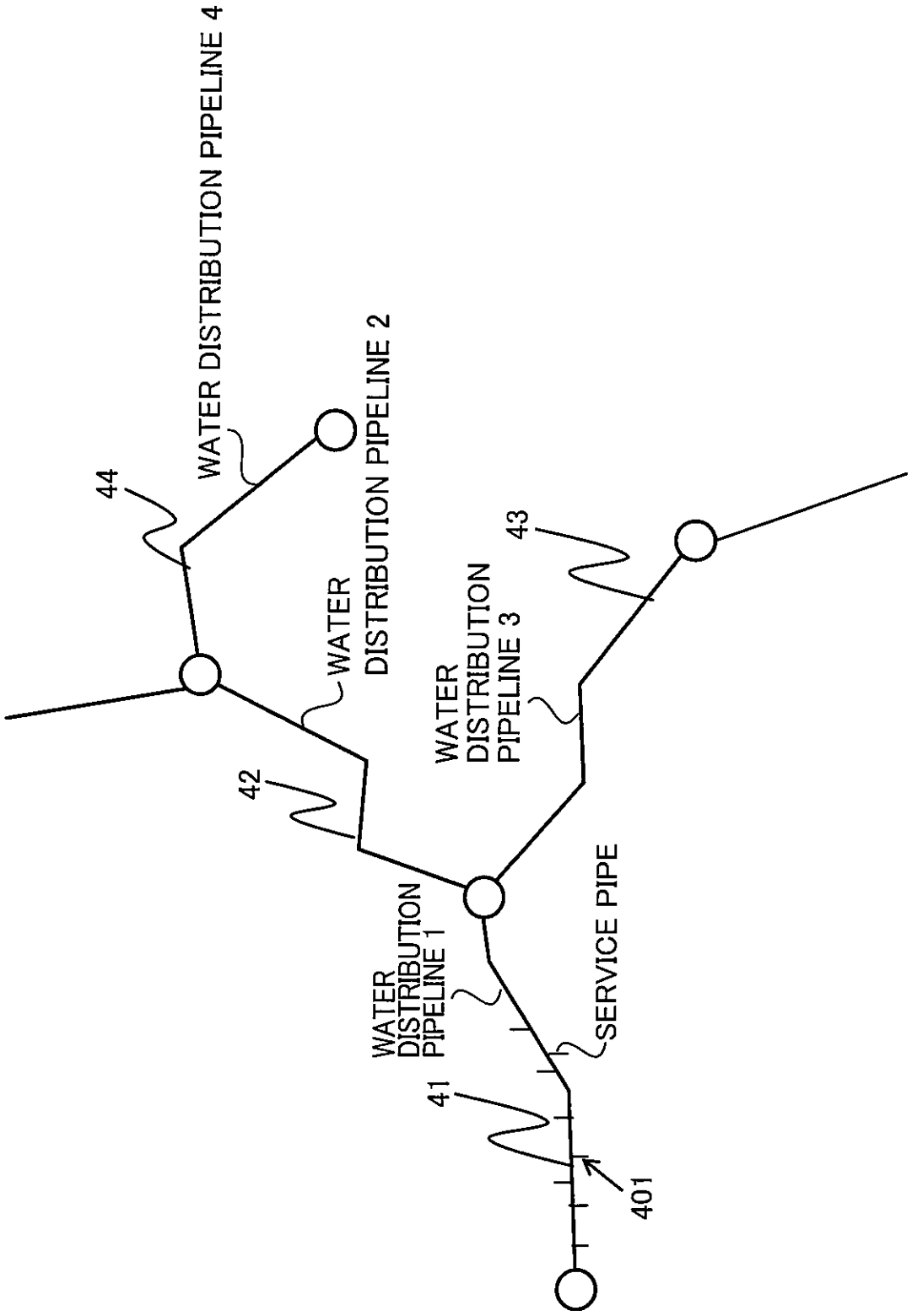

WATER DISTRIBUTION PIPELINE 4
44
WATER
DISTRIBUTION PIPELINE 2
WATER
DISTRIBUTION
PIPELINE 3
43
42
WATER
DISTRIBUTION
PIPELINE 1
SERVICE PIPE
41
401

FIG. 3

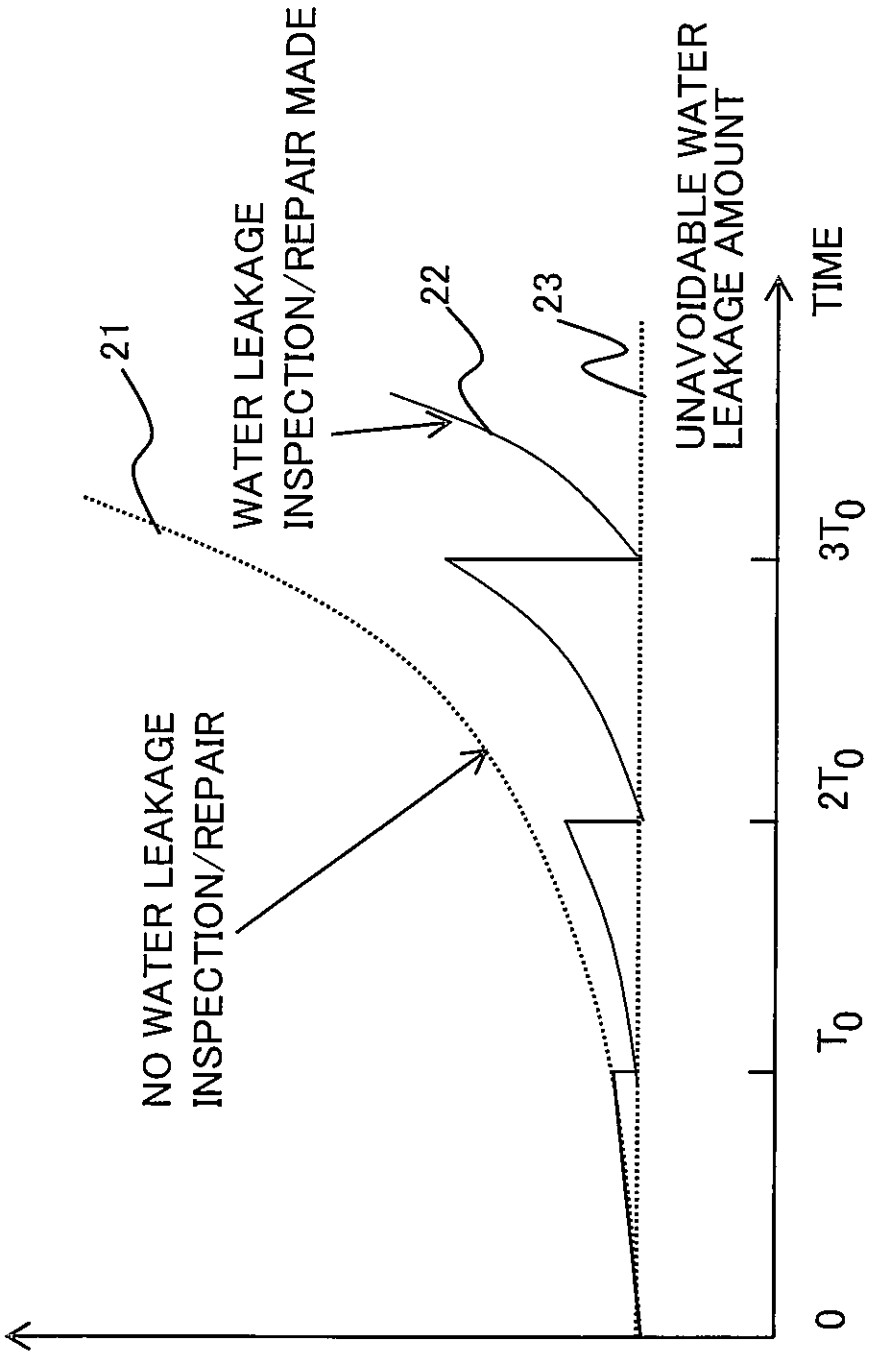

WATER LEAKAGE AMOUNT (m³/y)
NO WATER LEAKAGE INSPECTION/REPAIR
WATER LEAKAGE INSPECTION/REPAIR MADE
21
22
23
UNAVOIDABLE WATER LEAKAGE AMOUNT
TIME
0
T0
2T0
3T0

