

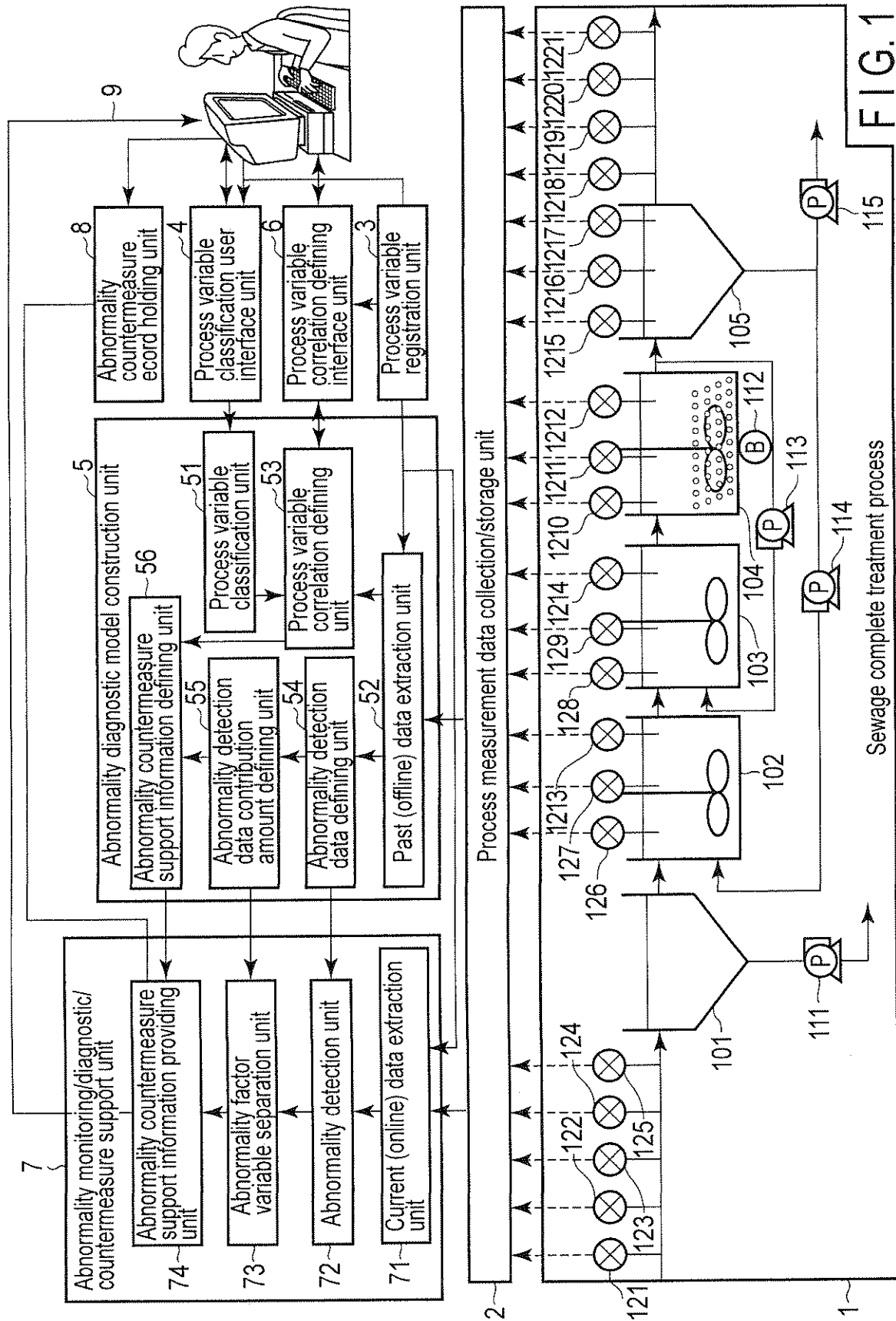


FIG. 1

Number	Variable name	Input variable	Output variable	Intermediate variable
[1]	Air supply amount	○		
[2]	Circulating flow rate	○		
[3]	Return flow rate	○		
[4]	Excess flow rate	○		
[5]	Rainfall			○
[6]	Sewage inflow amount			○
[7]	Influent TN			○
[8]	Influent TP			○
[9]	Influent UV			○
[10]	Anaerobic tank ORP			○
[11]	Anaerobic tank pH			○
[12]	Anoxic tank ORP			○
[13]	Anoxic tank pH			○
[14]	Aerobic PO ₄ -P			○
[15]	Aerobic tank DO			○
[16]	Aerobic tank NH ₄ -N			○
[17]	Aerobic tank MLSS			○
[18]	Reaction tank water temperature			○
[19]	Effluent TN		○	
[20]	Effluent TP		○	

FIG. 2

■ Example 1 of correlation determination rule

```

For k=1:n
  For j=1:n
    If | S(k,j) | > Th
      SS(k,j)=Correlation is present
    Else
      SS(k,j)=Correlation is absent
    End
  End
End
End

```

FIG. 3

■ Example 2 of correlation determination rule

```

For k=1:n
  For j=1:n
    If | S(k,j) | > Th1
      SS(k,j)=Strong correlation
    Else if | S(k,j) | > Th2
      SS(k,j)=Weak correlation
    Else
      SS(k,j)=Correlation is absent
    End
  End
End
End

```

FIG. 4

```

    ■Example 3 of correlation
    determination rule

    For k=1:n
      For j=1:n
        If | P(k,j) | > 1/n
          SS(k,j)=Correlation is present
        Else
          SS(k,j)=Correlation is absent
        End
      End
    End
  End

```

FIG. 5

```

    ■Abnormality factor candidate
    classification rule

    FU=[ ];
    FZ=[ ];
    FY=[ ];
    For k=1:3
      If FX(k) ∈ U
        FU=[FU FX(k)];
      Elseif FX(k) ∈ X
        FZ=[FZ FX(k)];
