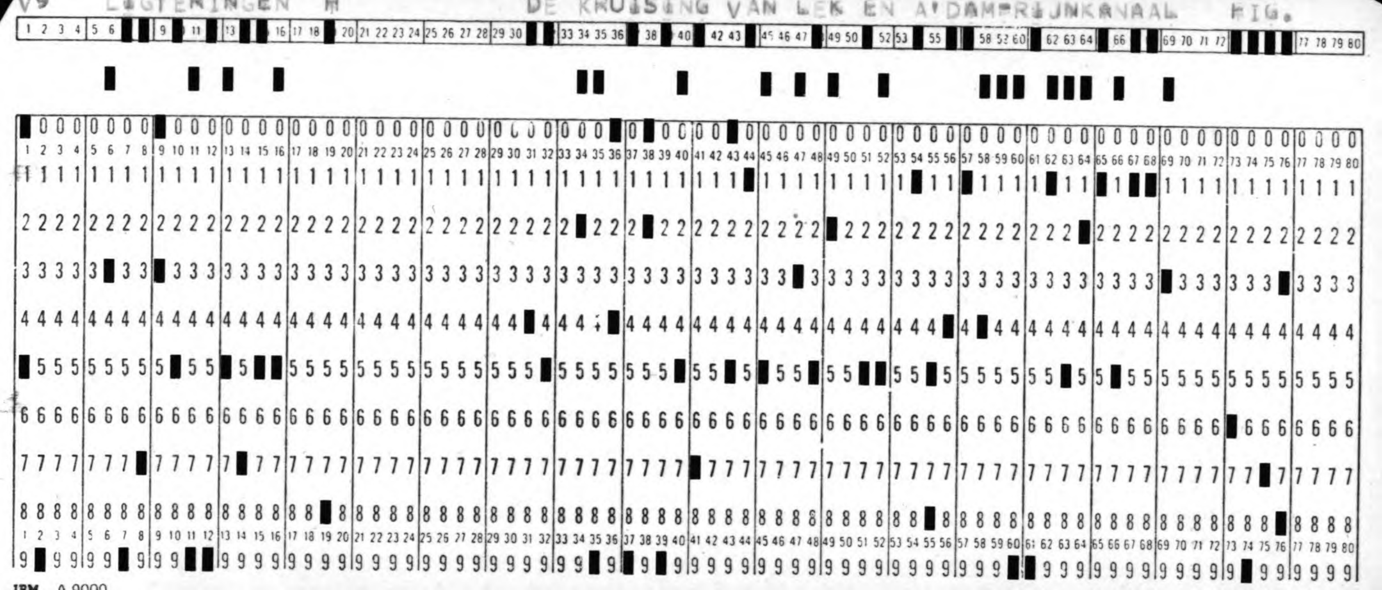
De kruising van
Lek en A'dam - Rijn kan.

Figuren

H. Ligteringen


DE KRUISING VAN LEK EN A'DAMRIJNKANAAL
FIG.

Schäufele 6725B

FIGUREN

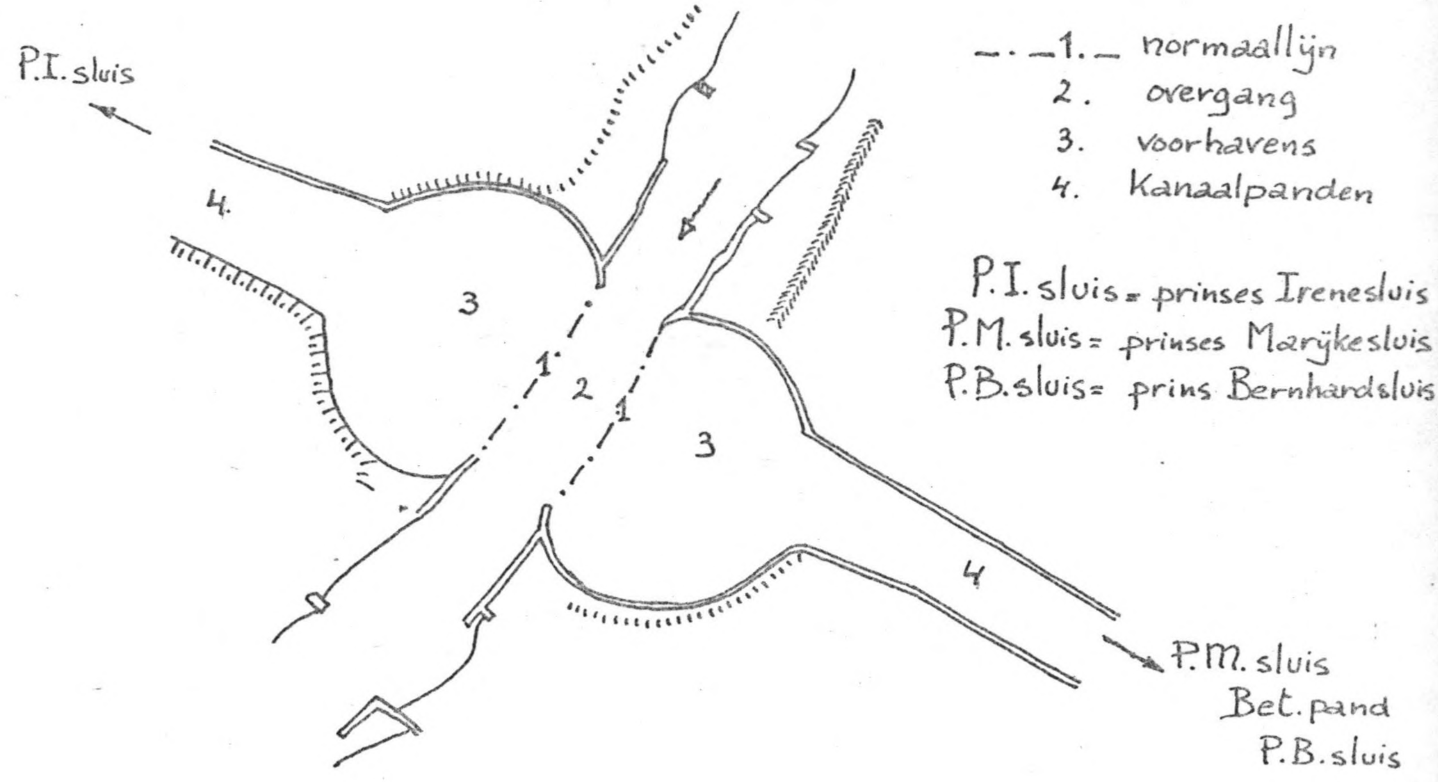


fig. 1a de „eieren van Thijsse"

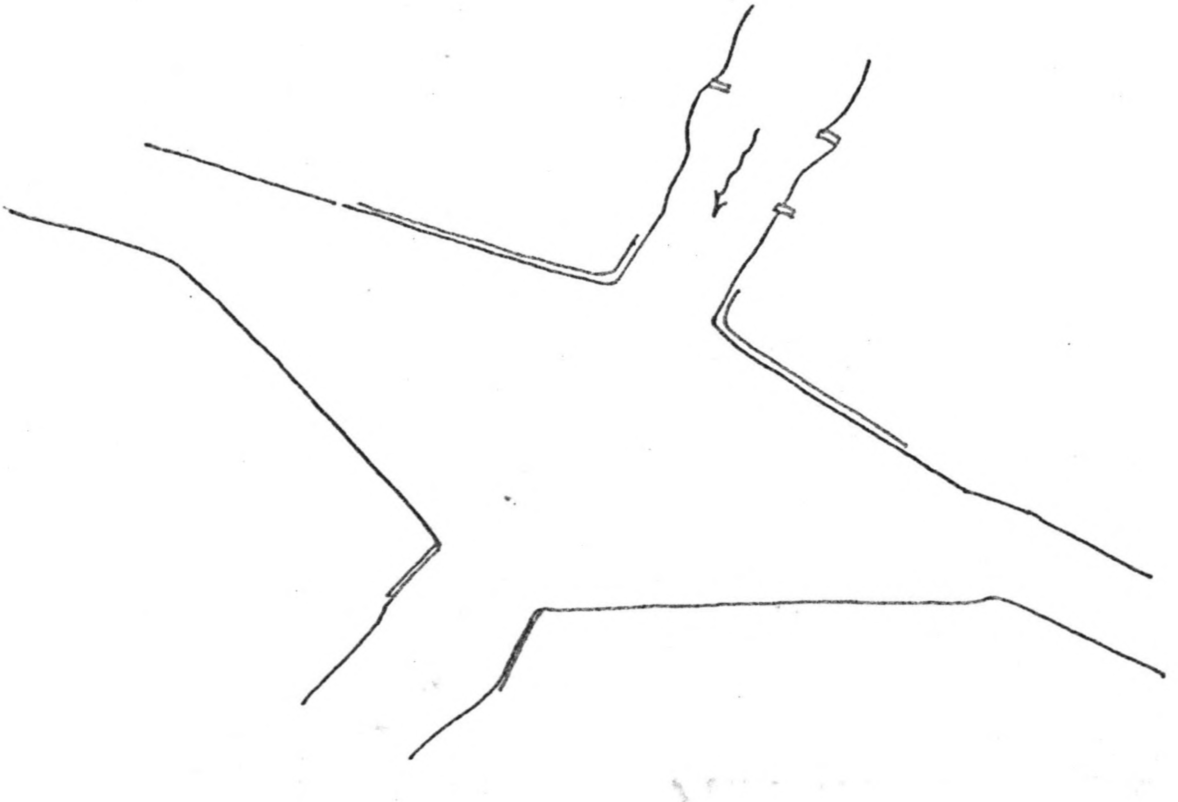


fig. 1 b Vorm, die door de Staatscommissie voorgesteld werd.