FIG. 4

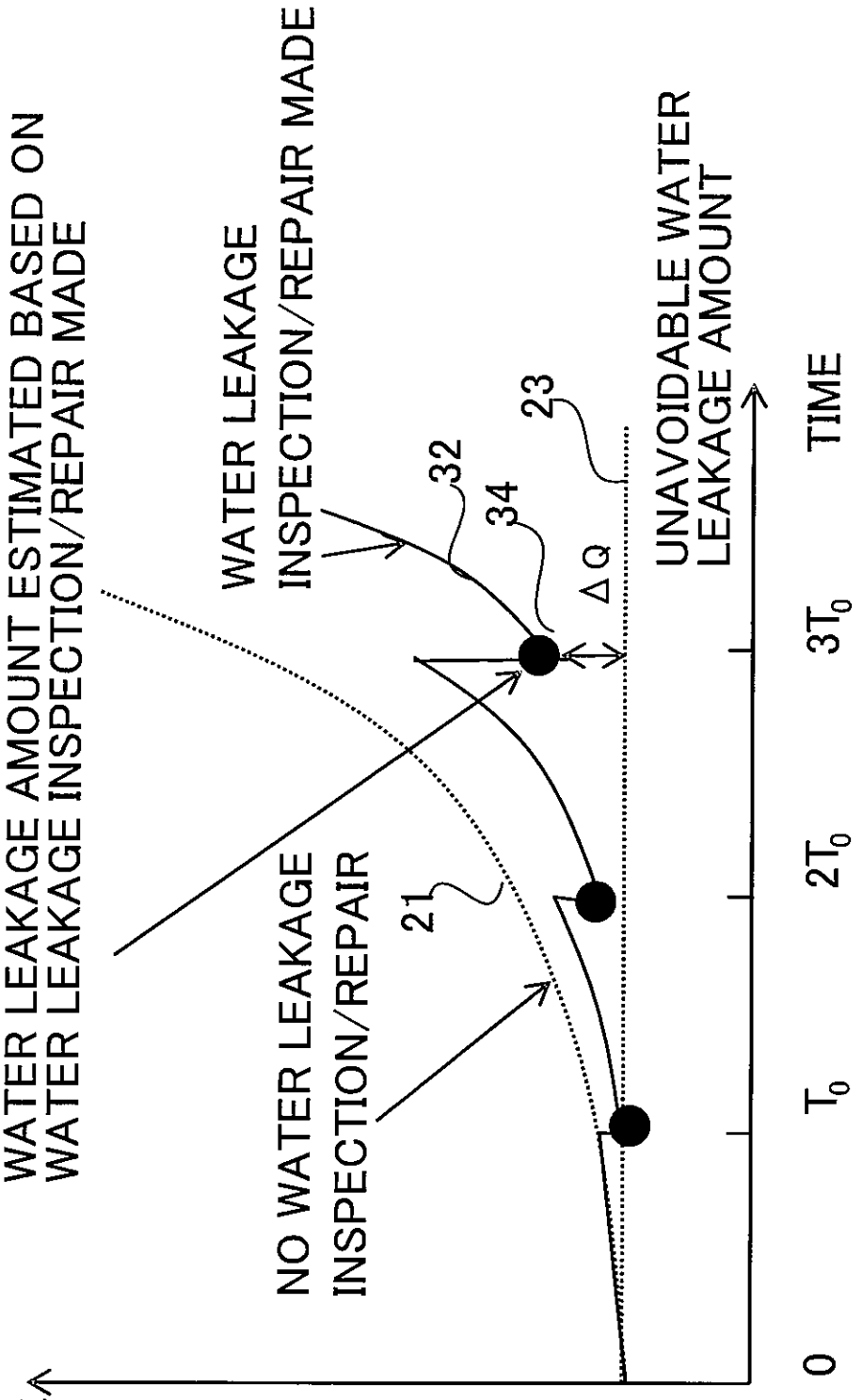

WATER LEAKAGE AMOUNT ESTIMATED BASED ON WATER LEAKAGE INSPECTION/REPAIR MADE
WATER LEAKAGE INSPECTION/REPAIR MADE
NO WATER LEAKAGE INSPECTION/REPAIR
21
32
34
23
ΔQ
UNAVOIDABLE WATER LEAKAGE AMOUNT
WATER LEAKAGE AMOUNT (m³/y)
0
T0
2T0
3T0
TIME