      Elseif FX(k) ∈ Y
        FY=[FY FX(k)];
      End
    End
  End

```

FIG. 7

	Input variable U				Intermediate variable Z										Output variable Y				
	Air supply amount	Circulating flow rate	Return flow rate	Excess flow rate	Rain-fall	Sewage inflow amount	Influent TN	Influent TP	Influent UV	Anaerobic tank ORP	Anaerobic tank pH	Anoxic tank ORP	Anoxic tank pH	Aerobic tank DO	Aerobic tank NH4-N	Aerobic tank MLSS	Reaction tank water temperature	Effluent TN	Effluent TP
Air supply amount	▨	×	×	×	○	⊙	○	○	○	×	×	×	×	⊙	⊙	×	×	○	○
Circulating flow rate	×	▨	×	×	○	⊙	×	×	×	×	×	⊙	×	×	⊙	×	×	○	○
Return flow rate	×	×	▨	×	○	⊙	×	×	×	⊙	×	×	×	×	×	×	×	⊙	⊙
Excess flow rate	×	×	×	▨	×	⊙	×	×	×	×	×	×	×	×	×	⊙	×	○	⊙
Rainfall	○	○	○	×	▨	⊙	×	○	⊙	×	⊙	⊙	⊙	×	×	×	▨	⊙	⊙
Sewage inflow amount	⊙	⊙	⊙	⊙	⊙	▨	×	×	⊙	○	○	×	○	⊙	×	○	×	⊙	⊙
Influent TN	○	×	×	×	×	×	▨	○	×	⊙	○	⊙	×	×	×	×	×	⊙	○
Influent TP	○	×	×	×	○	×	○	○	▨	⊙	○	×	○	×	×	⊙	×	○	⊙
Influent UV	○	×	×	×	⊙	⊙	×	○	×	○	○	×	×	×	×	⊙	×	○	○
Anaerobic tank ORP	×	×	⊙	×	×	○	×	⊙	×	▨	○	×	○	×	×	×	×	×	⊙
Anaerobic tank pH	×	×	×	×	⊙	○	○	○	×	▨	▨	○	▨	⊙	×	×	×	×	×
Anoxic tank ORP	×	⊙	×	×	⊙	×	⊙	⊙	×	×	○	×	▨	×	×	×	×	×	⊙
Anoxic tank pH	×	×	×	×	⊙	○	×	×	×	×	×	×	▨	×	×	×	×	×	×
Aerobic tank PO4-P	○	×	○	○	×	⊙	×	○	×	○	⊙	⊙	⊙	×	×	×	○	×	⊙
Aerobic tank DO	⊙	×	×	×	×	⊙	×	⊙	×	×	⊙	×	⊙	▨	⊙	×	×	○	○
Aerobic tank NH4-N	⊙	⊙	×	×	⊙	×	×	×	⊙	×	×	×	×	⊙	▨	×	○	⊙	×
Aerobic tank MLSS	×	×	×	⊙	×	○	×	×	⊙	×	×	×	×	×	×	▨	×	○	○
Reaction tank water temperature	×	×	×	×	⊙	×	×	×	×	×	×	×	×	×	×	×	▨	○	⊙
Effluent TN	○	○	⊙	○	⊙	⊙	⊙	○	×	×	×	○	×	×	○	○	○	▨	○
Effluent TP	○	○	⊙	⊙	⊙	⊙	⊙	⊙	○	⊙	×	⊙	×	○	×	○	⊙	○	▨

