

**SIMULERING AV MÄRK- O BRÄNNPORTAL**

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TILLHÖR REFERENSBIBLIOTEKET  
UTLÄNAS EJ

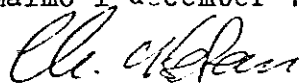
SIMULERING AV MÄRK- o BRÄNNPORTAL

Examensarbete utfört av Christer Nordström  
för Kockums Mekaniska Verkstads AB

Handledare

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### Sammanfattning

Det framtagna programsystemet syftar till simulering av en märk- o brännmaskin. Systemet innehåller förutom simuleringen även feltester och möjligheter för utloggning av ingående variabler. Resultatet av simuleringen ritas upp på en alfa-grafisk bildskärmsterminal, för vilken generella rutiner har utvecklats.

### Abstract

The programsystem simulates a marking- and cutting-machine. Beside the simulation the system contains errorchecks and loggingfacilities. The result of the simulation is drawn on a alpha-graphic terminal, for which general routines have been developed.

## Inledning

Föreliggande rapport beskriver ett programsystem för simulering av en märk- o brännportal. Den fysiska portalen avses tagas i drift under senare delen av 1975 i den s.k. Flaklinjen (Panelline) vid Kockums Mekaniska Verkstads AB (KMV). Vid Flaklinjen kommer plåtar av standardformat att svetsas samman till större enheter, vilka bränns till sin slutliga form och förses med förstyvande element. Märk- o brännportalens uppgift i Flaklinjen är alltså att bränna plåtarna samt att förse dem med märkningar och körnarslag för de förstyvande elementen.

## Ändamål

Programsystemet är framtaget för uttestning av de vid KMV utvecklade styrprogrammen till märk- o brännportalerna. För att underlätta detta har feltester och loggningsmöjligheter införts i programmen.

## Simuleringsobjekt

Portalerna är en KEBE Telerep TXA-S storlek 255.

### Målsättning

Programsystemet är i första hand framtaget för simulering av den ovan nämnda märk- o brännportalen. Alla ingående rutiner är dock skrivna på en generell form för att möjliggöra simulering av andra liknande objekt. En speciell del av programsystemet utgöres av de s.k. Basic Plot Routines vilka är grundläggande rutiner för kommunikation med en alfa-grafisk bildskärmsterminal. Dessa rutiner är givetvis skrivna för användning i generella tillämpningar och är alltså helt oberoende av simuleringsprogrammen.

### Systembeskrivning

Programsystemet skall implementeras på minidatorn KS500 från Kongsbergs Våpenfabrikk och opereras under reelltidssystemet KOS (Kongsberg Operating System).

Indata till systemet genereras av styrprogrammen för portalen. Kommunikationen mellan programsystemen sker via en Common-Area vilken innehåller alla förefintliga signaler till och från portalen. I denna Common-Area ligger även storheter som är specifika för simuleringen såsom positioner, hastigheter, tidskonstanter, m.m.

Programsystemets uppbyggnad finns beskrivet i bilaga 1.

## Portalbeskrivning

En översiktsbild över portalen visas i figur 1. Den har en maximal arbetsbredd på 28.8 meter och löper på en 45 meter lång räls.

Portalen drives av två likströmsmaskiner, en i vardera portalsidan. Då dessa är förbundna med ett lokalt servo fordras endast en styrsignal för positionering av portalen i x-led.

Av de sex huvudena kan endast de två brännarhuvudena positioneras via servo. De fyra märkhuvudena positioneras genom koppling till något av brännarhuvudena via bandet eller genom direkt koppling med klinkan. Se figur 2. Varje huvud kan kopplas till något av av bandets bägge sidor. Alla huvudena kan dessutom låsas fast vid tvärbalken.

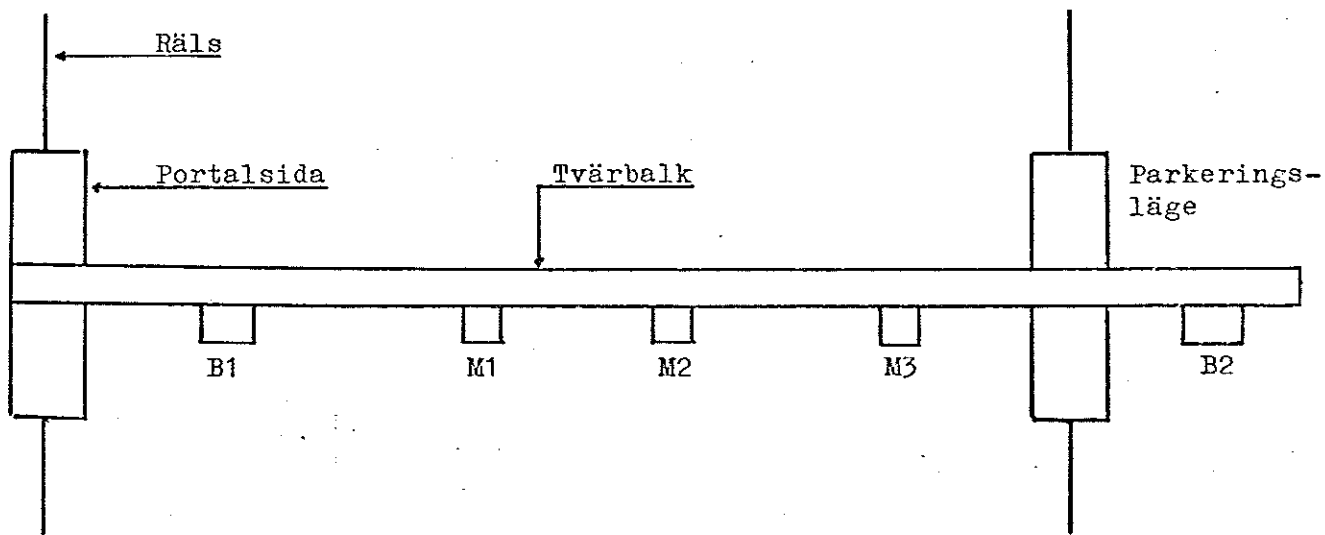
Brännarhuvudena är utrustade med trebrännaraggregat för skärning av plåten. De fyra märkhuvudena är utrustade med färgsprutor för markering och med körnare. Märkhuvudena 1 och 4 har dessutom organ för plåtkantsavkänning.