FIG. 5

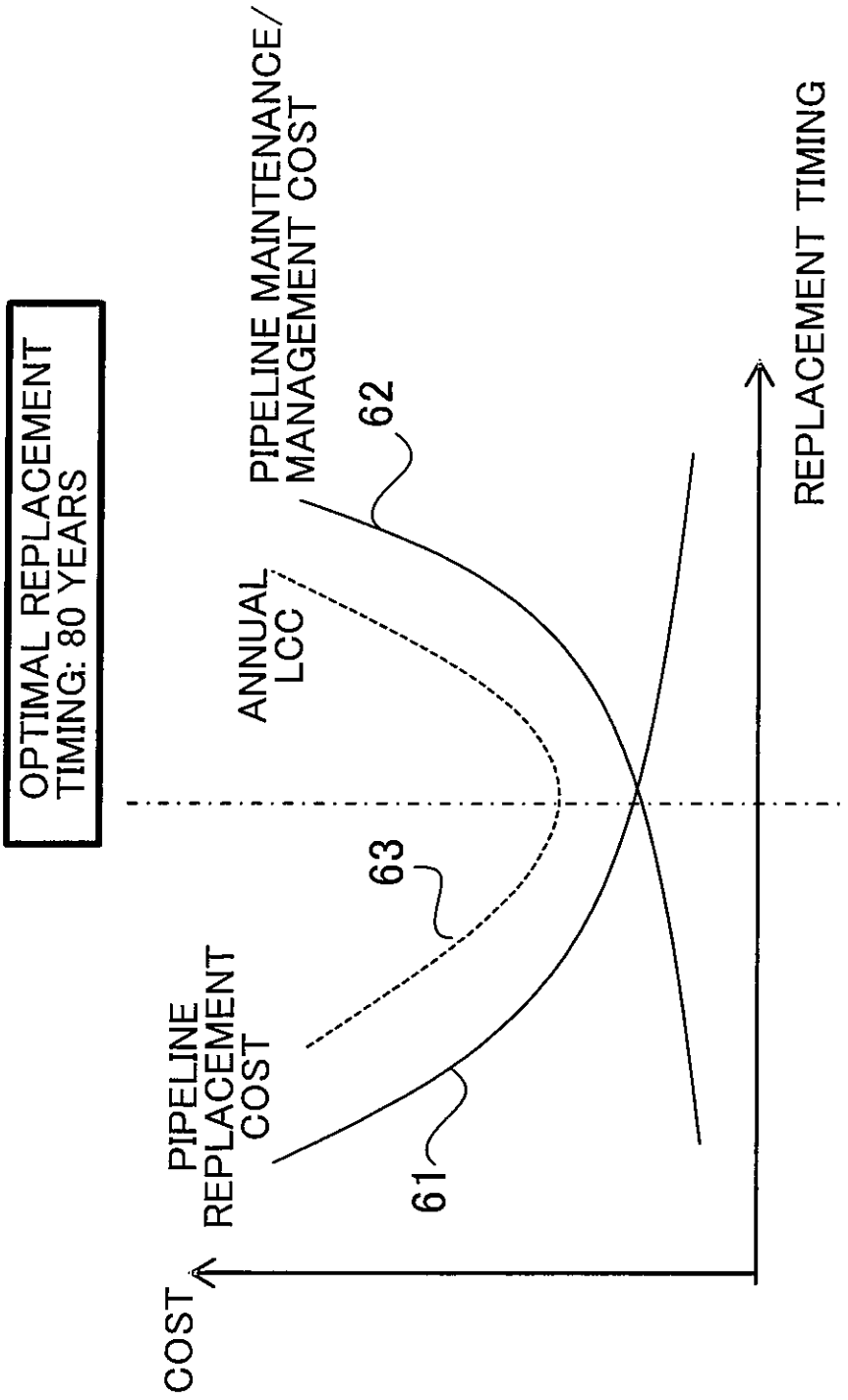

OPTIMAL REPLACEMENT TIMING: 80 YEARS
PIPELINE MAINTENANCE/ MANAGEMENT COST
62
ANNUAL LCC
63
PIPELINE REPLACEMENT COST
61
COST
REPLACEMENT TIMING
OPTIMAL REPLACEMENT TIMING

FIG. 6

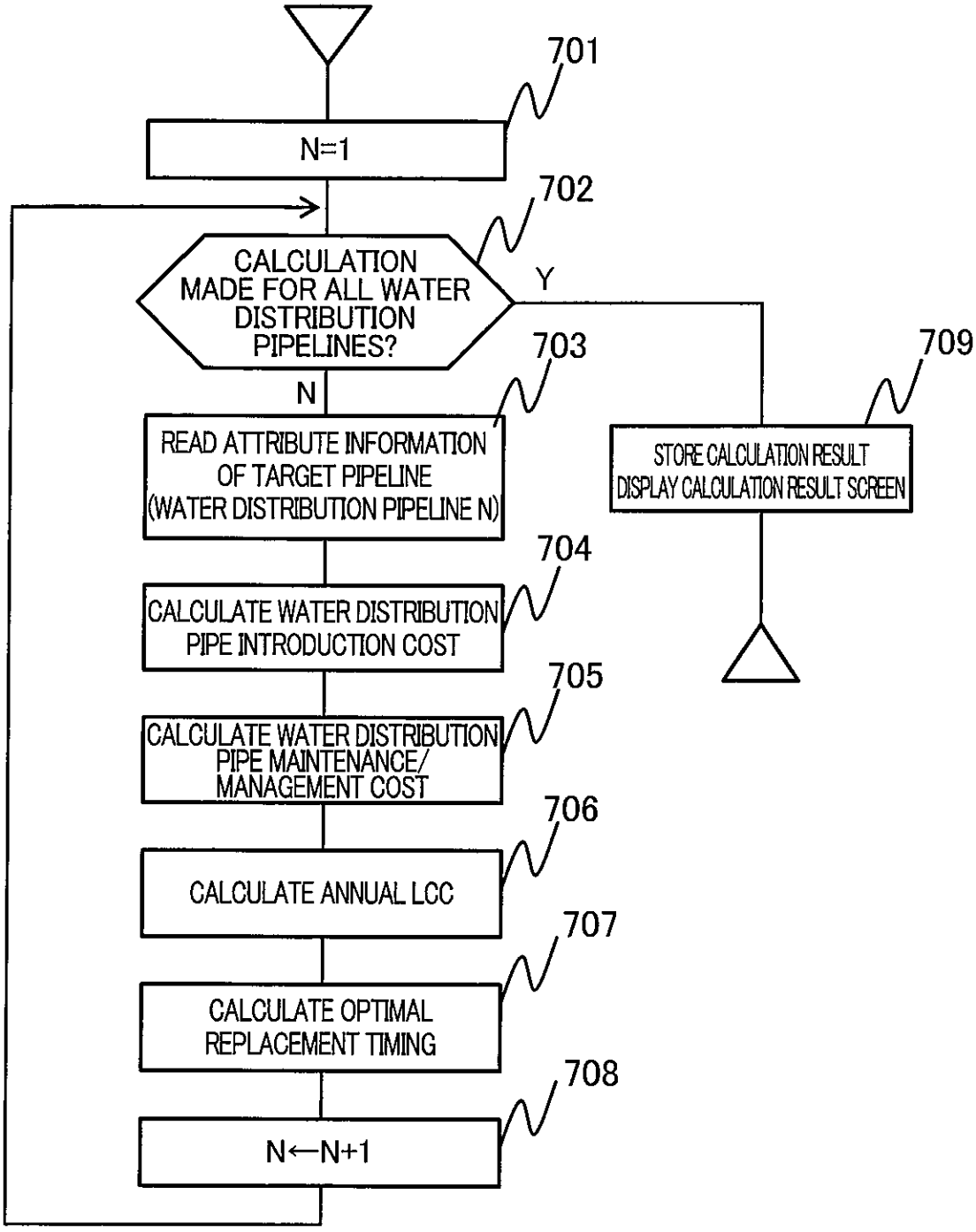

701
N=1
702
CALCULATION MADE FOR ALL WATER DISTRIBUTION PIPELINES?
Y
N
703
READ ATTRIBUTE INFORMATION OF TARGET PIPELINE (WATER DISTRIBUTION PIPELINE N)
704
CALCULATE WATER DISTRIBUTION PIPE INTRODUCTION COST
705
CALCULATE WATER DISTRIBUTION PIPE MAINTENANCE/ MANAGEMENT COST
706
CALCULATE ANNUAL LCC
707
CALCULATE OPTIMAL REPLACEMENT TIMING
708
N←N+1
709
STORE CALCULATION RESULT
DISPLAY CALCULATION RESULT SCREEN