FIG. 6

■Example of abnormality countermeasure support message generation rule (template)

```

If FX contains FY
  For each k
    Message( 'There is a sign of abnormality in performance index FY(k).' )
    Find correlated variables of FY(k) and store them to CV
    If CV contains input variable(s) U
      If the input variable(s) U contains FU
        MU=contained FU
        Message( 'Abnormality in performance index FY(k) occurs due to MU
                  at high probability. Please contemplate revising manipulated
                  variable MU.' )

      End
      MU1=U-MU
      Message( 'Abnormality factor of performance index FY(k) may be MU1.
                Please check manipulated variable MU1 as a precaution.' )
    End
    If CV contains hidden variable(s) Z
      If the hidden variable(s) Z contains FZ
        MZ=contained FZ
        Message( 'Abnormality in performance index FY(k) occurs due to MZ
                  at high probability. Please properly manage control value
                  MZ.' )

      End
      MZ1=Z-MZ
      Message( 'Abnormality factor of performance index FY(k) may be MZ1.
                Please check control value MZ1 as a precaution.' )
    End
  End
End
If FX contains FU which are not correlated FY
  For each k
    Message( 'There is a sign of abnormality in manipulated variable FU(k).
              Please check FU(k).' )
    Find correlated variables of FU(k) and store them to CV
  