## Problembeskrivning

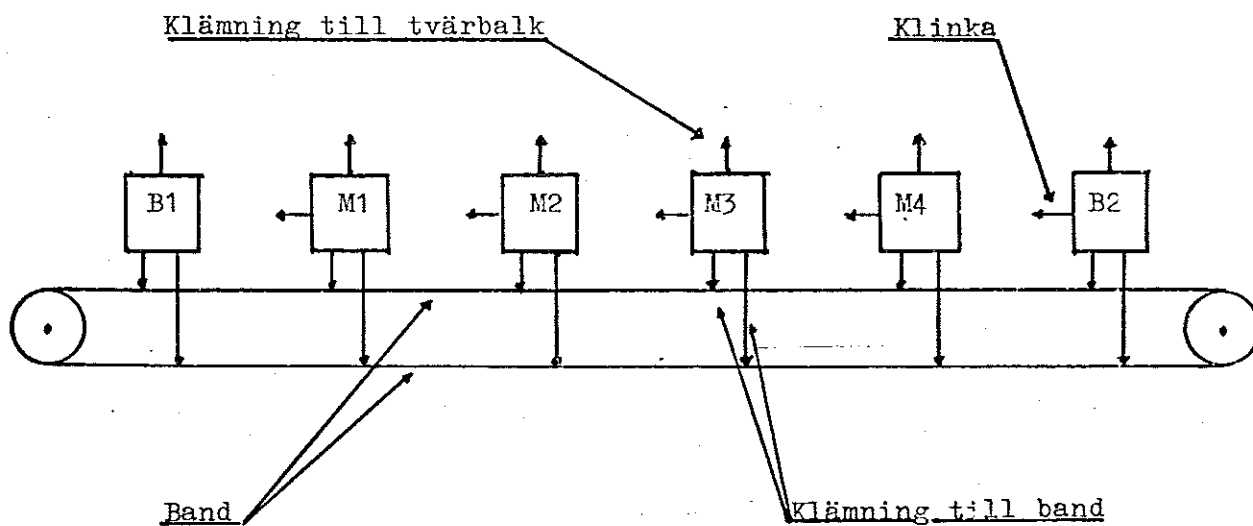
Två huvudsakliga problem har visat sig vid simuleringen av portalen, nämligen :

1) Att finna en användbar matematisk modell för att beskiva portalens och huvudenas rörelse. Detta finns beskrivet i bilaga 1.

2) Att finna en generell beskrivning av märkhuvudenas rörelse relativt drivande brännarhuvuds rörelse. Detta behandlas i bilaga 2.



Figur 1



Figur 2

B1, B2 = Brännare 1 resp. 2

M1, ..., M4 = Märkhuvud 1, ..., 4

## Resultat

Simuleringsprogrammet svarar på styrsignaler på samma sätt som den fysiska portalen. D.v.s de nya positionerna för portal och brännarhuvuden ställs ut som resolver-signaler i databasen, digitala signaler från gränslägesbrytare, motorventil, m.m ställs ut då dessa skulle ha aktiverats hos det fysiska systemet. Om något otillåtet händer under simuleringen, t.ex. huvudkollision, avbryts exekveringen och hela databasen listas ut på teletype.

Systemet innehåller också loggningsfaciliteter så att önskad information ur databasen kan listas med en godtycklig frekvens.

Under hela simuleringen ritas resultatet från aktiverade organ upp på en alfa-grafisk bildskärmsterminal. Ett exempel på en simulering visas i bilaga 3.



BILAGA 1

Program Guide

Program Description

Appendix 1

Appendix 2

Addressee/Subject

PRTSIM - PORTAL SIMULATION

Purpose

The program is primarily designed for simulation of the cutting- and marking-portal in station FLD in the panel line. However, all involved routines are written in a general way, so that other similar objects, e g the cutting portal in a vebb line, also may be simulated by the program.

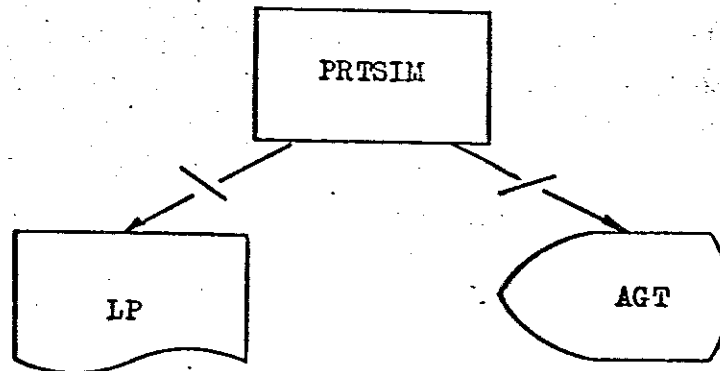
When changing object of simulation, the following measures are to be taken:

- Change the contents of the data base DATBAS, so that a realistic image of the new object is received.
- Adapt the COMMON-declarations in FORTRAN-routines to the new data bank. No changes are necessary in Assembler-routines.

The limiting parameter of the simulation program is the number of heads, which may not exceed 16.

The result of the simulation is shown on an alpha-graphic terminal. All routines which are involved in this part of the program are written in a general way, which makes them applicable in completely different applications.

Logical Computer



On the line printer LP the values of the variables in the data base DATBAS are printed out with a frequency desired by the user.

On the alpha-graphic terminal AGT the result of the simulation is drawn on a contour of a plate.

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Date

1974-12-11

Reference of document

Addressee/Subject

PRTSIM - PORTAL SIMULATION

**Input** All input to the system is generated by the control program for the portal (Ref 1).

**Result** The variables of the data base are listed on LP with a frequency given by the user. Each variable may be given a frequency which makes it possible to log out detached variables. If any error occurs in the simulation, the whole data base is listed. See Appendix 1.