FIG. 7

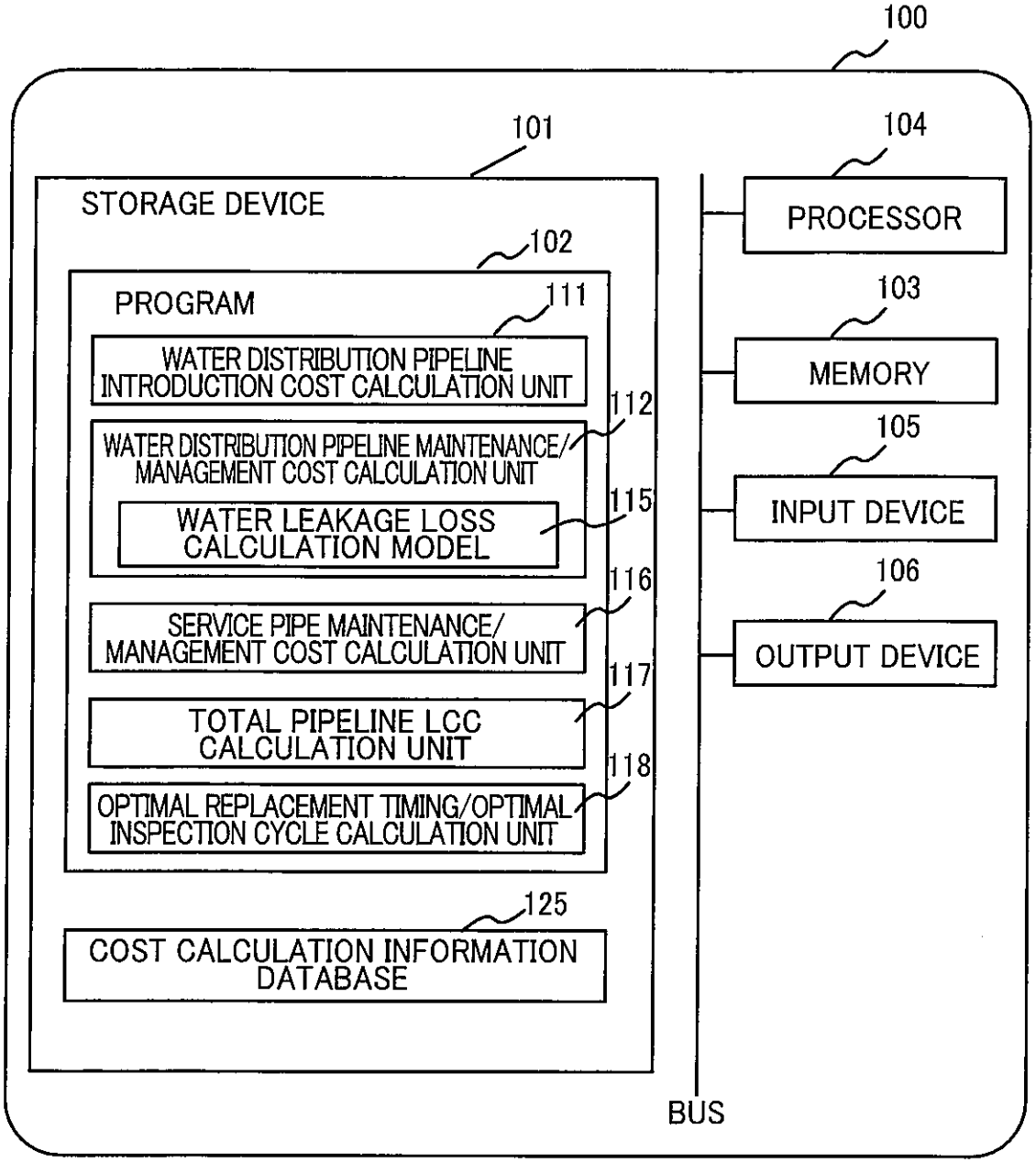

100
101
STORAGE DEVICE
102
PROGRAM
111
WATER DISTRIBUTION PIPELINE INTRODUCTION COST CALCULATION UNIT
112
WATER DISTRIBUTION PIPELINE MAINTENANCE/ MANAGEMENT COST CALCULATION UNIT
115
WATER LEAKAGE LOSS CALCULATION MODEL
116
SERVICE PIPE MAINTENANCE/ MANAGEMENT COST CALCULATION UNIT
117
TOTAL PIPELINE LCC CALCULATION UNIT
118
OPTIMAL REPLACEMENT TIMING/OPTIMAL INSPECTION CYCLE CALCULATION UNIT
125
COST CALCULATION INFORMATION DATABASE
104
PROCESSOR
103
MEMORY
105
INPUT DEVICE
106
OUTPUT DEVICE
BUS

FIG. 8

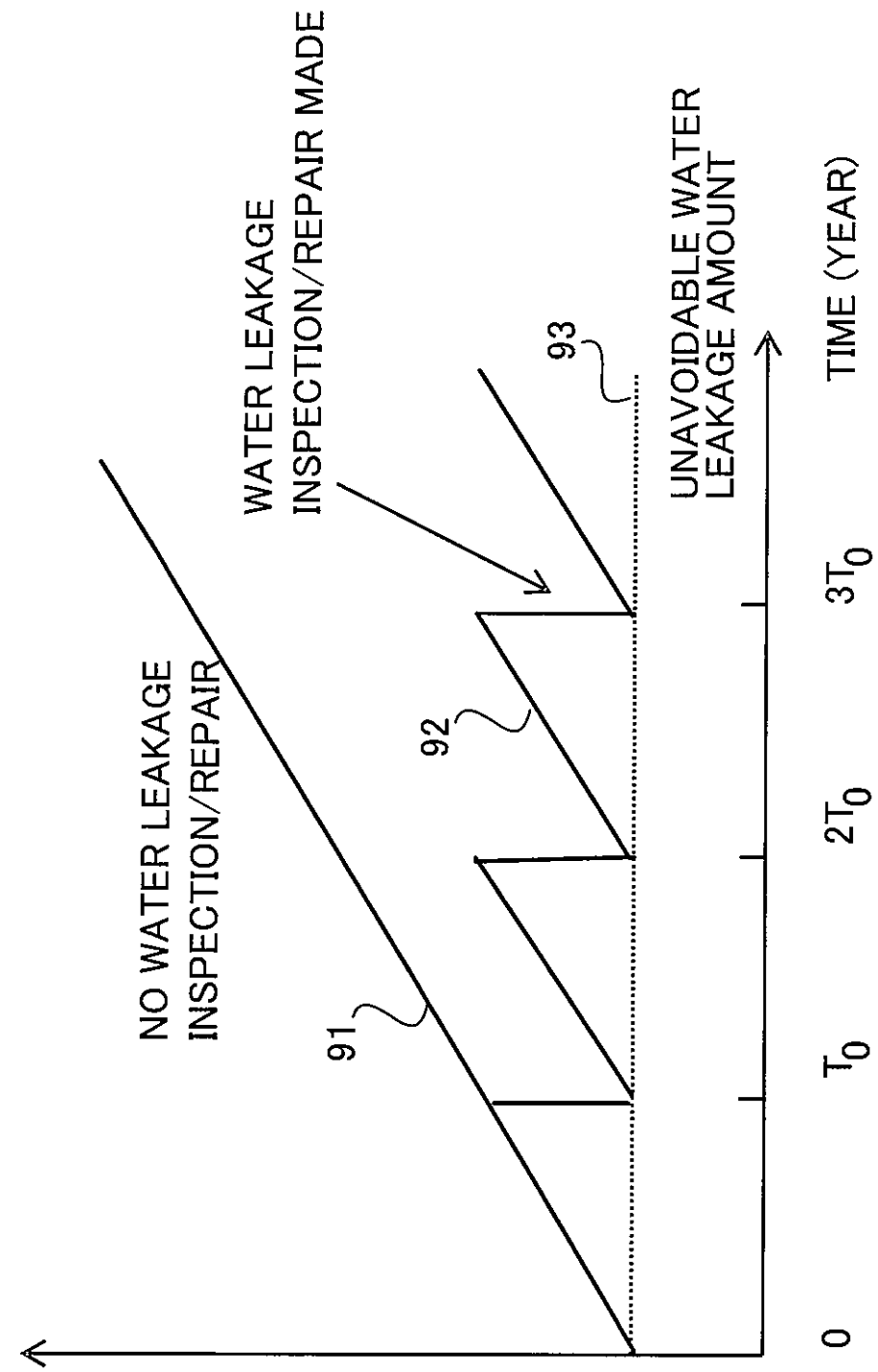

WATER LEAKAGE AMOUNT (m³/y)
NO WATER LEAKAGE INSPECTION/REPAIR
WATER LEAKAGE INSPECTION/REPAIR MADE
91
92
93
UNAVOIDABLE WATER LEAKAGE AMOUNT
0
T0
2T0
3T0
TIME (YEAR)

FIG. 9

125

COST CALCULATION INFORMATION DATABASE

PIPELINE NUMBER	PIPELINE LENGTH (m)	DIAMETER (mm)	PIPE TYPE	TIME OF USE (YEAR(S))	NUMBER OF REPAIRS	INFORMATION ON GROUND	INSPECTION CYCLE FOR WATER LEAKAGE (YEAR(S))	SPECIFICATIONS	UNAVOIDABLE WATER LEAKAGE AMOUNT	OPTIMAL REPLACEMENT TIMING
1	3500	200	DIP	40	1 (35TH YEAR)	GOOD	3			
2	2000	250	DIP	30	2 (25TH AND 30TH YEAR)	GOOD	3			
·	·	·	·	·	·	·	·			