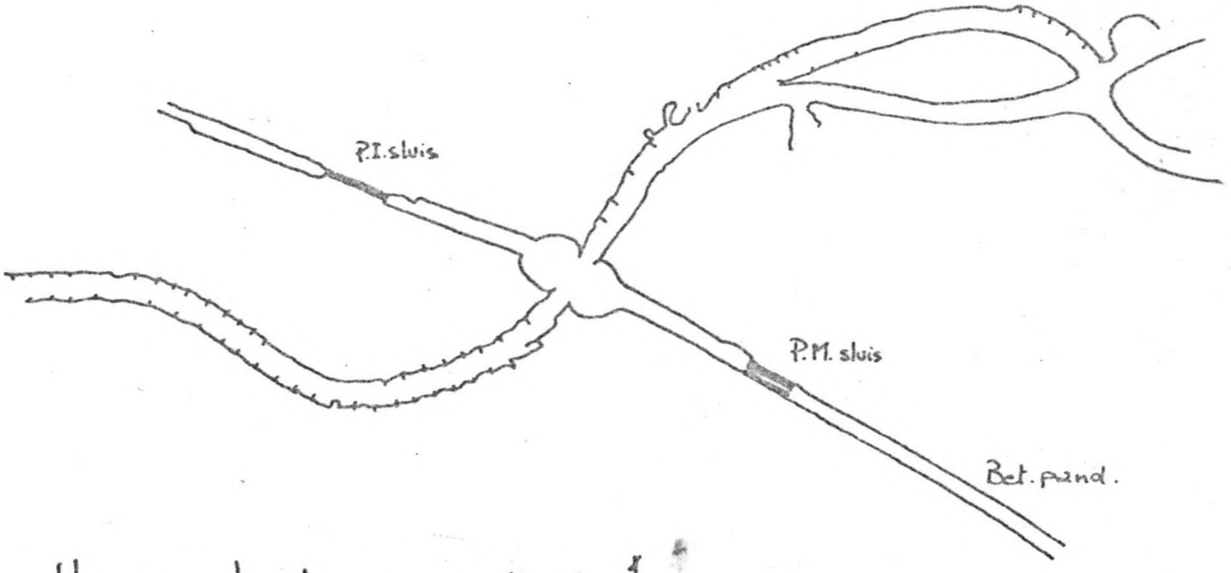


Fig. 2 Huidige toestand schaal 1:50.000

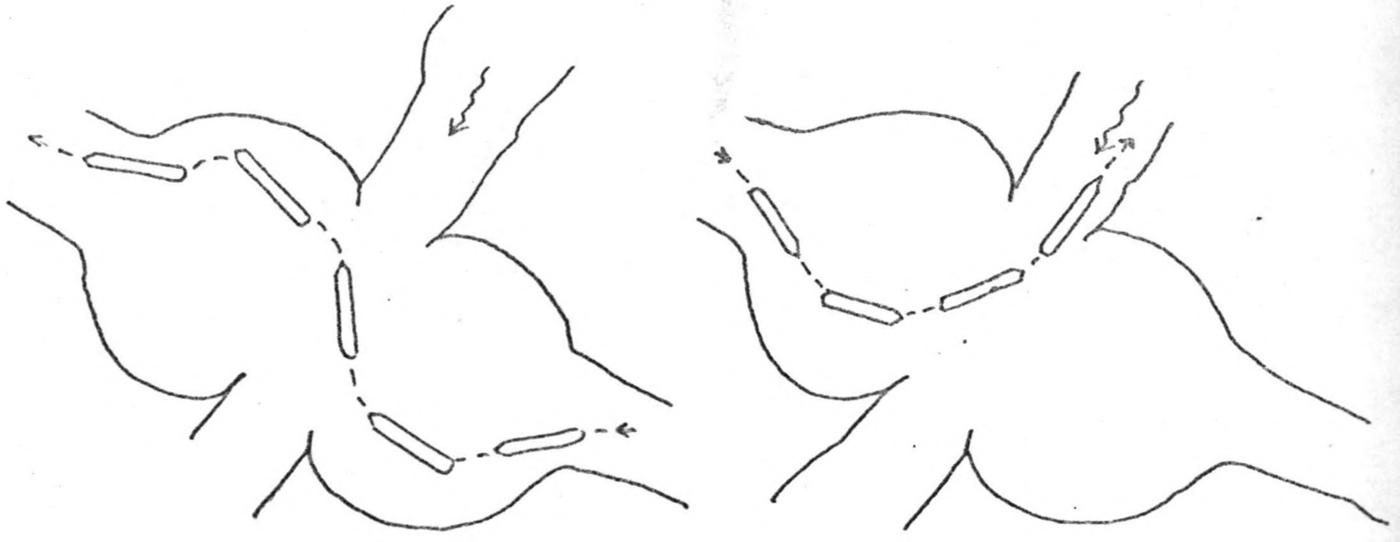


Fig.3 Overstekend en afslaand scheepvaart verkeer.