The result from the flame cutters, paint sprayers and the punch are written on the alpha-graphic terminal AGT. The contour of the plate and the actual clamping of the heads also occur on the screen. (Ref 2)

**References**

1. 245 NOV 172
2. 245 NOV 172, Enclosure 1, Page 4

Addressee/Subject

PRTSIM - PORTAL SIMULATIONTheory

The program is based on five subprograms which are administered by MAINS. The program flow chart is shown in Appendix 2. Two of the five programs are user-defined, namely UPST and CONTROL.

The subprogram UPST is a starting-up program which assigns values to the variables in the data bases DATBAS, RITBAS and LOGBAS. The data bases are described below. CONTROL is the control program for the portal.

The three remaining programs will be described below.

After executing UPST as a one-shot-program, the other four subprograms are forming a loop in which they are executed sequentially. It is possible to halt the execution from the CONTROL-program via DATBAS.

The simulation of the behaviour of the portal is performed by SIM. This subprogram handles a number of subroutines, which are called upon as a function of the actual state of the portal. The moving masses are described mathematically by two differential equations, one for movements controlled by the servoes, the other for uncontrolled movements (i.e. the moving masses are disengaged). It is assumed that servo-controlled movements may be described by the transfer function G as:

$$G = \frac{K \cdot U}{s(Ts+1)}$$

where

K is a proportion constant

U is the control signal

T is a time constant

G may be transferred to a differential form:

$$1) \quad \frac{d^2x}{dt^2} + \frac{1}{T} \frac{dx}{dt} = \frac{1}{T} \cdot K \cdot U$$

where x is the distance of movement and t the time.

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PRTSIM - PORTAL SIMULATION

The solution of 1) may be written:

$$x(t) = K \cdot U \cdot t + x(0) - T(K \cdot U - \dot{x}(0)) + T(K \cdot U - \dot{x}(0))e^{-\frac{t}{T}}$$

where

$x(0)$  is the starting position

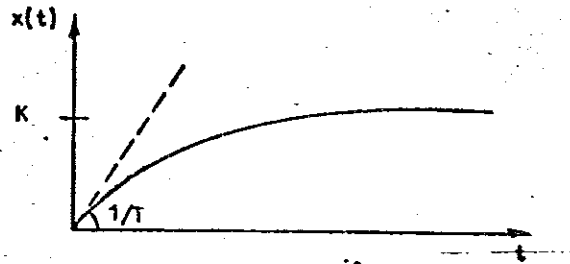
$\dot{x}(0)$  is the starting velocity

The velocity may be obtained as the first derivative with respect to the time:

$$\dot{x}(t) = K \cdot U - (K \cdot U - \dot{x}(0))e^{-\frac{t}{T}}$$

This gives a possibility of deciding experimentally the value of the time constant  $T$  and the proportion constant  $K$ .

The response on a unit step, with the initial velocity equal to 0, will be:



As the control signal is constant during the sample interval, it is possible to transform the solution of 1) into a sample form:

$$\begin{cases} x(t+T_s) = K \cdot U \cdot T_s + x(t) - T(K \cdot U - \dot{x}(t)) + T(K \cdot U - \dot{x}(t))e^{-\frac{T_s}{T}} \\ \dot{x}(t+T_s) = K \cdot U - (K \cdot U - \dot{x}(t))e^{-\frac{T_s}{T}} \end{cases}$$

where  $T_s$  is the sample interval.

These equations are then used to simulate the servo-controlled movement.

The uncontrolled movement may be described by:

$$2) \quad \frac{d^2x}{dt^2} + C = 0$$

where  $C$  is a constant.

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PRTSIM - PORTAL SIMULATION

The solution of 2) may be written:

$$\begin{cases} x(t) = -\frac{Ct^2}{2} + \dot{x}(0) \cdot t + x(0) \\ \dot{x}(t) = -Ct + \dot{x}(0) \quad \dot{x}(t) > 0 \end{cases}$$

where C may be decided in a way similar to that described above.

The sampled form will be:

$$\begin{cases} x(t+T_s) = -\frac{C}{2} T_s^2 + \dot{x}(t) \cdot T_s + x(t) \\ \dot{x}(t+T_s) = -CT_s + \dot{x}(t) \end{cases}$$

The subprogram RITA is used to show the result of the simulation on an alpha-graphic terminal. RITA is based on the BASIC PLOT ROUTINES which are Assembler-coded routines for handling of the terminal.

LOGGA is a subprogram for listing of the variables in the data base DATBAS.