```

A

A

FIG. 8

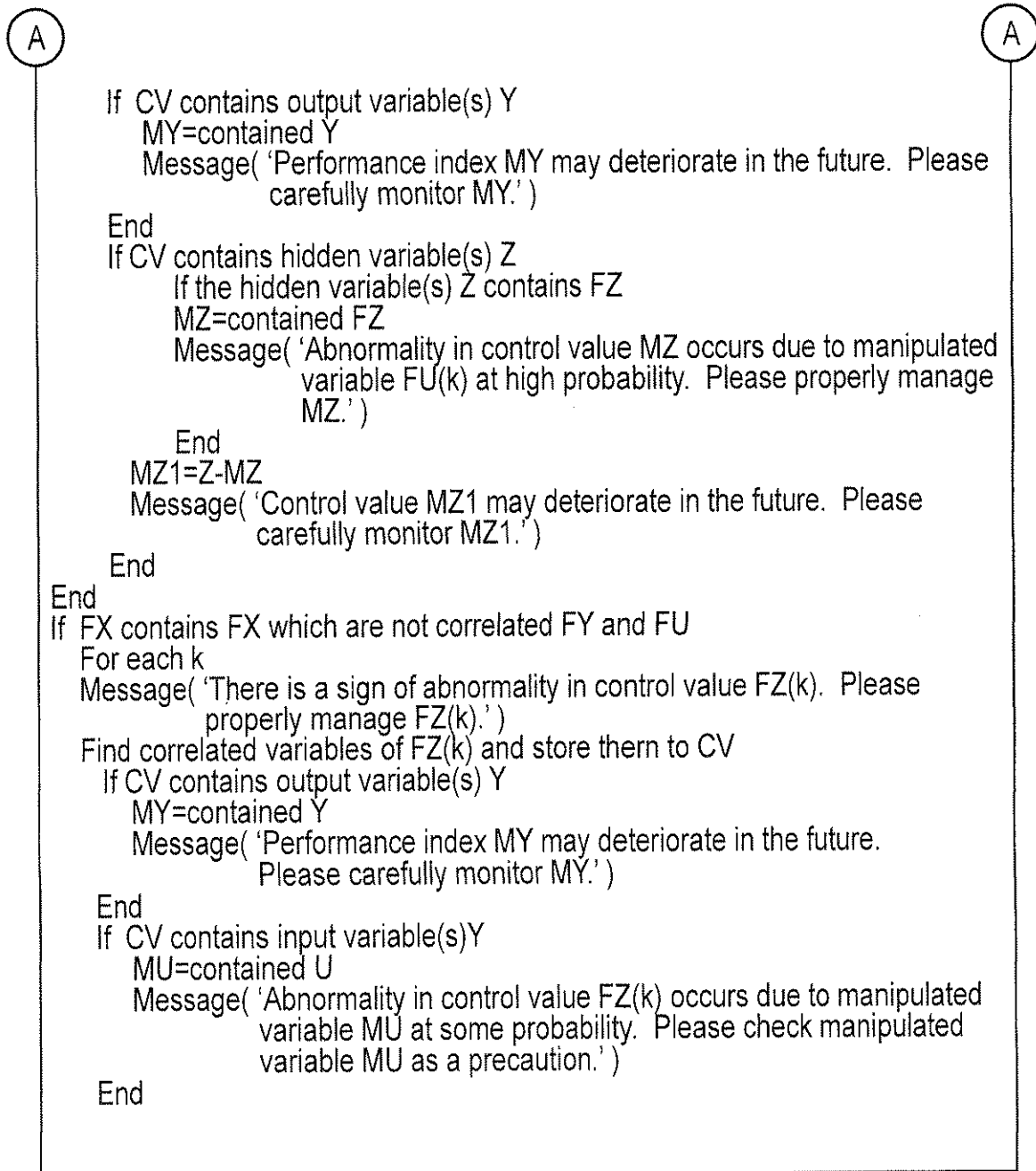


FIG. 9

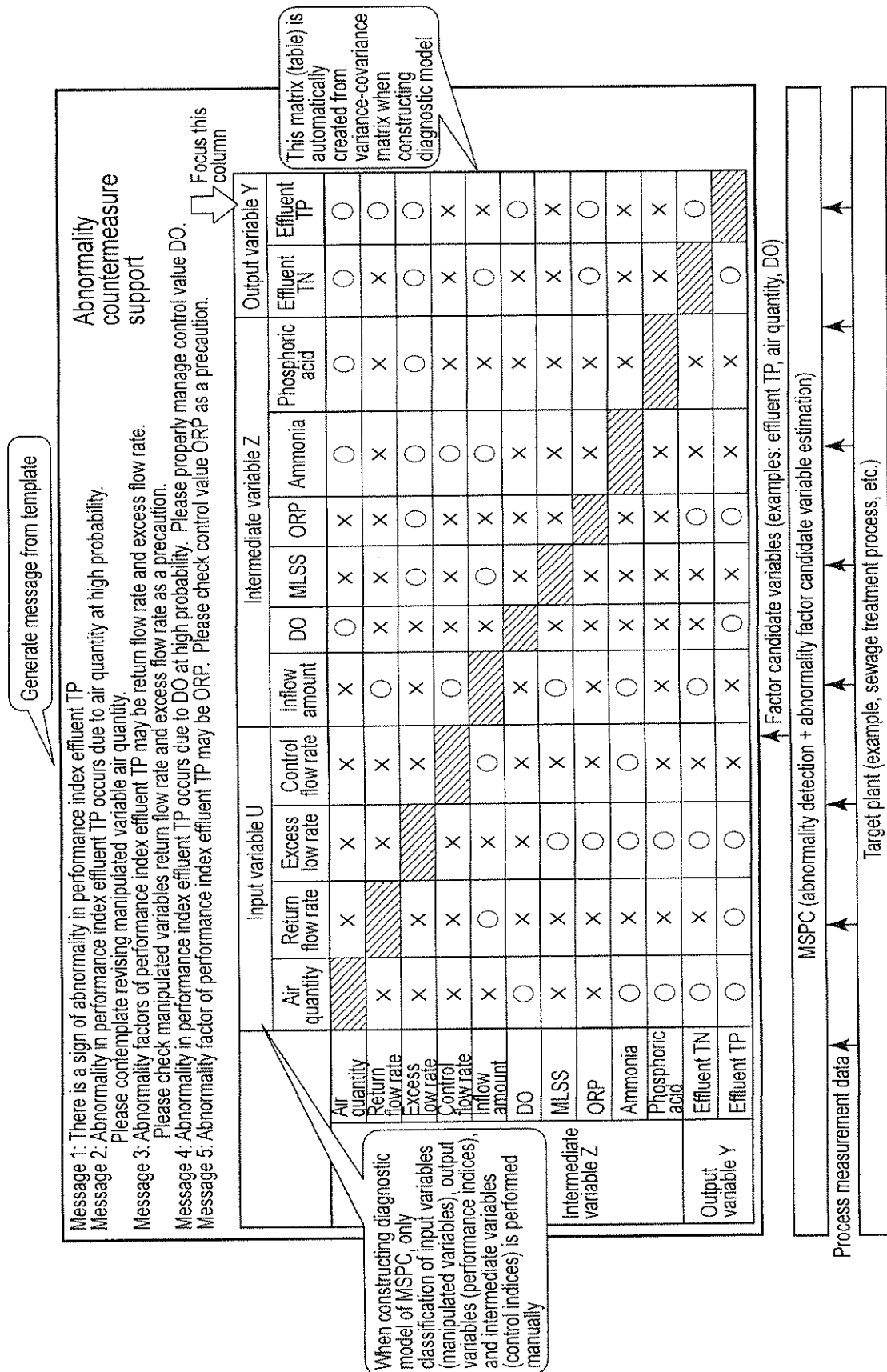


FIG. 10

■ Examples of countermeasure support message

Message 1: There is a sign of abnormality in performance index effluent TP

Message 2: Abnormality in performance index effluent TP occurs due to air quantity at high probability.

Please contemplate revising manipulated variable air quantity.

Message 3: Abnormality factors of performance index effluent TP may be return flow rate and excess flow rate.

Please check manipulated variables return flow rate and excess flow rate as a precaution.

Message 4: Abnormality in performance index effluent TP occurs due to DO at high probability. Please properly manage control value DO.

Message 5: Abnormality factor of performance index effluent TP may be ORP. Please check control value ORP as a precaution.