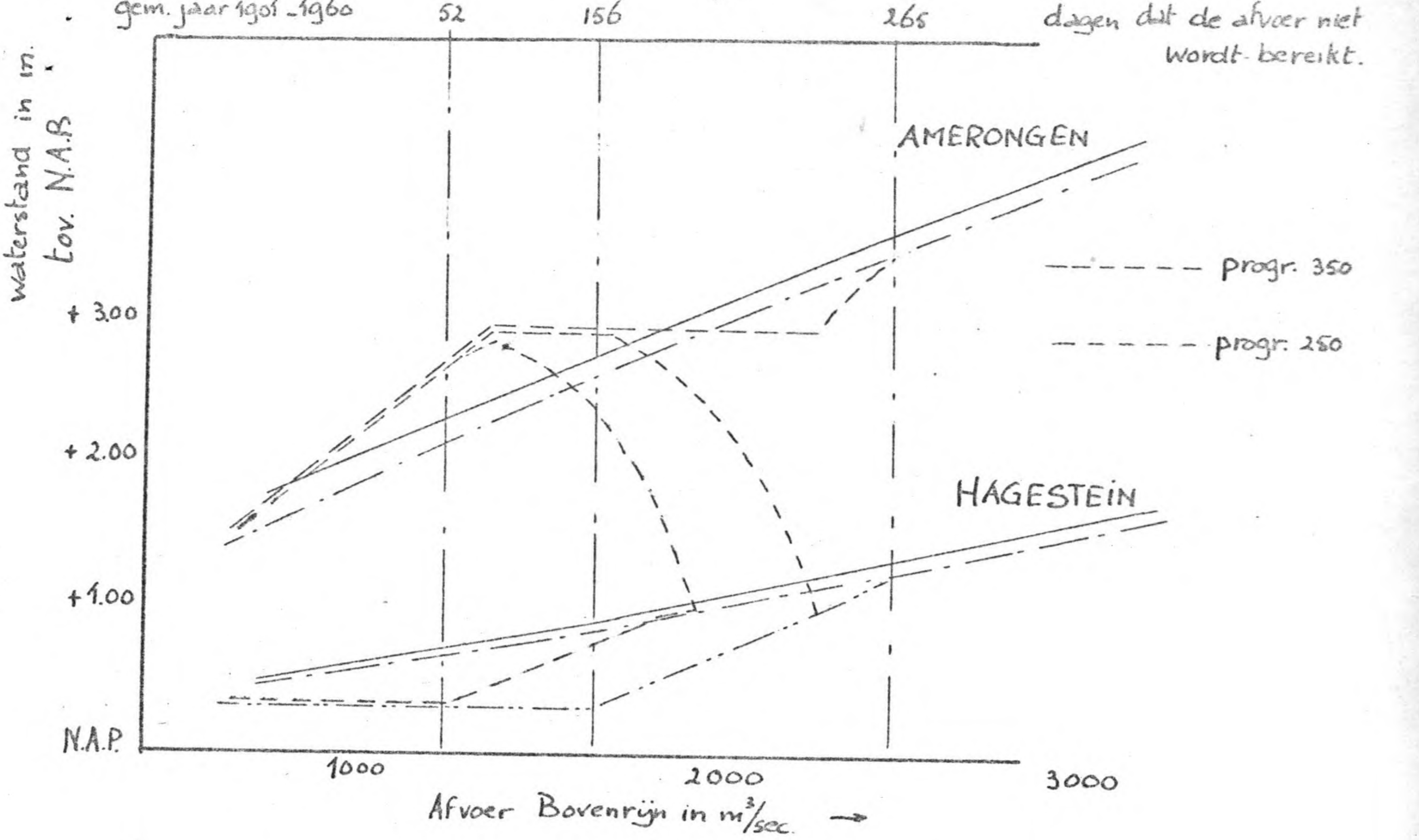
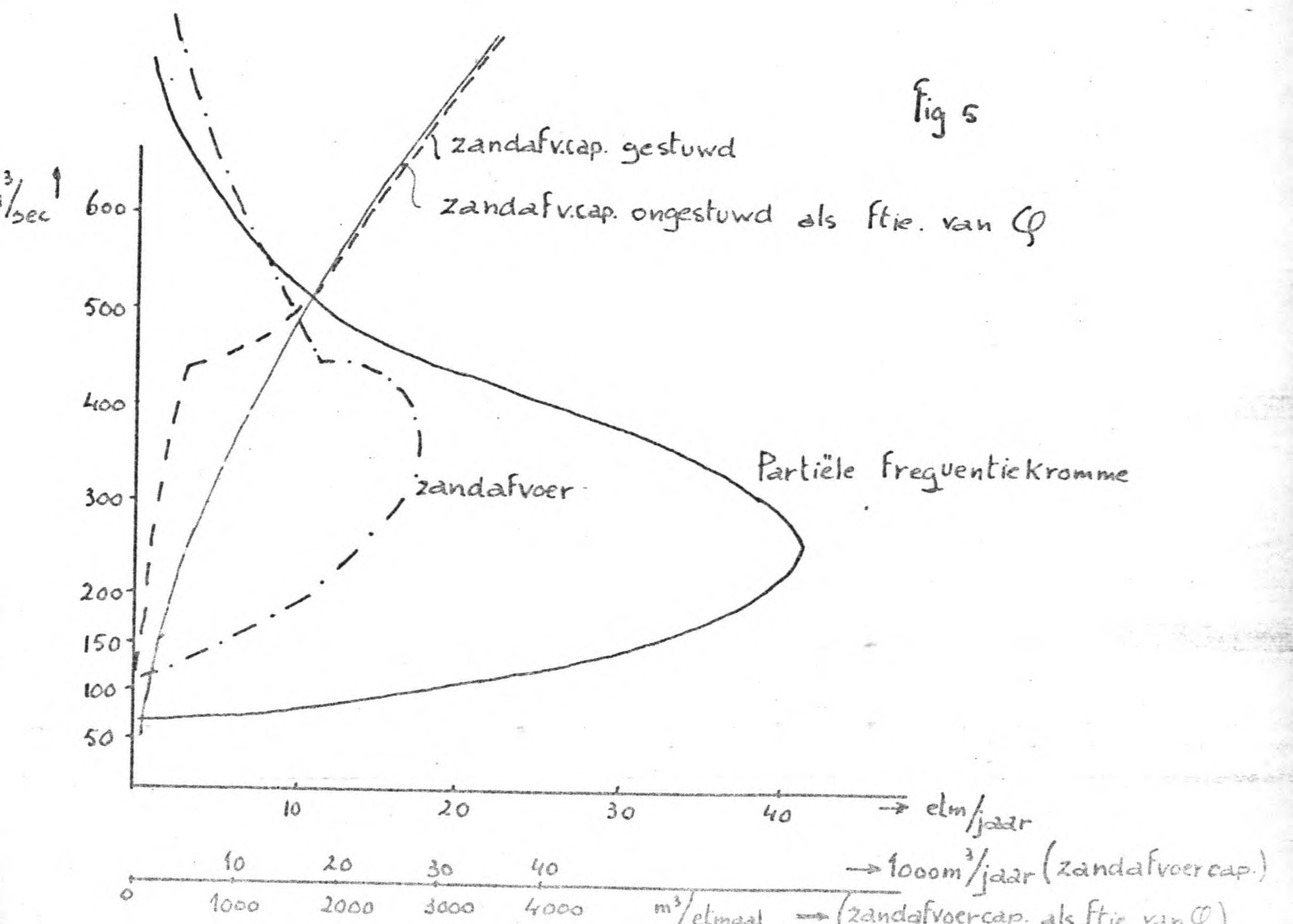


fig. 4 Afvoerprogramma Benedenrivieren.



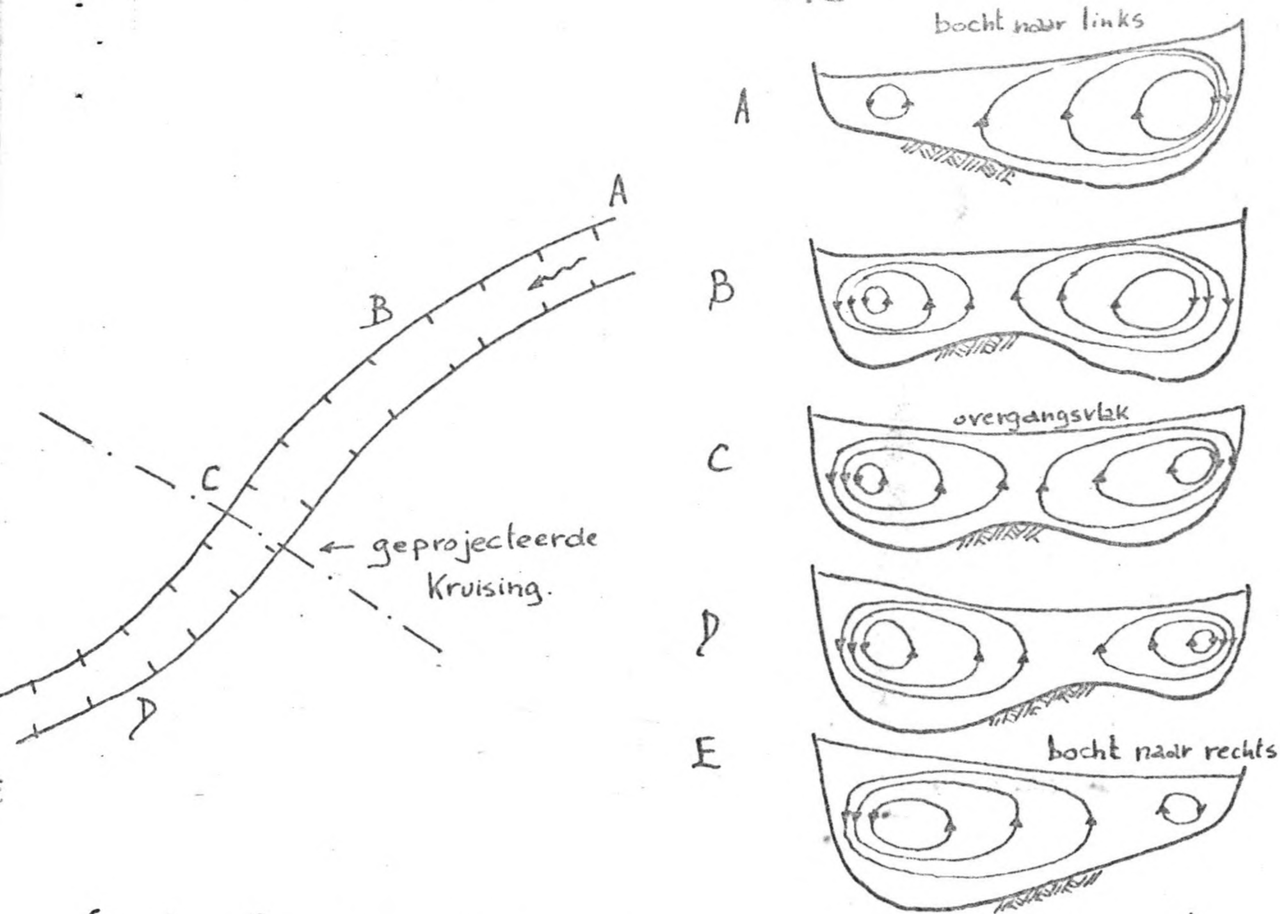


fig. 6 Secundaire stroming in de rivier

fig. 7 Secundaire stroming neer en rivier (Sterk overtrokken weergegeven)