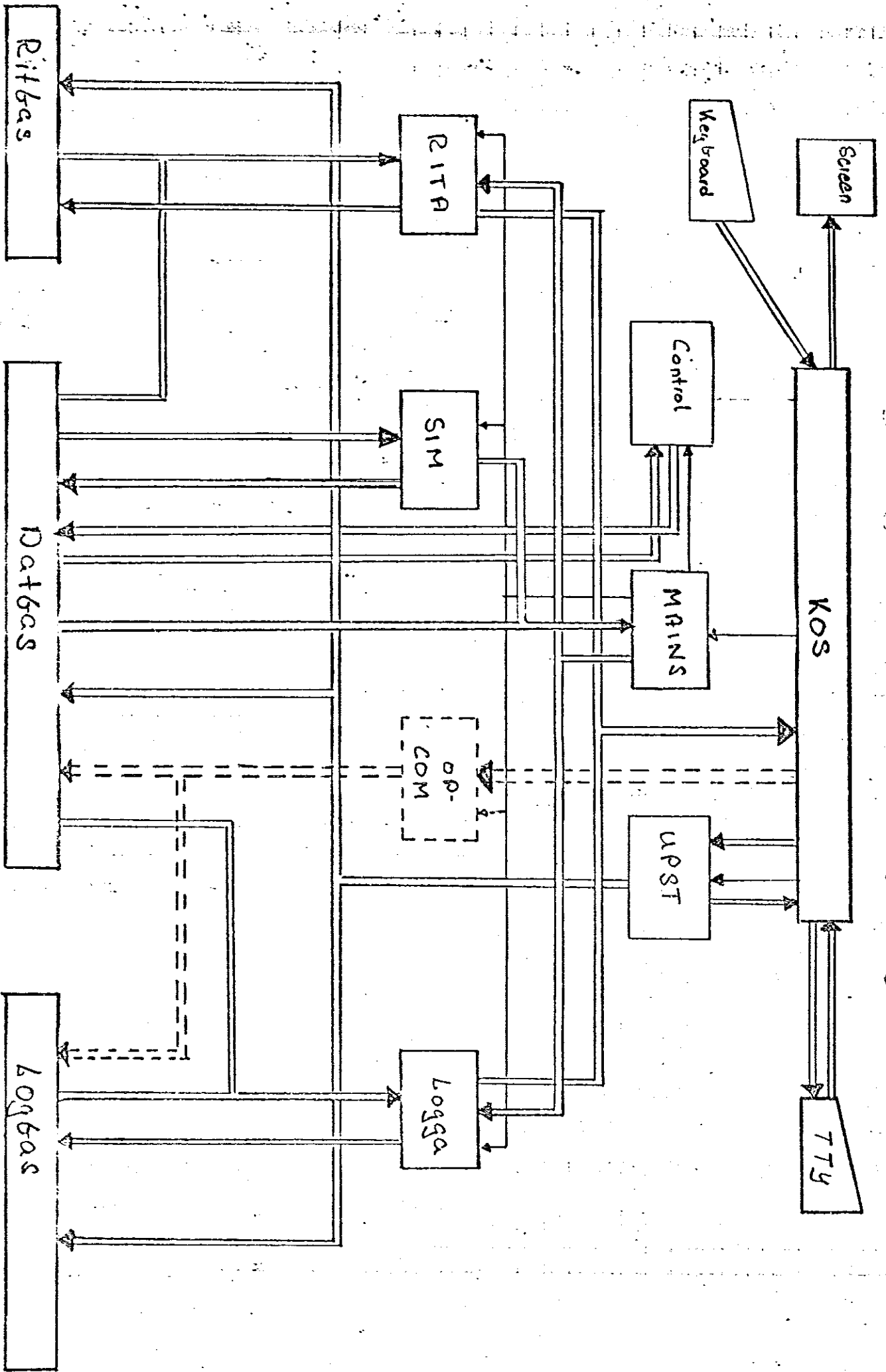
The data base DATBAS holds all variables for the simulation such as time constants, velocities, positions and so on.

LOGBAS contains logging variables which correspond to the variables in DATBAS. Each logging variable holds a value which is defined by the user. This value is the listing frequency for the corresponding variable in DATBAS.

RITBAS is an internal data base for the BASIC PLOT ROUTINES. It holds parameters as screen mode, pointer to the buffers and origin on the screen.

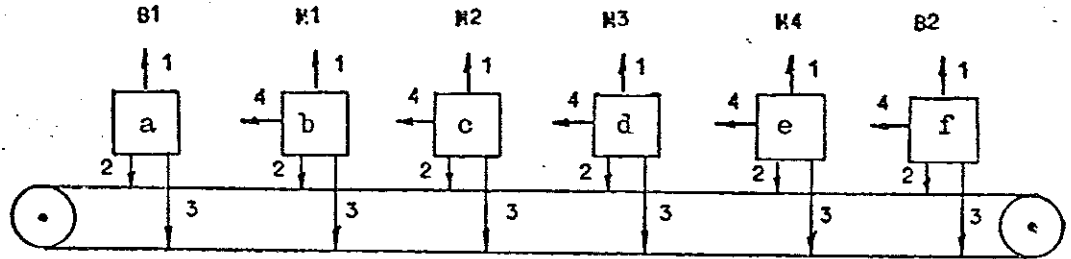
Remarks

The program OPCOM is an operator communication program, which may be implemented in PRTSIM. This program should perform input and output to DATBAS and LOGBAS.



Addressee/Subject  
**BNTB - EVALUATE STATES OF MOVEMENT**

Theory



- Index 1: Connection to portal
- Index 2: Connection to congruent band side
- Index 3: Connection to reverse band side
- Index 4: Activated hook.

It is possible to describe the movement of the heads with states, whose logical values decide the directions of movement of the heads, which are relative to the burner heads driving them.

The states are divided into four groups:

- Movement congruous with burner head 1
- Movement reversed to burner head 1
- Movement congruous with burner head 2
- Movement reversed to burner head 2

Each head is given a state in each group. If the state is **.TRUE.**, the head is moving in accordance with the group name.

You will find the following logical equations:

(Note that  $+ \equiv .OR.$ ,  $\cdot \equiv .AND.$ )

Movement congruous to burner head 1.

$$Tb+ = a_2(b_2 + c_4(c_2 + d_4(d_2 + e_4(e_2 + f_4f_2)))) + a_3(b_3 + c_4(c_3 + d_4(d_3 + e_4(e_3 + f_4f_3)))) +$$

$b_4$

$$Tc+ = a_2(c_2 + c_4b_2 + d_4(d_2 + e_4(e_2 + f_4f_2))) + a_3(c_3 + c_4b_3 + d_4(d_3 + e_4(e_3 + f_4f_3))) + b_4 \left\{ b_2(c_2 + d_4(d_2 + e_4(e_2 + f_4f_2))) + b_3(c_3 + d_4(d_3 + e_4(e_3 + f_4f_3))) + \right.$$