SERVICE PIPE NUMBER	PIPELINE LENGTH (m)	DIAMETER (mm)	PIPE TYPE	TIME OF USE (YEAR(S))	NUMBER OF REPAIRS	SPECIFICATIONS	UNAVOIDABLE WATER LEAKAGE AMOUNT	···
d11	15	20	SP	12	1 (10TH YEAR)			···
d12	15	20	SP	5	0			···
···	···	···	···	···	···	···	···	···
d21	7	20	SP	3	0			···
···	···	···	···	···	···	···	···	···

FIG. 10

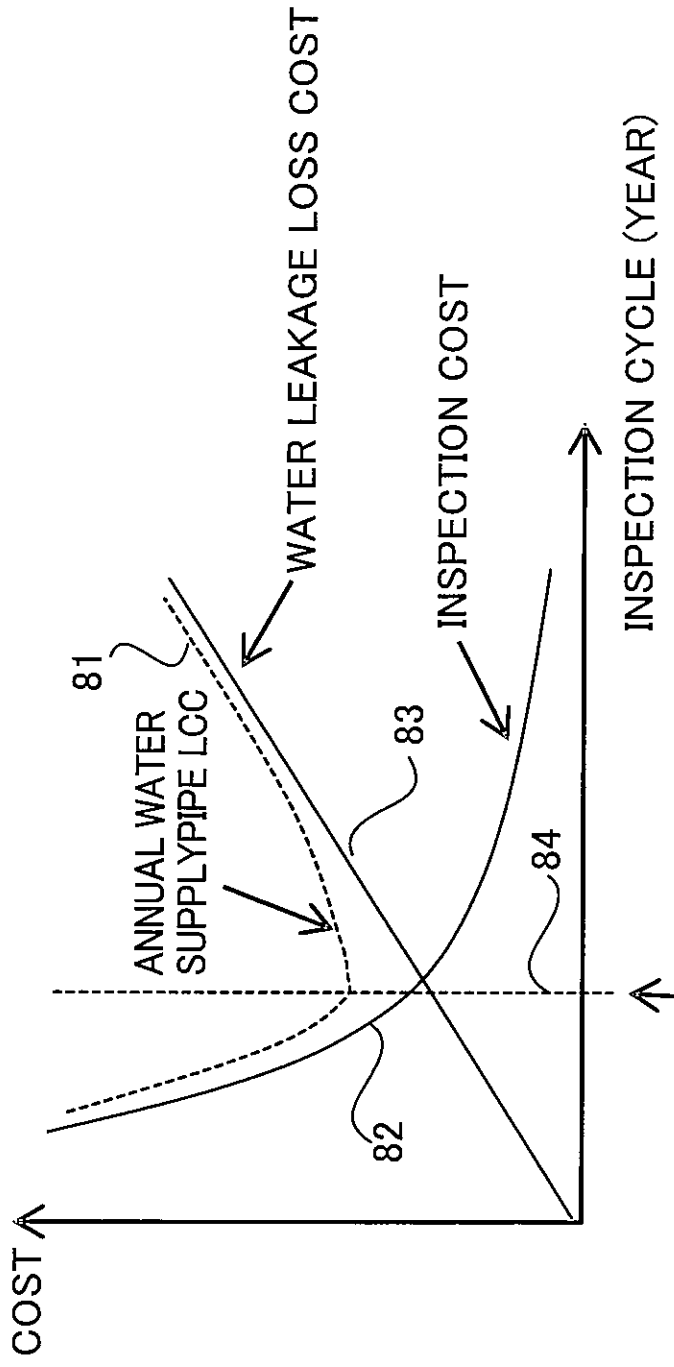

COST
INSPECTION CYCLE (YEAR)
WATER LEAKAGE LOSS COST
INSPECTION COST
ANNUAL WATER SUPPLY PIPE LCC
INSPECTION CYCLE MINIMIZING SERVICE PIPE LCC
81
82
83
84

FIG. 11

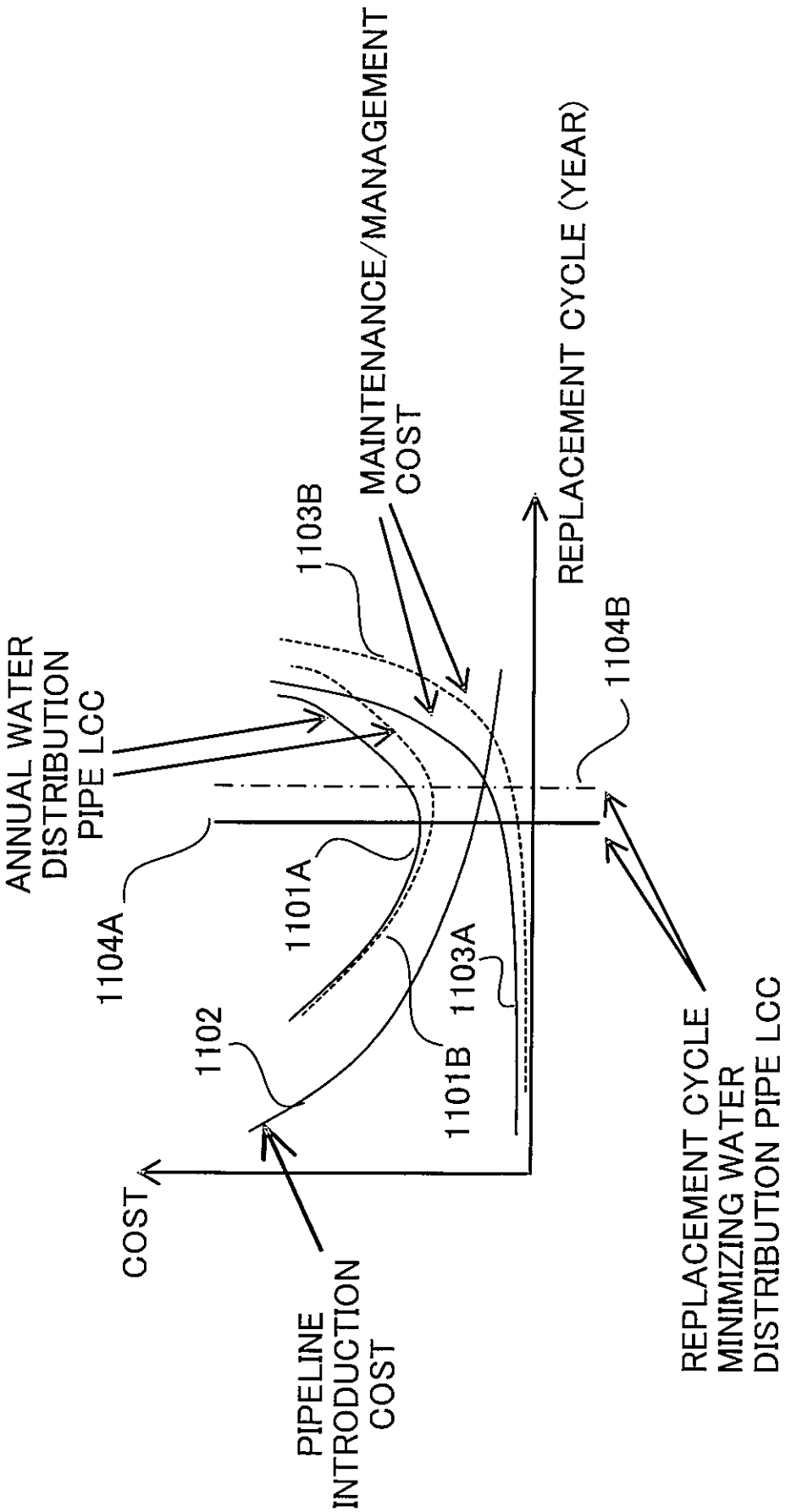
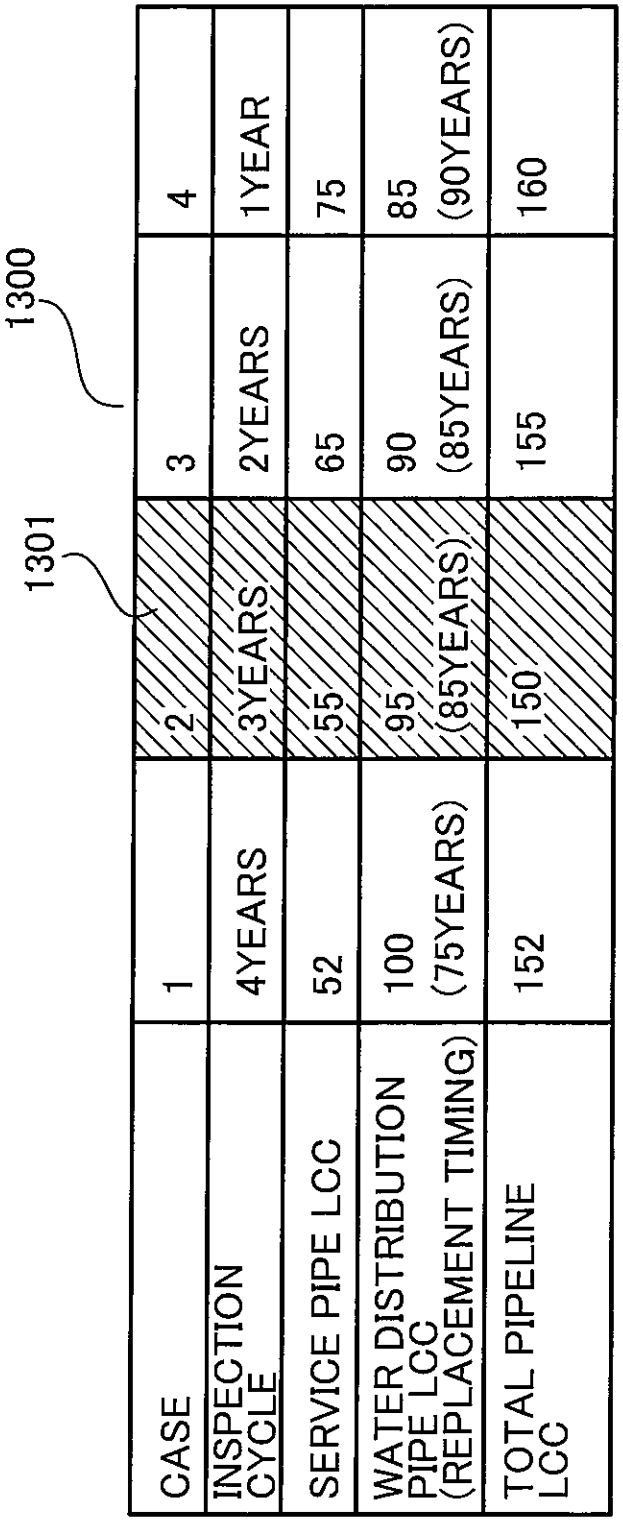