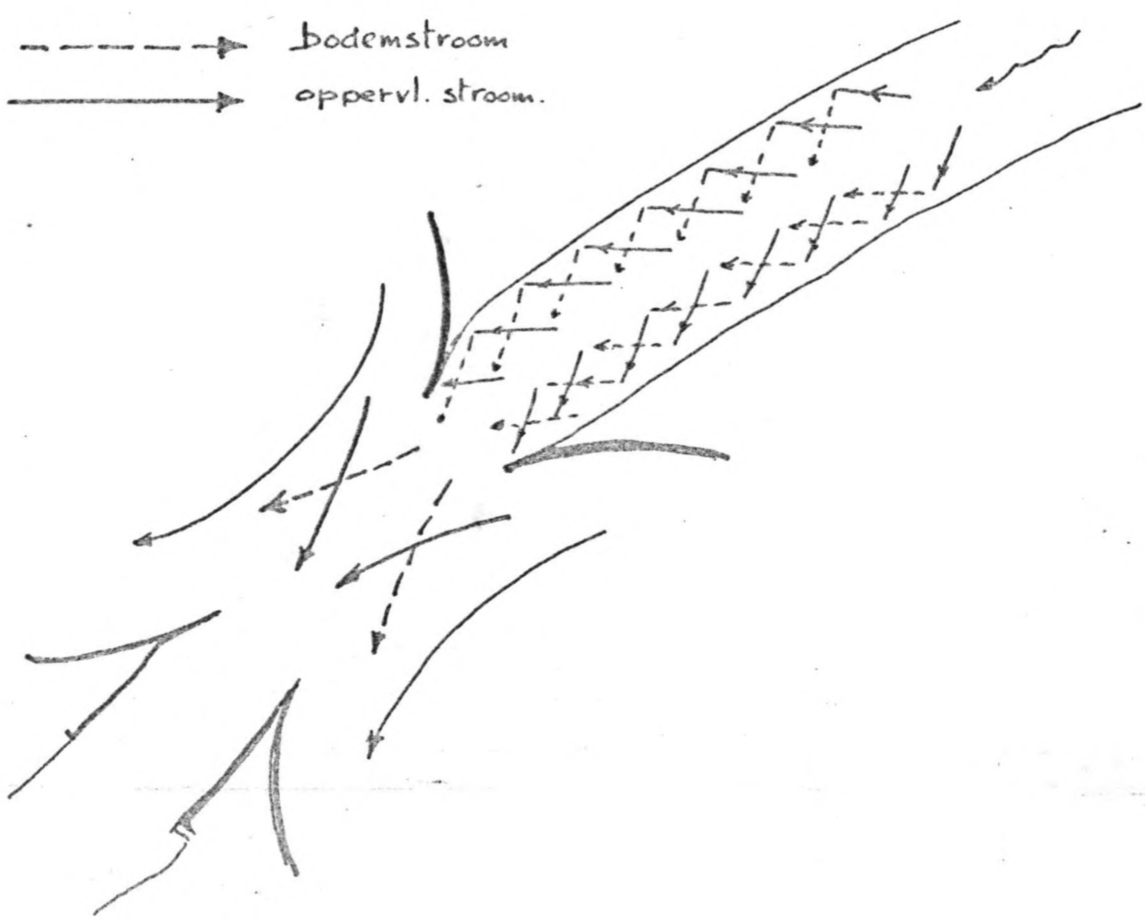
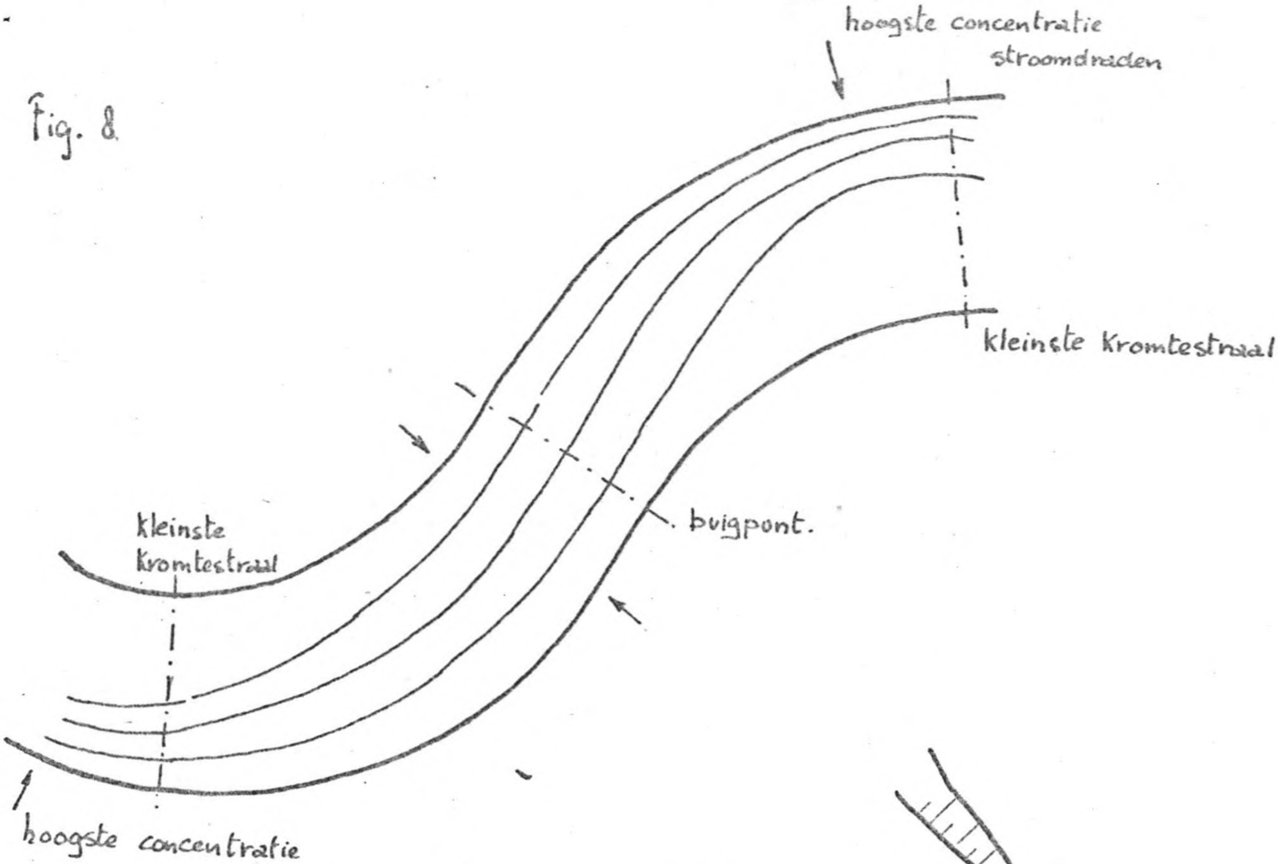