$c_4$



Addressee/Subject

BNTE - EVALUATE STATES OF MOVEMENT

$$T_d+ = a_2(d_2 + d_4(c_2 + c_4b_2) + e_4(e_2 + f_4f_2)) +$$

$$a_3(d_3 + d_4(c_3 + c_4b_3) + e_4(e_3 + f_4f_3)) +$$

$$b_4 \left\{ b_2(d_2 + d_4c_2 + e_4(e_2 + f_4f_2)) + \right.$$

$$b_3(d_3 + d_4c_3 + e_4(e_3 + f_4f_3)) +$$

$$c_4 < c_2(d_2 + e_4(e_2 + f_4f_2)) +$$

$$c_3(d_3 + e_4(e_3 + f_4f_3)) +$$

$$\left. \begin{matrix} d_4 > \end{matrix} \right\}$$

$$T_e+ = a_2(e_2 + e_4(d_2 + d_4(c_2 + c_4b_2)) + f_4f_2) +$$

$$a_3(e_3 + e_4(d_3 + d_4(c_3 + c_4b_3)) + f_4f_3) +$$

$$b_4 \left\{ b_2(e_2 + e_4(d_2 + d_4c_2) + f_4f_2) + \right.$$

$$b_3(e_3 + e_4(d_3 + d_4c_3) + f_4f_3) +$$

$$c_4 < c_2(e_2 + e_4d_2 + f_4f_2) +$$

$$c_3(e_3 + e_4d_3 + f_4f_3) +$$

$$d_4 [ d_2(e_2 + f_4f_2) +$$

$$d_3(e_3 + f_4f_3) +$$

$$\left. \begin{matrix} e_4 > \end{matrix} \right\}$$

$$T_f+ = a_2(f_2 + f_4(e_2 + e_4(d_2 + d_4(c_2 + c_4b_2)))) +$$

$$a_3(f_3 + f_4(e_3 + e_4(d_3 + d_4(c_3 + c_4b_3)))) +$$

$$b_4 \left\{ b_2(f_2 + f_4(e_2 + e_4(d_2 + d_4c_2))) + \right.$$

$$b_3(f_3 + f_4(e_3 + e_4(d_3 + d_4c_3))) +$$

$$c_4 < c_2(f_2 + f_4(e_2 + e_4d_2)) +$$

$$c_3(f_3 + f_4(e_3 + e_4d_3)) +$$

$$d_4 [ d_2(f_2 + e_2f_4) +$$

$$d_3(f_3 + e_3f_4) +$$

$$e_4 \{ e_2f_2 +$$

$$e_3f_3 +$$

$$\left. \begin{matrix} f_4 > \end{matrix} \right\} \right\}$$

Addressee/Subject

INTE - EVALUATE STATES OF MOVEMENT

Movement reversed to burner head 1

$$Tb- = a_3(b_2 + c_4(c_2 + d_4(d_2 + e_4(e_2 + f_4f_2)))) + a_2(b_3 + c_4(c_3 + d_4(d_3 + e_4(e_3 + f_4f_3))))$$

$$Tc- = a_3(c_2 + c_4b_2 + d_4(d_2 + e_4(e_2 + f_4f_2))) + a_2(c_3 + c_4b_3 + d_4(d_3 + e_4(e_3 + f_4f_3))) + b_4 \left\{ b_3(c_2 + d_4(d_2 + e_4(e_2 + f_4f_2))) + b_2(c_3 + d_4(d_3 + e_4(e_3 + f_4f_3))) \right\}$$

$$Td- = a_3(d_2 + d_4(c_2 + c_4b_2) + e_4(e_2 + f_4f_2)) + a_2(d_3 + d_4(c_3 + c_4b_3) + e_4(e_3 + f_4f_3)) + b_4 \left\{ b_3(d_2 + d_4c_2 + e_4(e_2 + f_4f_2)) + b_2(d_3 + d_4c_3 + e_4(e_3 + f_4f_3)) + c_4 \left\langle c_3(d_2 + e_4(e_2 + f_4f_2)) + c_2(d_3 + e_4(e_3 + f_4f_3)) \right\rangle \right\}$$

$$Te- = a_3(e_2 + e_4(d_2 + d_4(c_2 + c_4b_2)) + f_4f_2) + a_2(e_3 + e_4(d_3 + d_4(c_3 + c_4b_3)) + f_4f_3) + b_4 \left\{ b_3(e_2 + e_4(d_2 + d_4c_2) + f_4f_2) + b_2(e_3 + e_4(d_3 + d_4c_3) + f_4f_3) + c_4 \left\langle c_3(e_2 + e_4d_2 + f_4f_2) + c_2(e_3 + e_4d_3 + f_4f_3) + d_4[d_3(e_2 + f_4f_2) + d_2(e_3 + f_4f_3)] \right\rangle \right\}$$

$$Tf- = a_3(f_2 + f_4(e_2 + e_4(d_2 + d_4(c_2 + c_4b_2)))) + a_2(f_3 + f_4(e_3 + e_4(d_3 + d_4(c_3 + c_4b_3)))) + b_4 \left\{ b_3(f_2 + f_4(e_2 + e_4(d_2 + d_4c_2))) + b_2(f_3 + f_4(e_3 + e_4(d_3 + d_4c_3))) + c_4 \left\langle c_3(f_2 + f_4(e_2 + e_4d_2)) + c_2(f_3 + f_4(e_3 + e_4d_2)) \right\rangle \right\}$$

Mottogare

BNTE - EVALUATE STATES OF MOVEMENT

$$d_4 [ d_3 (f_2 + e_2 f_4) + d_2 (f_3 + e_3 f_4) + e_4 \{ e_3 f_2 + e_2 f_3 \} ] > \}$$

Movement congruous to burner head 2

$$T_{e+} = f_2 (e_2 + e_4 (d_2 + d_4 (c_2 + c_4 (b_2 + b_4 a_2)))) + f_3 (e_3 + e_4 (d_3 + d_4 (c_3 + c_4 (b_3 + b_4 a_3)))) + f_4$$

$$T_{d+} = f_2 (d_2 + e_4 e_2 + d_4 (c_2 + c_4 (b_2 + b_4 a_2))) + f_3 (d_3 + e_4 e_3 + d_4 (c_3 + c_4 (b_3 + b_4 a_3))) + f_4 \{ e_2 (d_2 + d_4 (c_2 + c_4 (b_2 + b_4 a_2))) + e_3 (d_3 + d_4 (c_3 + c_4 (b_3 + b_4 a_3))) \} e_4$$

$$T_{c+} = f_2 (c_2 + d_4 (d_2 + e_4 e_2) + c_4 (b_2 + b_4 a_2)) + f_3 (c_3 + d_4 (d_3 + e_4 e_3) + c_4 (b_3 + b_4 a_3)) + f_4 \{ e_2 (c_2 + d_4 d_2 + c_4 (b_2 + b_4 a_2)) + e_3 (c_3 + d_4 d_3 + c_4 (b_3 + b_4 a_3)) + e_4 (d_2 (c_2 + c_4 (b_2 + b_4 a_2)) + d_3 (c_3 + c_4 (b_3 + b_4 a_3))) \} d_4 > \}$$