ANNUAL WATER DISTRIBUTION PIPE LCC
MAINTENANCE/MANAGEMENT COST
REPLACEMENT CYCLE (YEAR)
COST
PIPELINE INTRODUCTION COST
REPLACEMENT CYCLE MINIMIZING WATER DISTRIBUTION PIPE LCC
1102
1101A
1101B
1103A
1103B
1104A
1104B

FIG. 12



CASE	1	2	3	4
INSPECTION CYCLE	4YEARS	3YEARS	2YEARS	1YEAR
SERVICE PIPE LCC	52	55	65	75
WATER DISTRIBUTION PIPE LCC (REPLACEMENT TIMING)	100 (75YEARS)	95 (85YEARS)	90 (85YEARS)	85 (90YEARS)
TOTAL PIPELINE LCC	152	150	155	160

FIG. 13

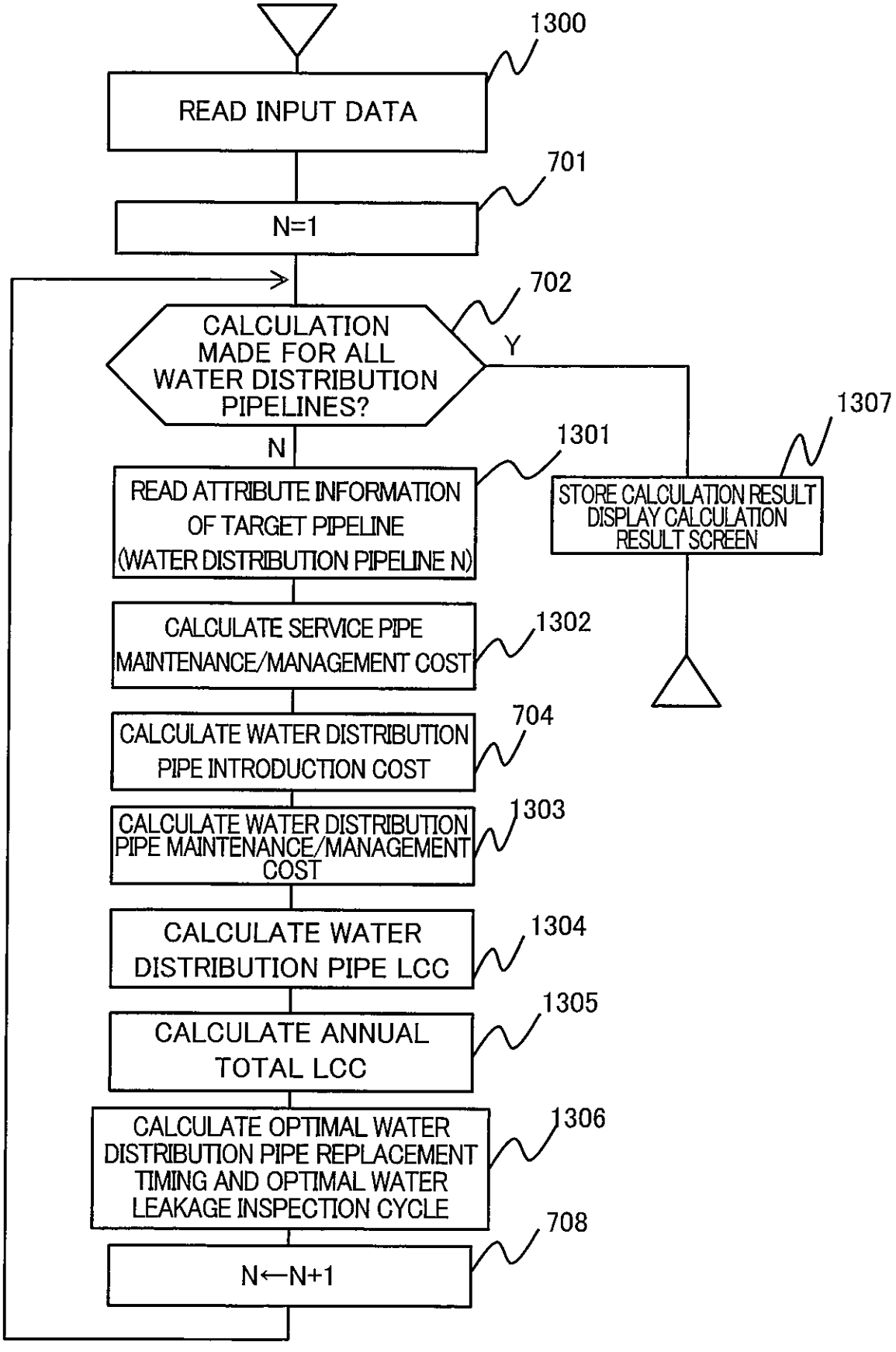

1300
READ INPUT DATA
701
N=1
702
CALCULATION MADE FOR ALL WATER DISTRIBUTION PIPELINES?
Y
N
1307
STORE CALCULATION RESULT DISPLAY CALCULATION RESULT SCREEN
1301
READ ATTRIBUTE INFORMATION OF TARGET PIPELINE (WATER DISTRIBUTION PIPELINE N)
1302
CALCULATE SERVICE PIPE MAINTENANCE/MANAGEMENT COST
704
CALCULATE WATER DISTRIBUTION PIPE INTRODUCTION COST
1303
CALCULATE WATER DISTRIBUTION PIPE MAINTENANCE/MANAGEMENT COST
1304
CALCULATE WATER DISTRIBUTION PIPE LCC
1305
CALCULATE ANNUAL TOTAL LCC
1306
CALCULATE OPTIMAL WATER DISTRIBUTION PIPE REPLACEMENT TIMING AND OPTIMAL WATER LEAKAGE INSPECTION CYCLE
708
N←N+1