FIG. 11

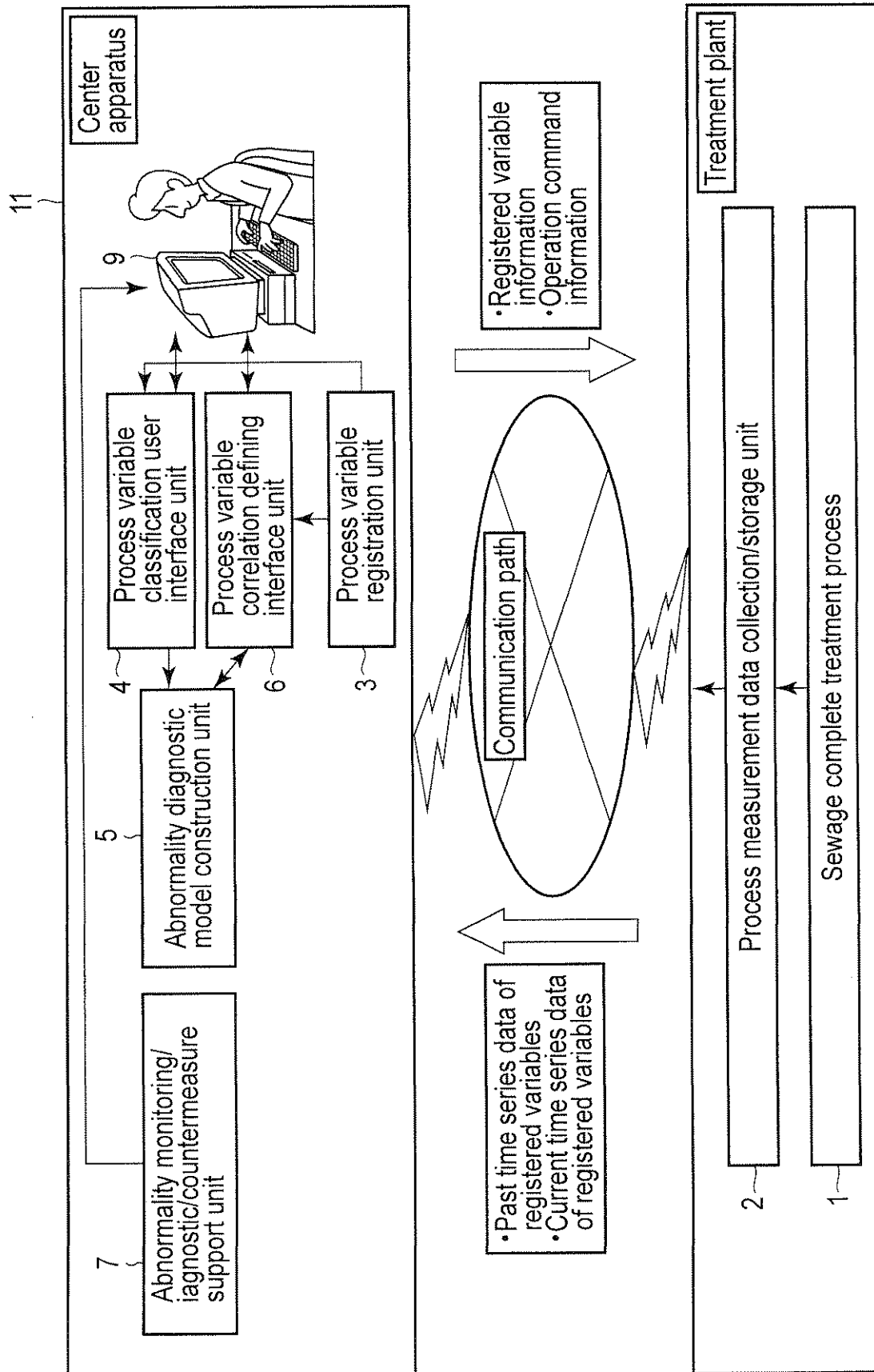