Mottagare

BNT E - EVALUATE STATES OF MOVEMENT

$$Tb+ = f_2(b_2 + c_4(c_2 + d_4(d_2 + e_4e_2))) + b_4a_2) +$$

$$f_3(b_3 + c_4(c_3 + d_4(d_3 + e_4e_3))) + b_4a_3) +$$

$$f_4 \left\{ e_2(b_2 + c_4(c_2 + d_4d_2)) + b_4a_2) + \right.$$

$$e_3(b_3 + c_4(c_3 + d_4d_3)) + b_4a_3) +$$

$$e_4 < d_2(b_2 + c_4c_2 + b_4a_2) +$$

$$d_3(b_3 + b_4c_3 + b_4a_3) +$$

$$d_4[c_2(b_2 + b_4a_2) +$$

$$c_3(b_3 + b_4a_3) +$$

$$\left. \textcircled{c_4} \right] > \left. \right\}$$

$$Ta+ = f_2(a_2 + b_4(b_2 + c_4(c_2 + d_4(d_2 + e_4e_2)))) +$$

$$f_3(a_3 + b_4(b_3 + c_4(c_3 + d_4(d_3 + e_4e_3)))) +$$

$$f_4 \left\{ e_2(a_2 + b_4(b_2 + c_4(c_2 + d_4d_2))) + \right.$$

$$e_3(a_3 + b_4(b_3 + c_4(c_3 + d_4d_3))) +$$

$$e_4 < d_2(a_2 + b_4(b_2 + c_4c_2)) +$$

$$d_3(a_3 + b_4(b_3 + c_4c_3)) +$$

$$d_4[c_2(a_2 + b_4b_2) +$$

$$c_3(a_3 + b_4b_3) +$$

$$c_4 \left\{ b_2a_2 + \right.$$

$$b_3a_3 +$$

$$\left. \left. \textcircled{b_4} \right\} \right] > \left. \right\}$$

Movement reversed to burner head 2

$$Te- = f_3(e_2 + e_4(d_2 + d_4(c_2 + c_4(b_2 + b_4a_2)))) +$$

$$f_2(e_3 + e_4(d_3 + d_4(c_3 + c_4(b_3 + b_4a_3))))$$

$$Td- = f_3(d_2 + e_4e_2 + d_4(c_2 + c_4(b_2 + b_4a_2))) +$$

$$f_2(d_3 + e_4e_3 + d_4(c_3 + c_4(b_3 + b_4a_3))) +$$

$$f_4 \left\{ e_3(d_2 + d_4(c_2 + c_4(b_2 + b_4a_2))) + \right.$$

$$\left. e_2(d_3 + d_4(c_3 + c_4(b_3 + b_4a_3))) \right\}$$

Mottagare

BNTE - EVALUATE STATES OF MOVEMENT

$$Tc- = f_3(c_2 + d_4(d_2 + e_4e_2) + c_4(b_2 + b_4a_2)) + \\ f_2(c_3 + d_4(d_3 + e_4e_3) + c_4(b_3 + b_4a_3)) + \\ f_4 \left\{ \begin{array}{l} e_3(c_2 + d_4d_2 + c_4(b_2 + b_4a_2)) + \\ e_2(c_3 + d_4d_3 + c_4(b_3 + b_4a_3)) + \\ e_4 < d_3(c_2 + c_4(b_2 + b_4a_2)) + \\ d_2(c_3 + c_4(b_3 + b_4a_3)) > \end{array} \right\}$$

$$Tb- = f_3(b_2 + c_4(c_2 + d_4(d_2 + e_4e_2)) + b_4a_2) + \\ f_2(b_3 + c_4(c_3 + d_4(d_3 + e_4e_3)) + b_4a_3) + \\ f_4 \left\{ \begin{array}{l} e_3(b_2 + c_4(c_2 + d_4d_2) + b_4a_2) + \\ e_2(b_3 + c_4(c_3 + d_4d_3) + b_4a_3) + \\ e_4 < d_3(b_2 + c_4c_2 + b_4a_2) + \\ d_2(b_3 + c_4c_3 + b_4a_3) + \\ d_4[c_3(b_2 + b_4a_2) + \\ c_2(b_3 + b_4a_3)] > \end{array} \right\}$$

$$Ta- = f_3(a_2 + b_4(b_2 + c_4(c_2 + d_4(d_2 + e_4e_2)))) + \\ f_2(a_3 + b_4(b_3 + c_4(c_3 + d_4(d_3 + e_4e_3)))) + \\ f_4 \left\{ \begin{array}{l} e_3(a_2 + b_4(b_2 + c_4(c_2 + d_4d_2))) + \\ e_2(a_3 + b_4(b_3 + c_4(c_3 + d_4d_3))) + \\ e_4 < d_3(a_2 + b_4(b_2 + c_4c_2)) + \\ d_2(a_3 + b_4(b_3 + c_4c_3)) + \\ d_4[c_3(a_2 + b_4b_2) + \\ c_2(a_3 + b_4b_3) + \\ c_4 \left\{ \begin{array}{l} b_3a_2 + \\ b_2a_3 \end{array} \right\} ] > \end{array} \right\}$$

Mottagare

BNTE - EVALUATE STATES OF MOVEMENT

If you let variables marked ( ) change places and if you omit variables marked  $\bigcirc$  you will find that the equations for reversed movement will turn into equations for congruous movement.