Fig. 8



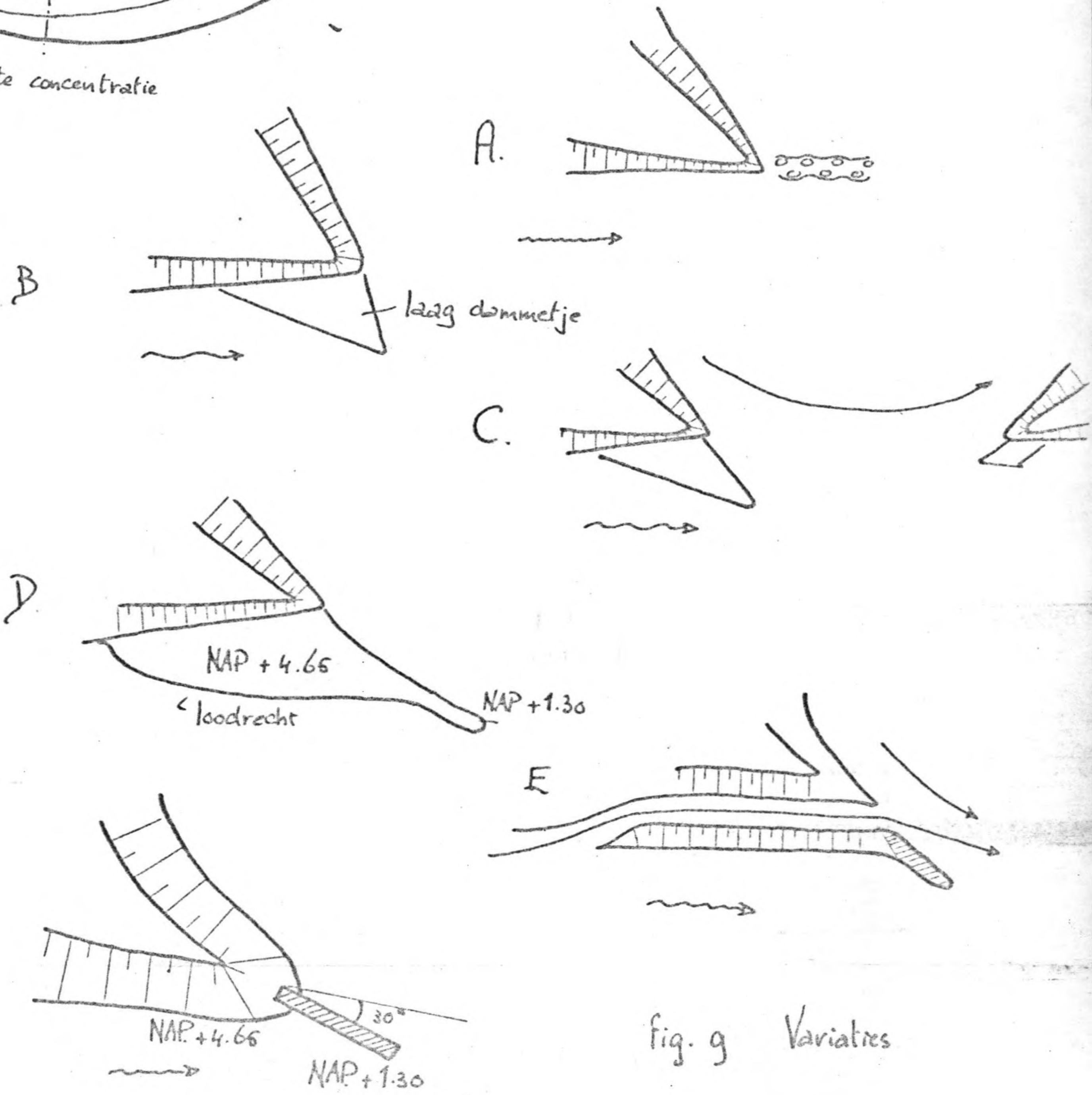


fig. 9 Variaties

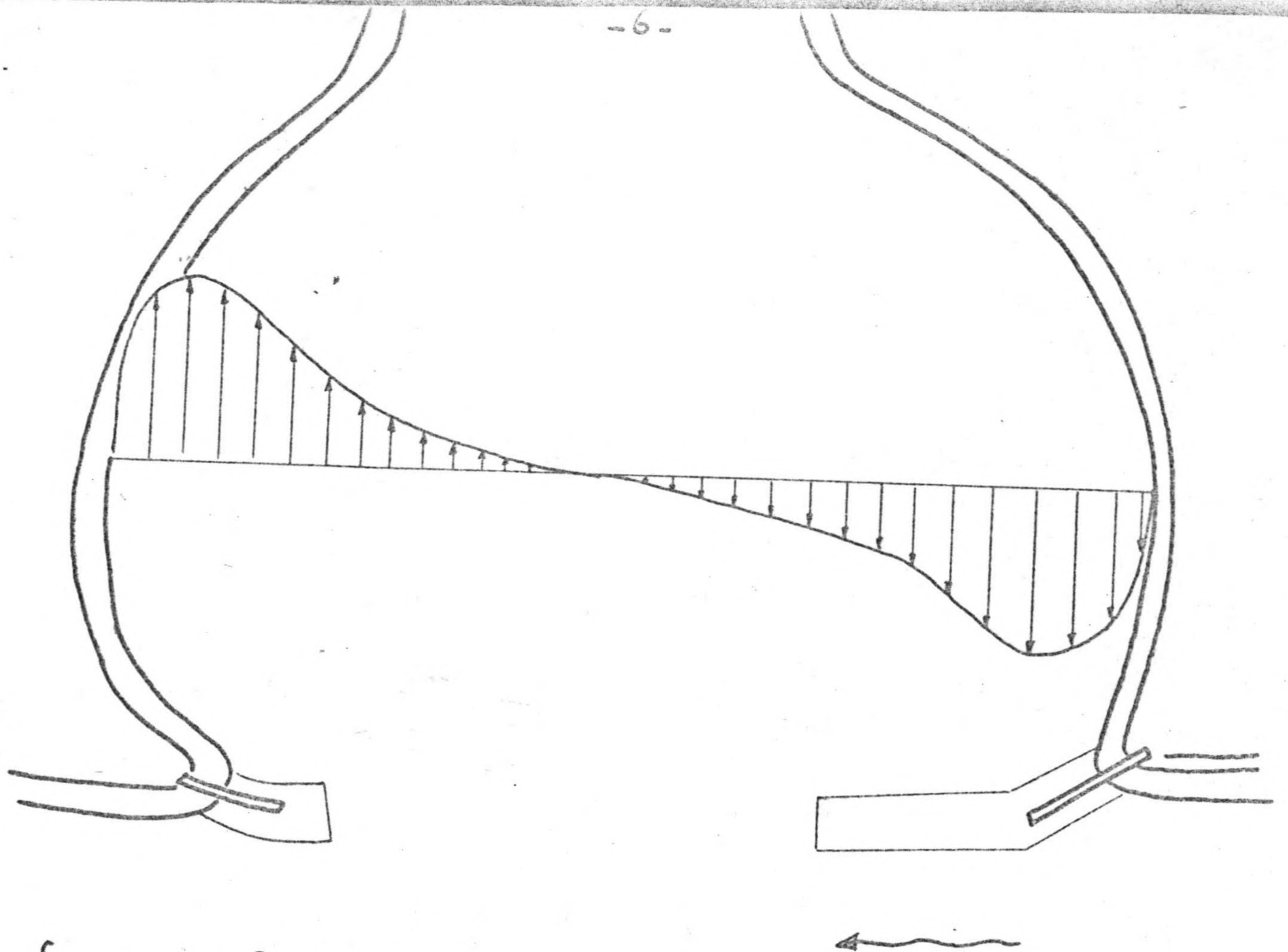


fig. 10 Snelheidsverdeling in de neer

fig. 12 Verschil in snelheidsverdeling noord.- en zuidelijke voorhaven.

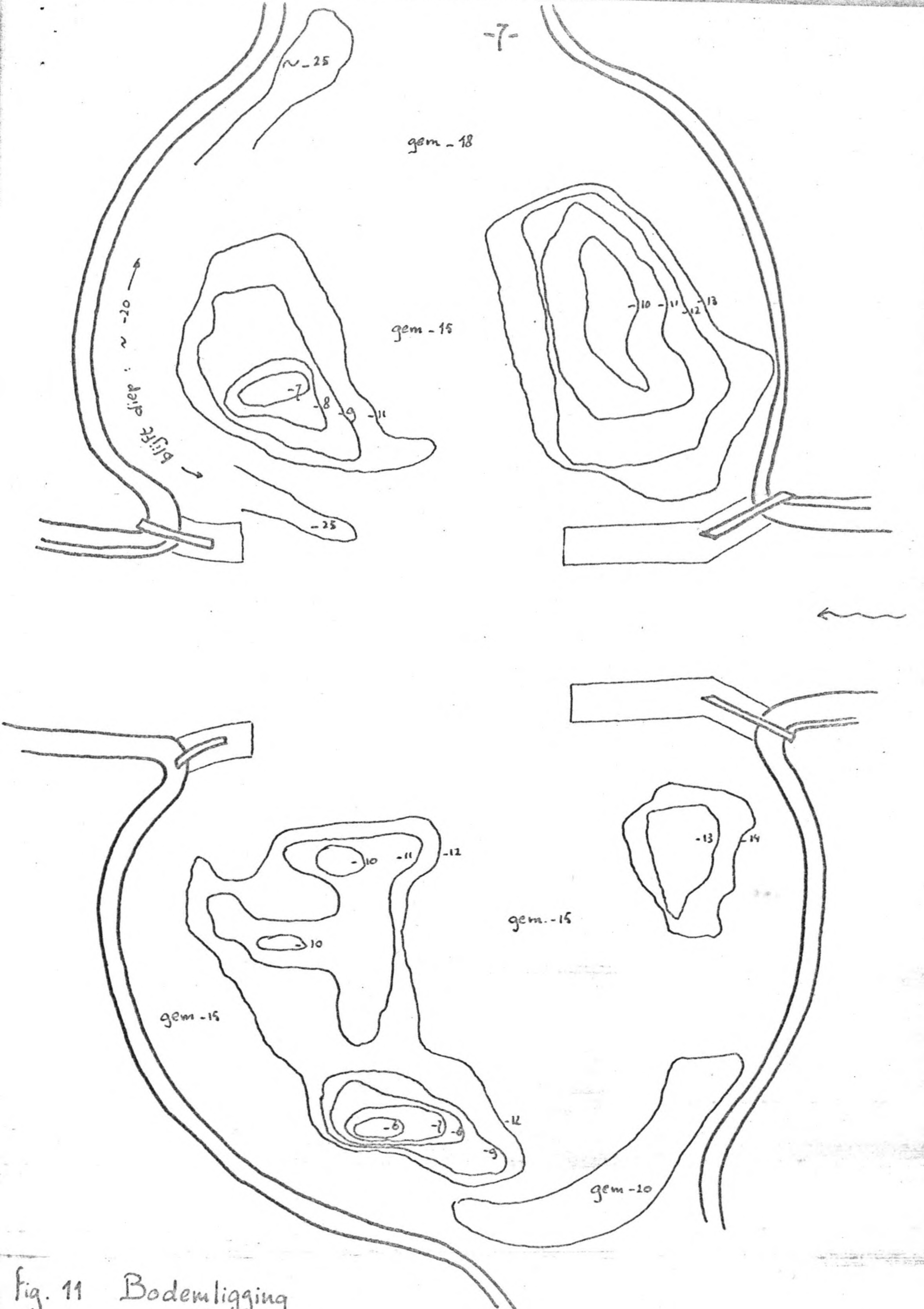


Fig. 11 Bodemligging
maten in dm. t.o.v. NAP.