FIG. 12

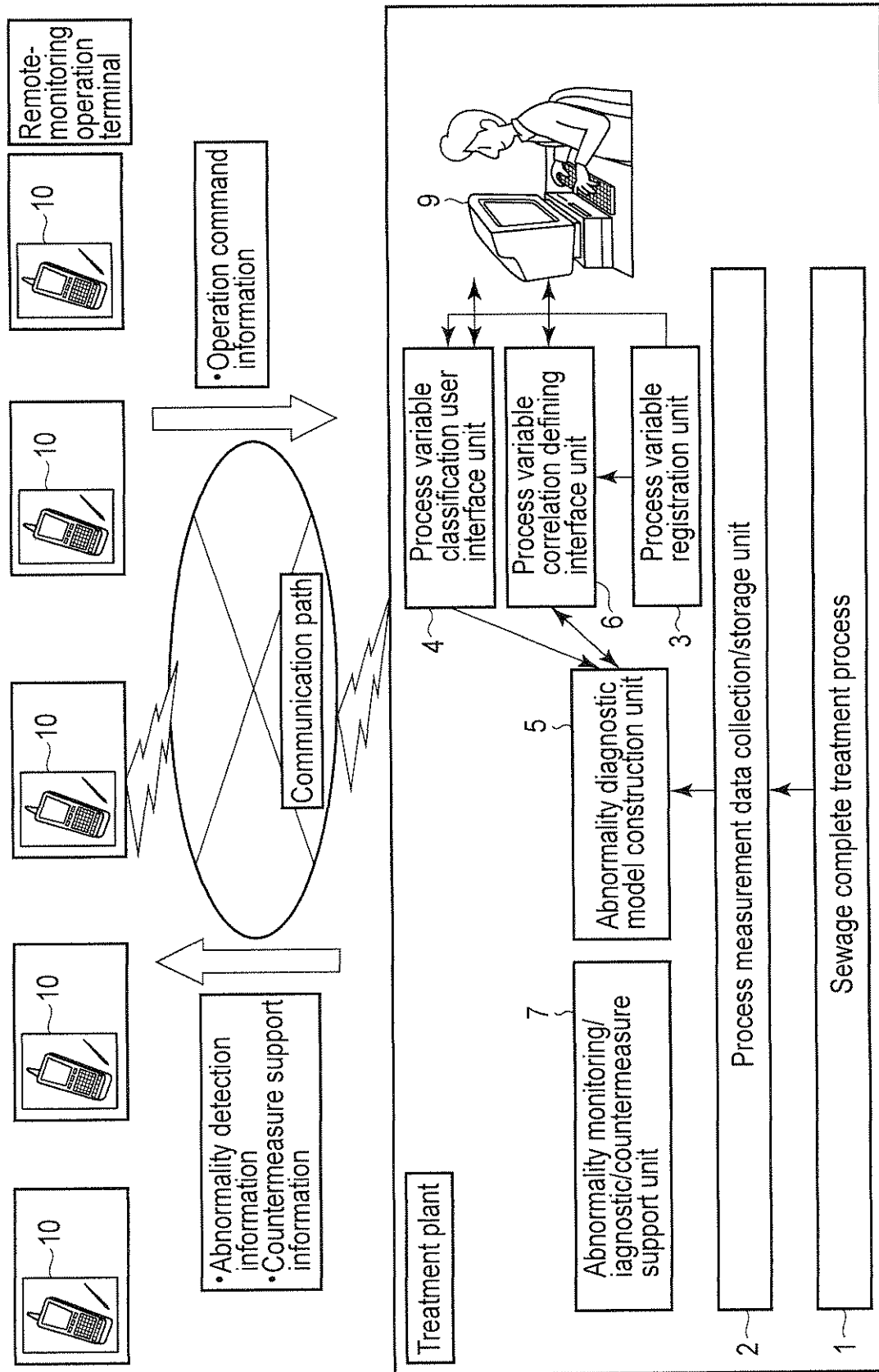


FIG. 13