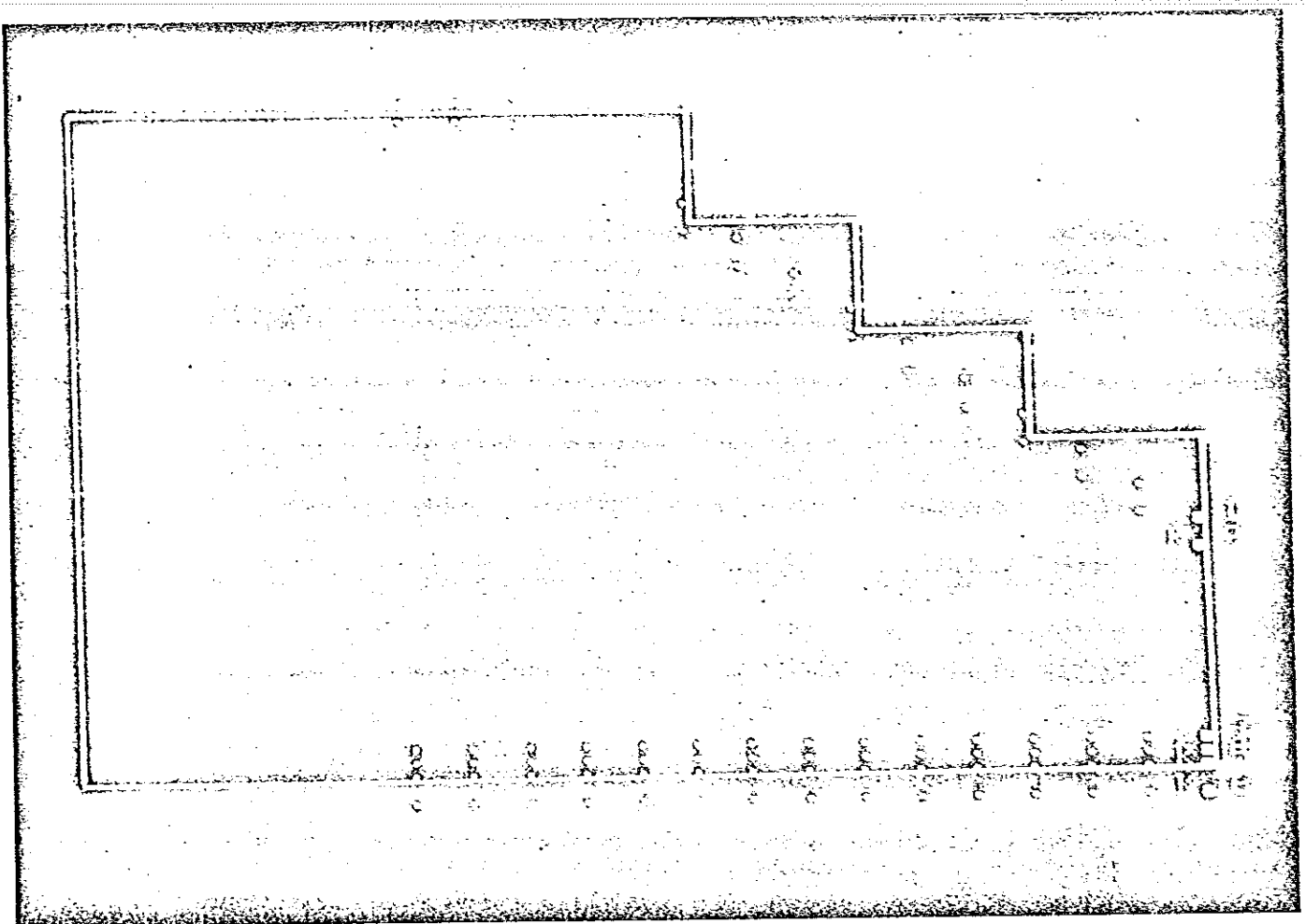
If you then reverse the state vectors and shift state vector 4 one step to the left you will turn the equations for movement congruous with and reversed to burner head 2 over to the corresponding equations for burner head 1.

It is then obvious that the four groups might be evaluated in the same manner.

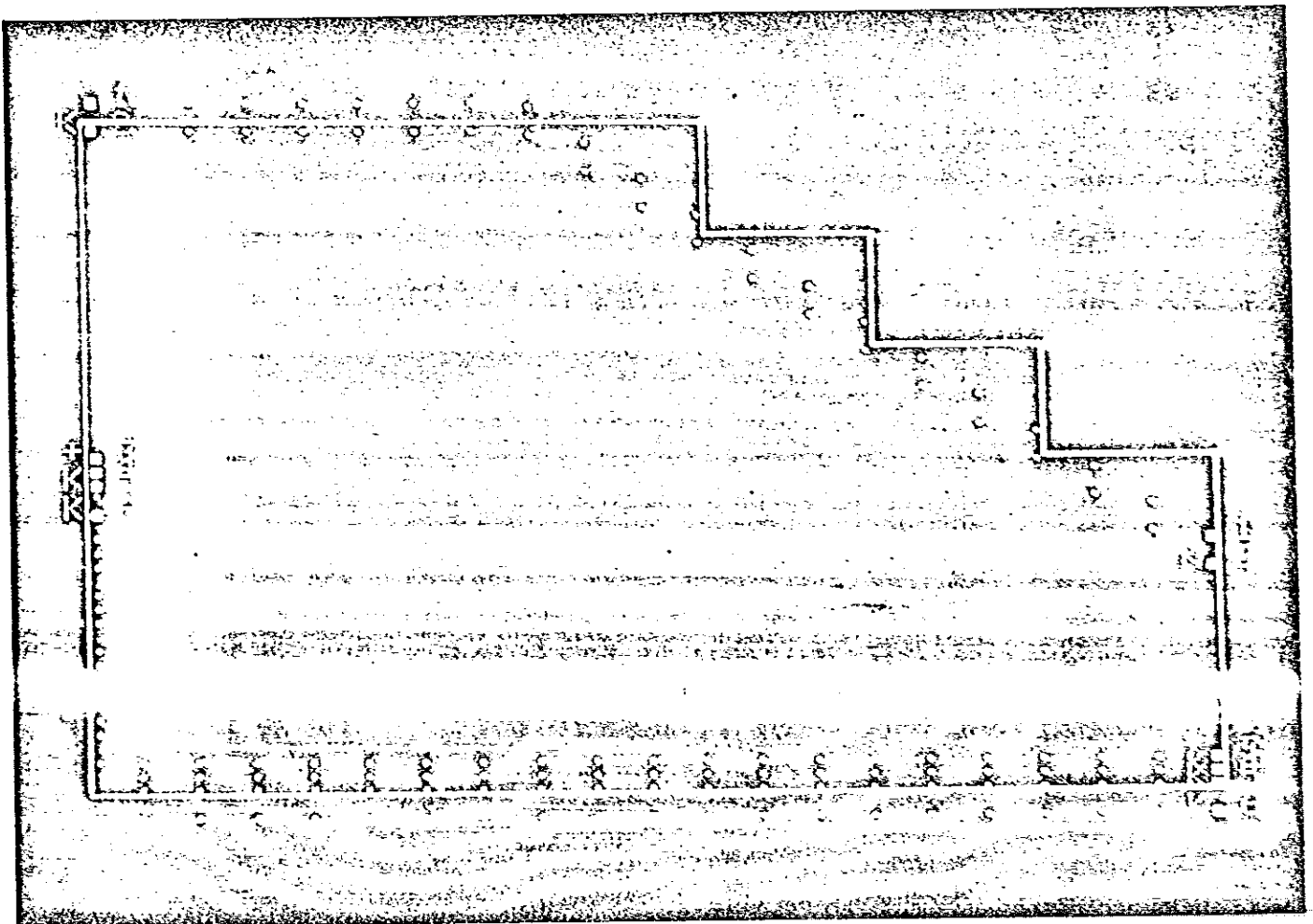
If you study the equations for movement congruous with burner head 1, you will find that they are varying in a regular way. Furthermore, you will find that the same partial results are to be found in each equation. If you use these observations, it is possible to evaluate the equations parallely.