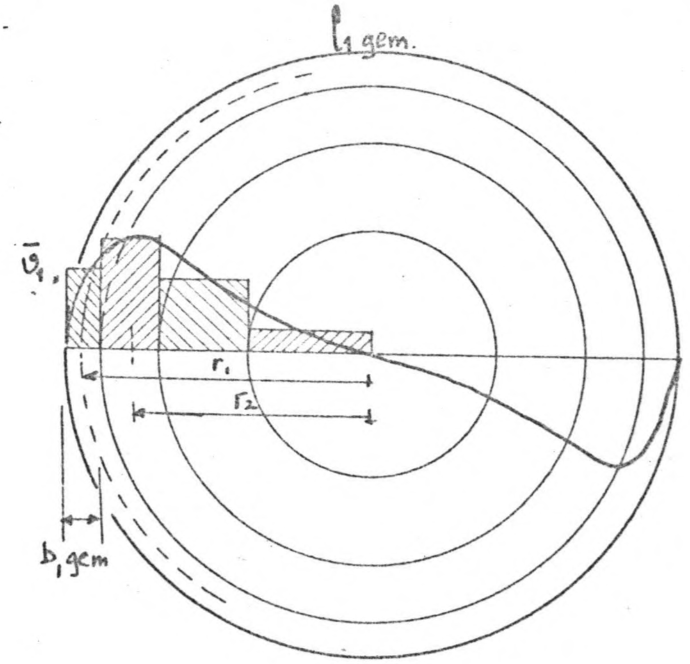


Fig. 13

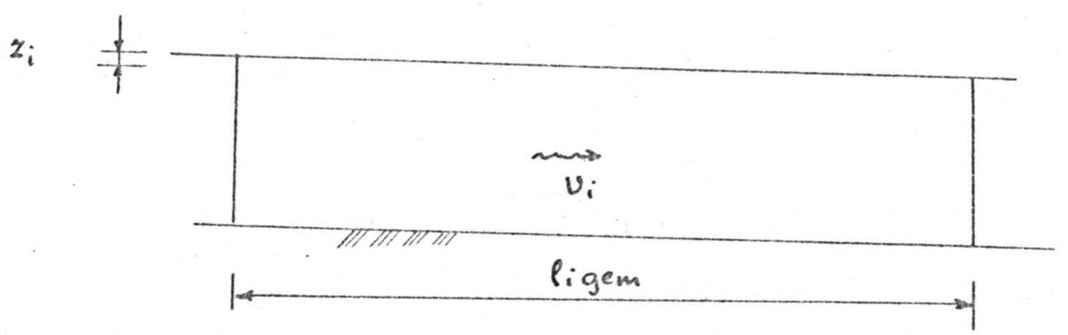


Fig. 14

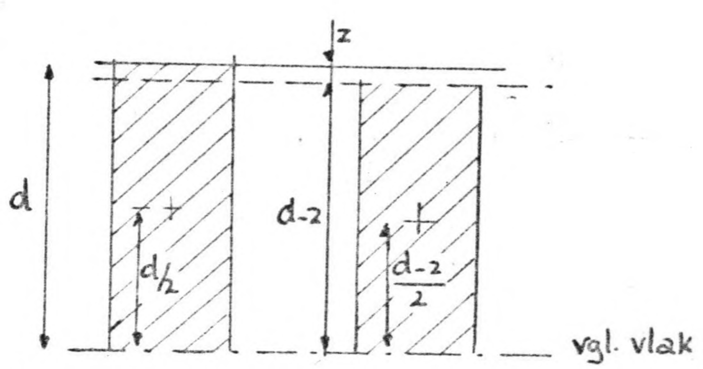


Fig. 15 Afname potentiële energie

$$\tfrac{1}{2}\rho g d^2 - \tfrac{1}{2}\rho g (d-z)^2 =$$

$$\cancel{\tfrac{1}{2}\rho g d^2} - \cancel{\tfrac{1}{2}\rho g d^2} + \rho g d z - \left(\tfrac{1}{2}\rho g z^2\right) =$$

(te verwaarlozen

$$= \underline{\rho g d z}$$

Fig. 16

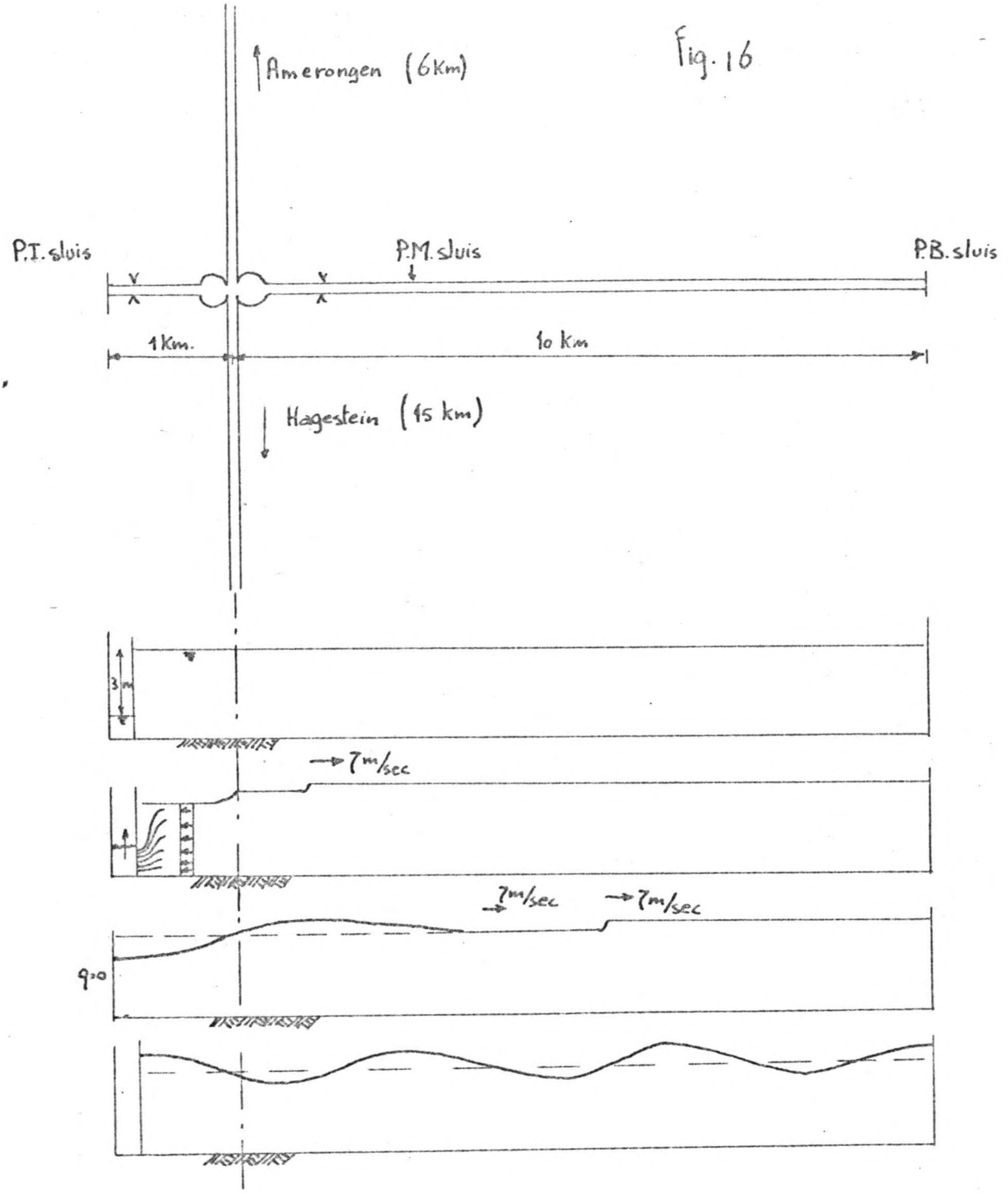


Fig. 17

niet stabiele wervelstraat.

stabiele wervelstraat.