FIG. 14

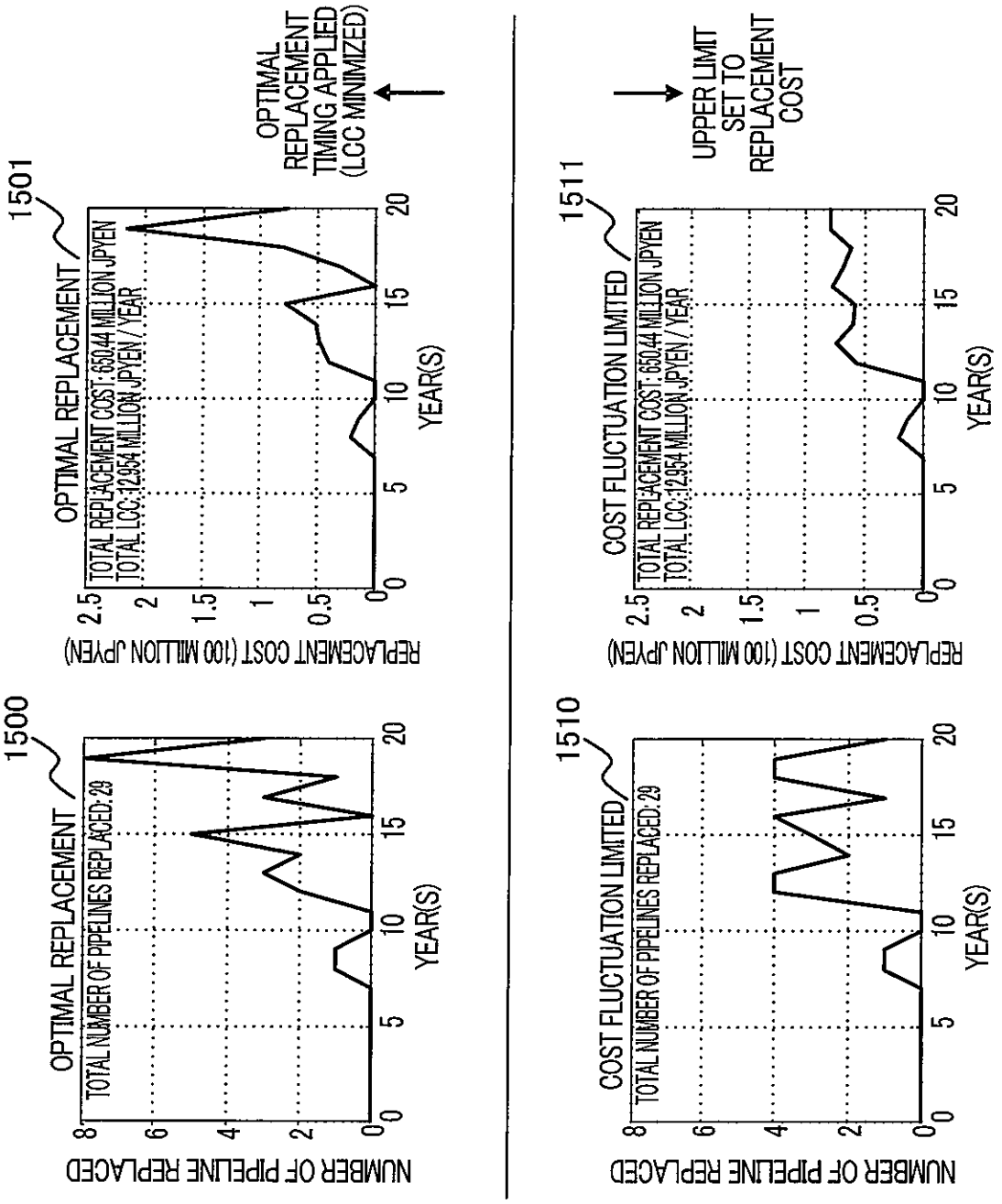

1500
OPTIMAL REPLACEMENT
TOTAL NUMBER OF PIPELINES REPLACED: 29
NUMBER OF PIPELINE REPLACED
YEAR(S)
1501
OPTIMAL REPLACEMENT
TOTAL REPLACEMENT COST: 650.44 MILLION JPYEN
TOTAL LCC: 12.954 MILLION JPYEN / YEAR
REPLACEMENT COST (100 MILLION JPYEN)
YEAR(S)
OPTIMAL REPLACEMENT TIMING APPLIED (LCC MINIMIZED)
1510
COST FLUCTUATION LIMITED
TOTAL NUMBER OF PIPELINES REPLACED: 29
NUMBER OF PIPELINE REPLACED
YEAR(S)
1511
COST FLUCTUATION LIMITED
TOTAL REPLACEMENT COST: 650.44 MILLION JPYEN
TOTAL LCC: 12.954 MILLION JPYEN / YEAR
REPLACEMENT COST (100 MILLION JPYEN)
YEAR(S)
UPPER LIMIT SET TO REPLACEMENT COST

FIG. 15

PIPELINE NUMBER	REPLACEMENT COST (100 MILLION JPYEN)
12	0.44
17	0.09
59	0.2
105	0.17
149	0.13
169	0.27
176	0.17
221	0.25
294	0.3
306	0.09
335	0.06
336	0.06
363	0.68
370	0.13
374	0.15
391	0.13
393	0.27
412	0.25
482	0.12
533	0.09
581	0.18
615	0.26
636	0.13
653	0.8
723	0.34
813	0.15
846	0.09
862	0.23
970	0.26

FIG. 16

YEAR (S)	REPLACEMENT COST (100 MILLION JPYEN)	PIPELINE NUMBER			
0	0	0			
1	0	0			
2	0	0			
3	0	0			
4	0	0			
5	0	0			
6	0	0			
7	0	0			
8	0.2	59			
9	0.13	391			
10	0	0			
11	0	0			
12	0.39	393	482		
13	0.49	294	306	533	
14	0.52	169	412		
15	0.78	336	370	615	846
16	0	0			
17	0.29	17	149	335	
18	0.8	653			
19	2.17	105	221	363	374
20	0.76	12	176	813	

FIG. 17

YEAR (S)	REPLACEMENT COST (100 MILLION JPYEN)	PIPELINE NUMBER			
0	0	0			
1	0	0			
2	0	0			
3	0	0			
4	0	0			
5	0	0			
6	0	0			
7	0	0			
8	0.2	59			
9	0.13	391			
10	0	0			
11	0	0			
12	0.57	17	294	335	482
13	0.74	370	393	412	533
14	0.61	615	723		
15	0.59	169	846	862	
16	0.77	176	221	306	970
17	0.68	363			
18	0.61	105	149	581	636
19	0.8	12	336	374	813
20	0.8	653			