BILAGA 3

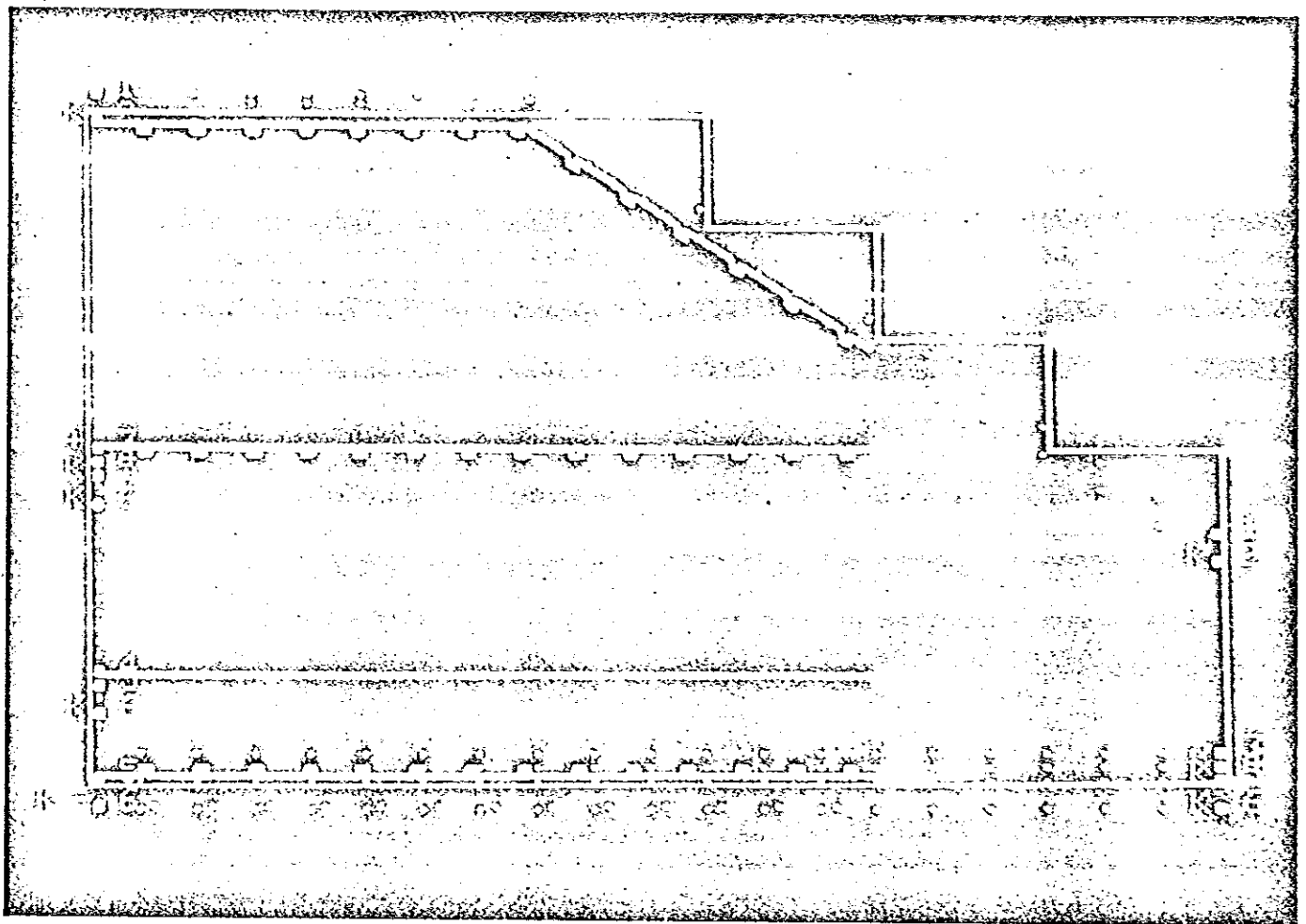
Exempel på simulering



1. Uppmätningstvåndan, portalen rör sig från höger till vänster och huvudpositionerna anges av punktlinjer. Huvudenas kopplingsstatus återfinnes i högra kanten av flaket.
2. Positionering för märkvåndan. Ny kopplingsstatus anges.







3. Uppmärkningsvändan, observera körnarlagen på märklinjerna.

4. Avkänning av gränslägesbrytare, ny huvudkoppling erhålles och anges.