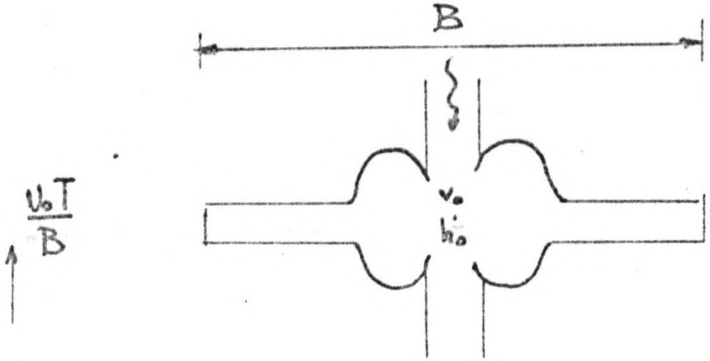
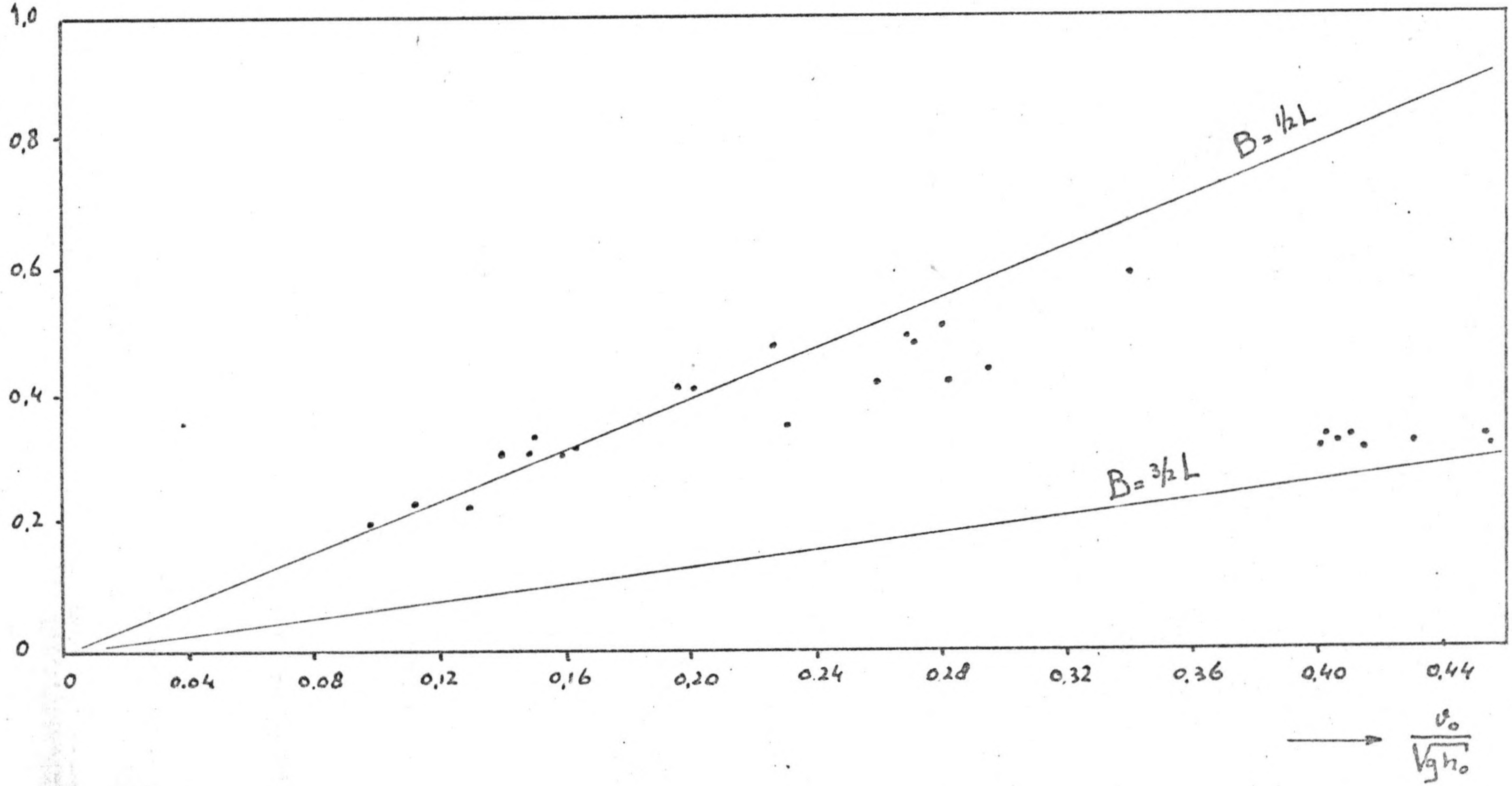


fig. 18. Overspringen der frekwentie.

slingertijd T gemeten met tengel



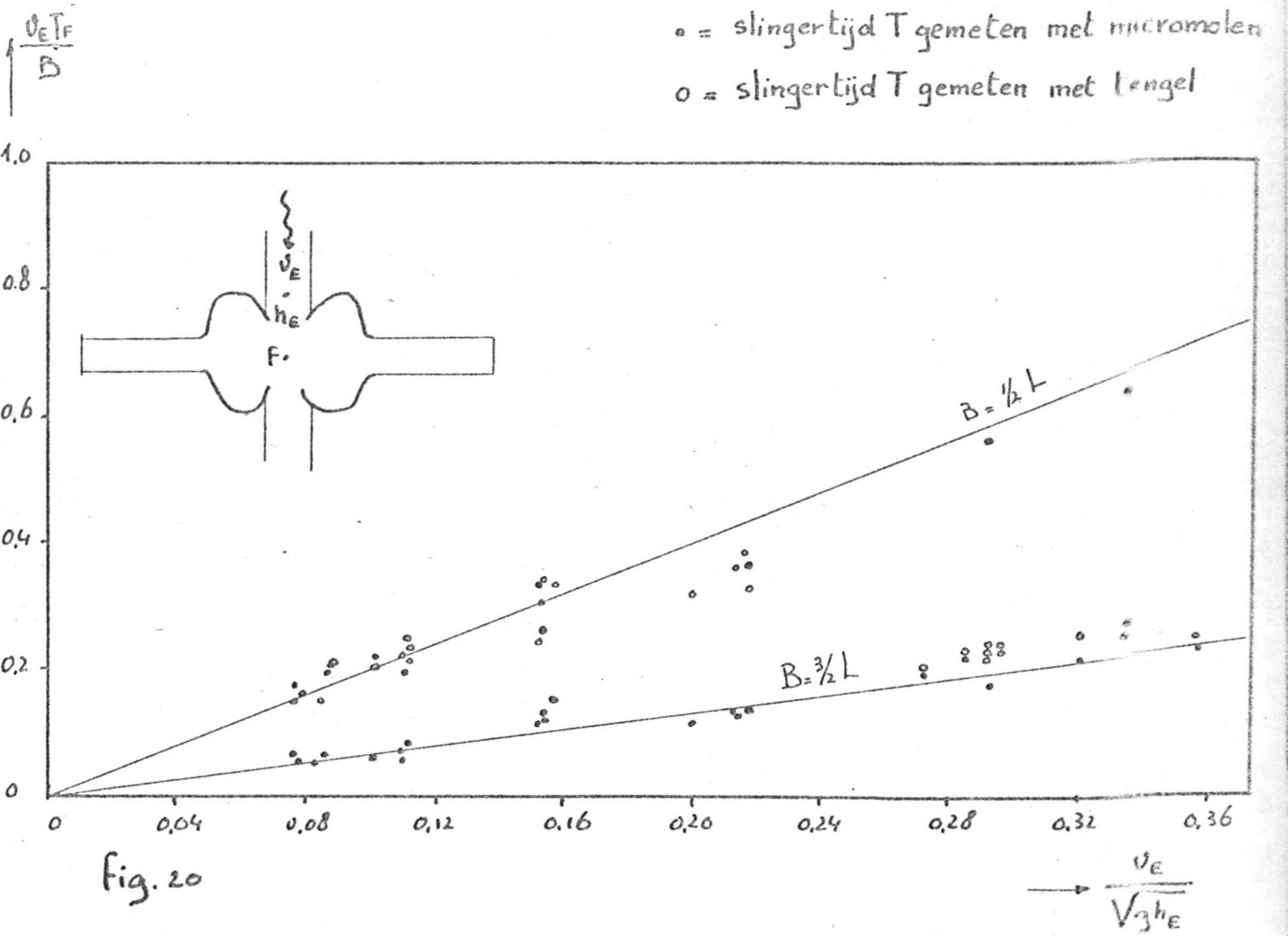


Fig. 20

Fig. 19. Schatting model de Voorst bij 120 liter debiet.