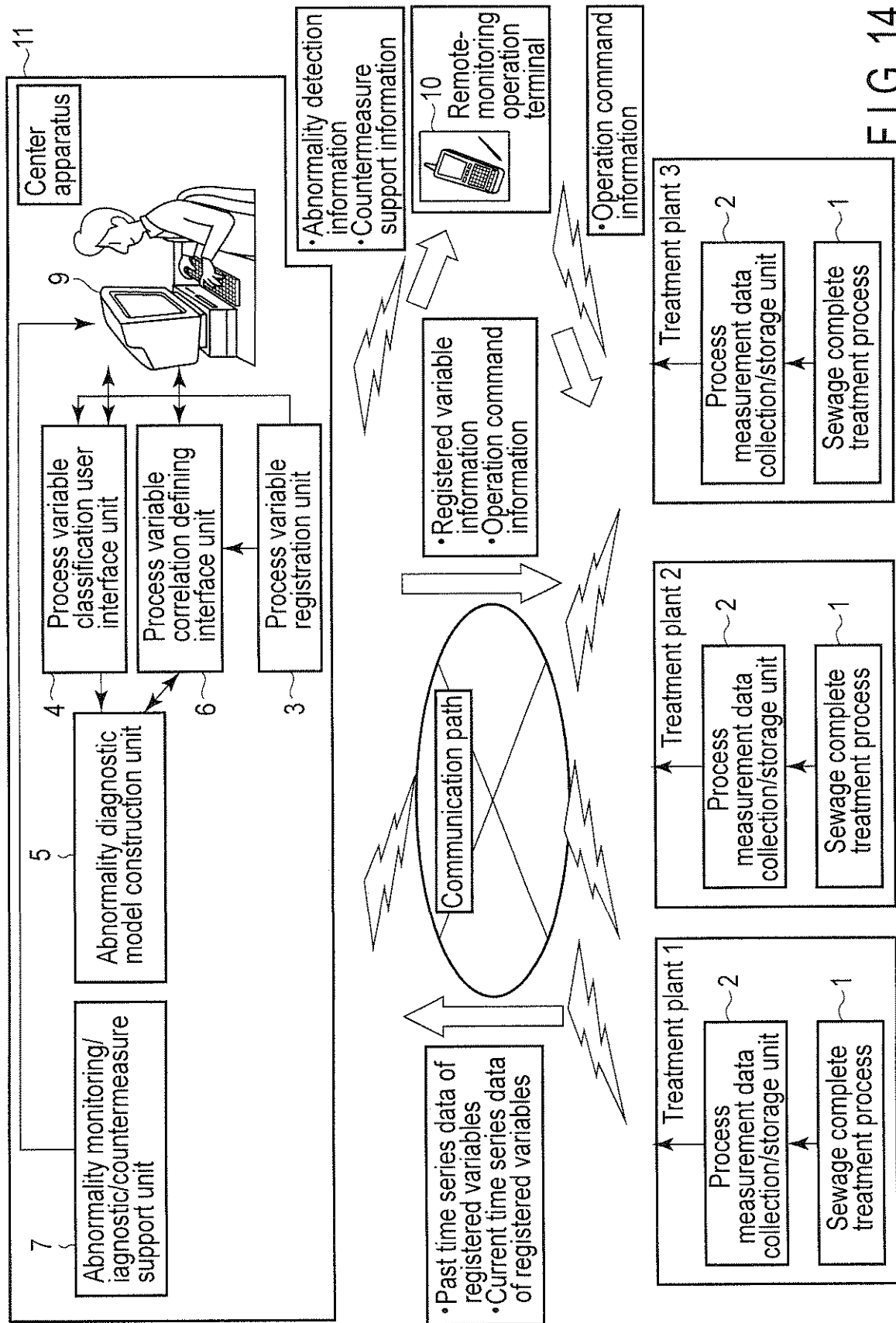


FIG. 14