FIG. 18

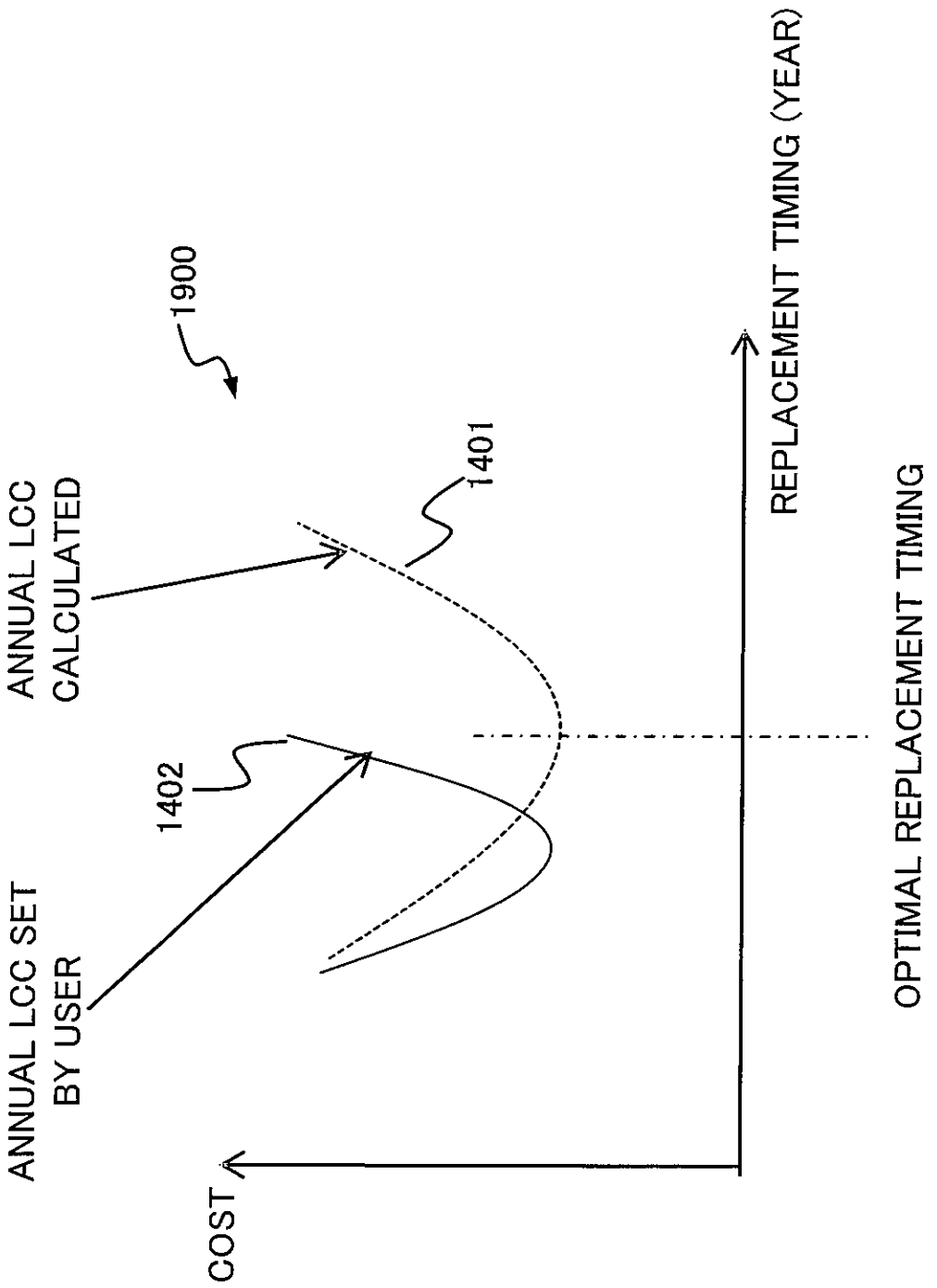

1900
ANNUAL LCC CALCULATED
1401
1402
ANNUAL LCC SET BY USER
COST
REPLACEMENT TIMING (YEAR)
OPTIMAL REPLACEMENT TIMING

FIG. 19

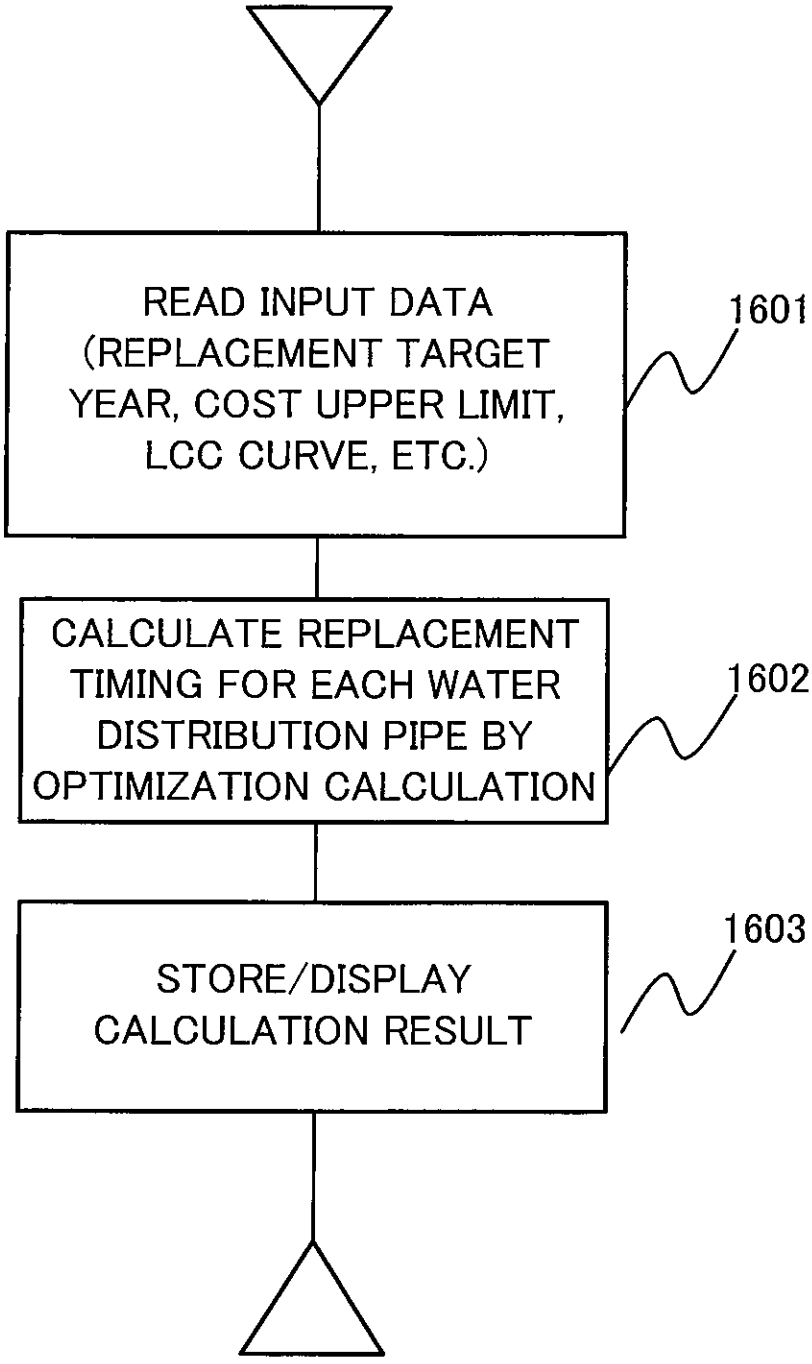

READ INPUT DATA (REPLACEMENT TARGET YEAR, COST UPPER LIMIT, LCC CURVE, ETC.)
1601
CALCULATE REPLACEMENT TIMING FOR EACH WATER DISTRIBUTION PIPE BY OPTIMIZATION CALCULATION
1602
STORE/DISPLAY CALCULATION RESULT
1603

FIG. 20