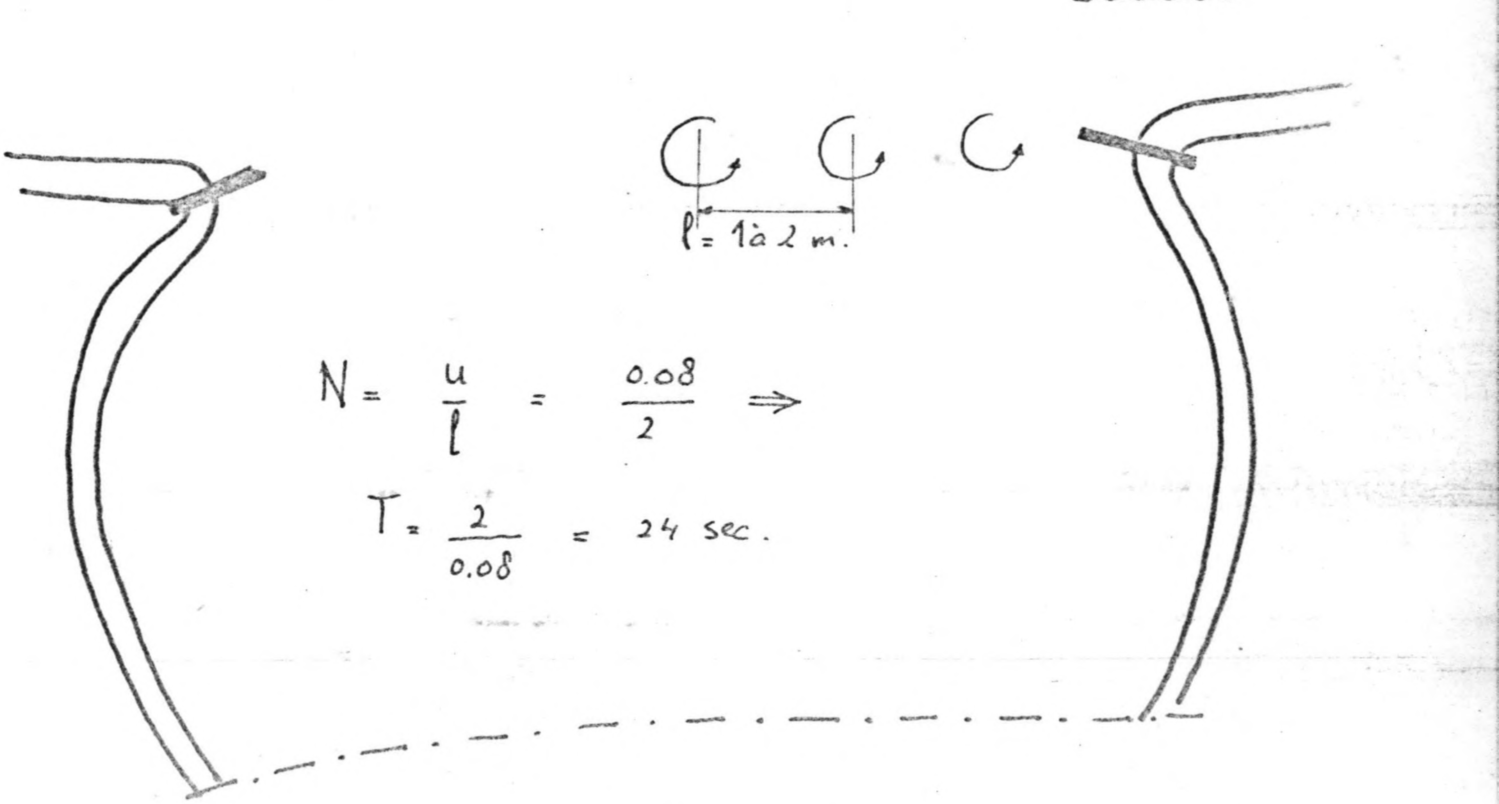


Fig. 21.

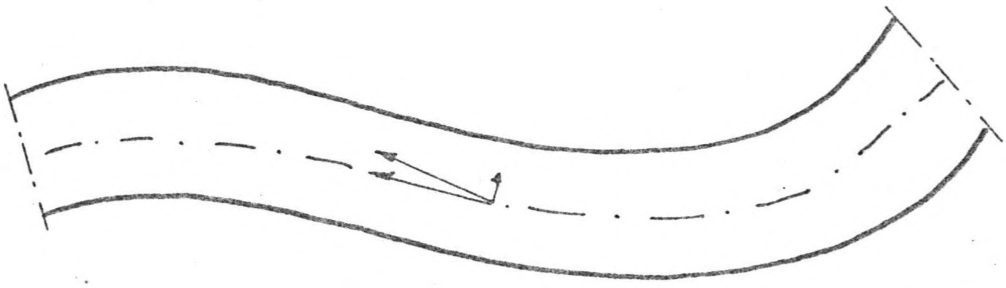


fig. 22 $\frac{L}{v} = T$

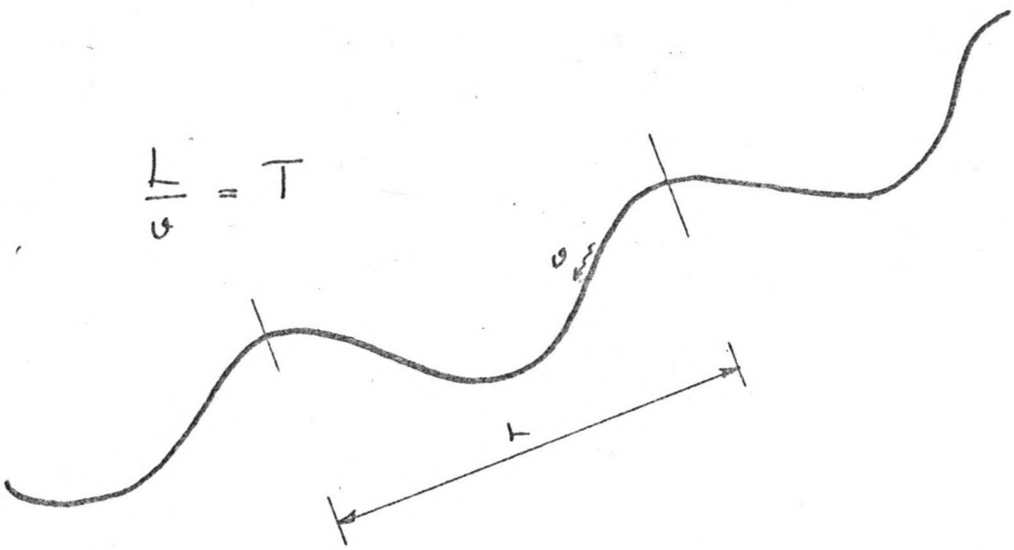


fig.23

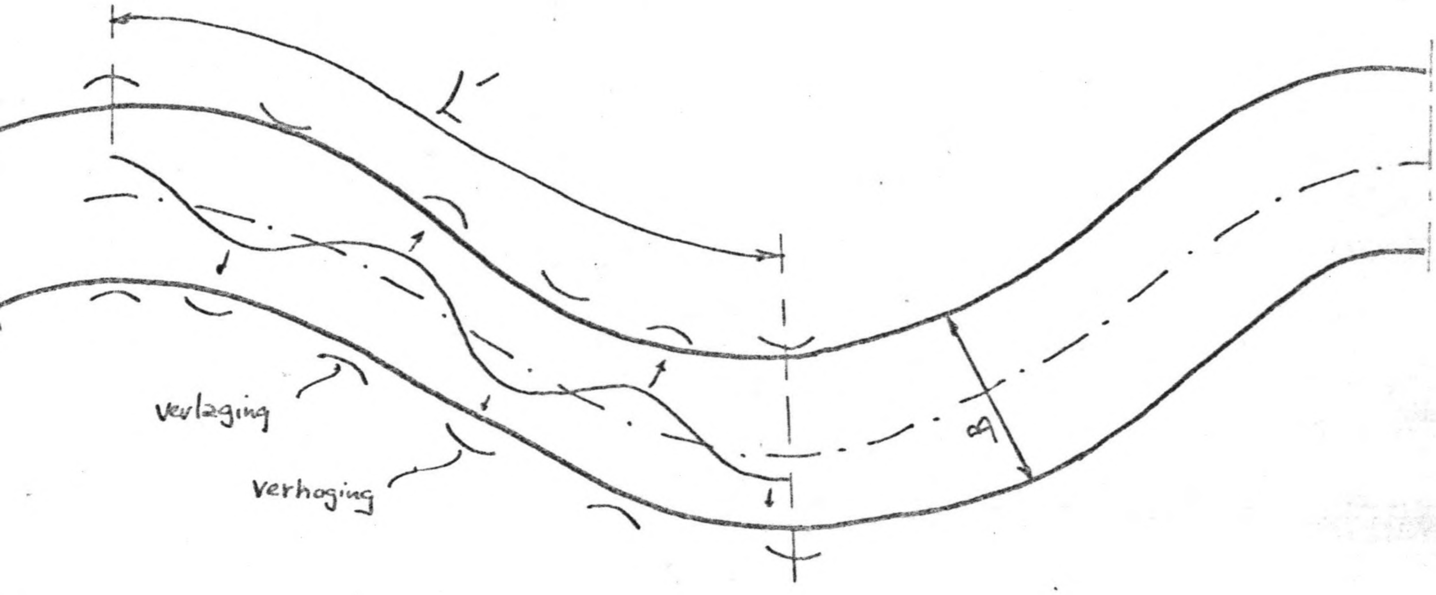
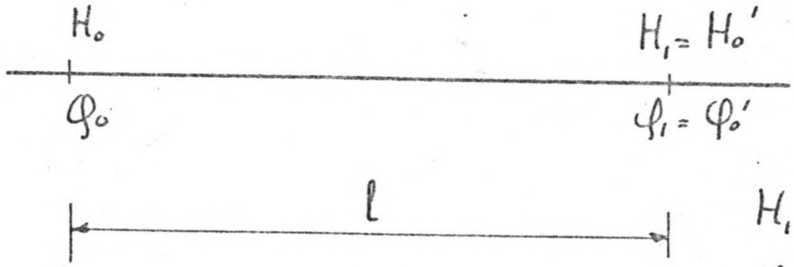
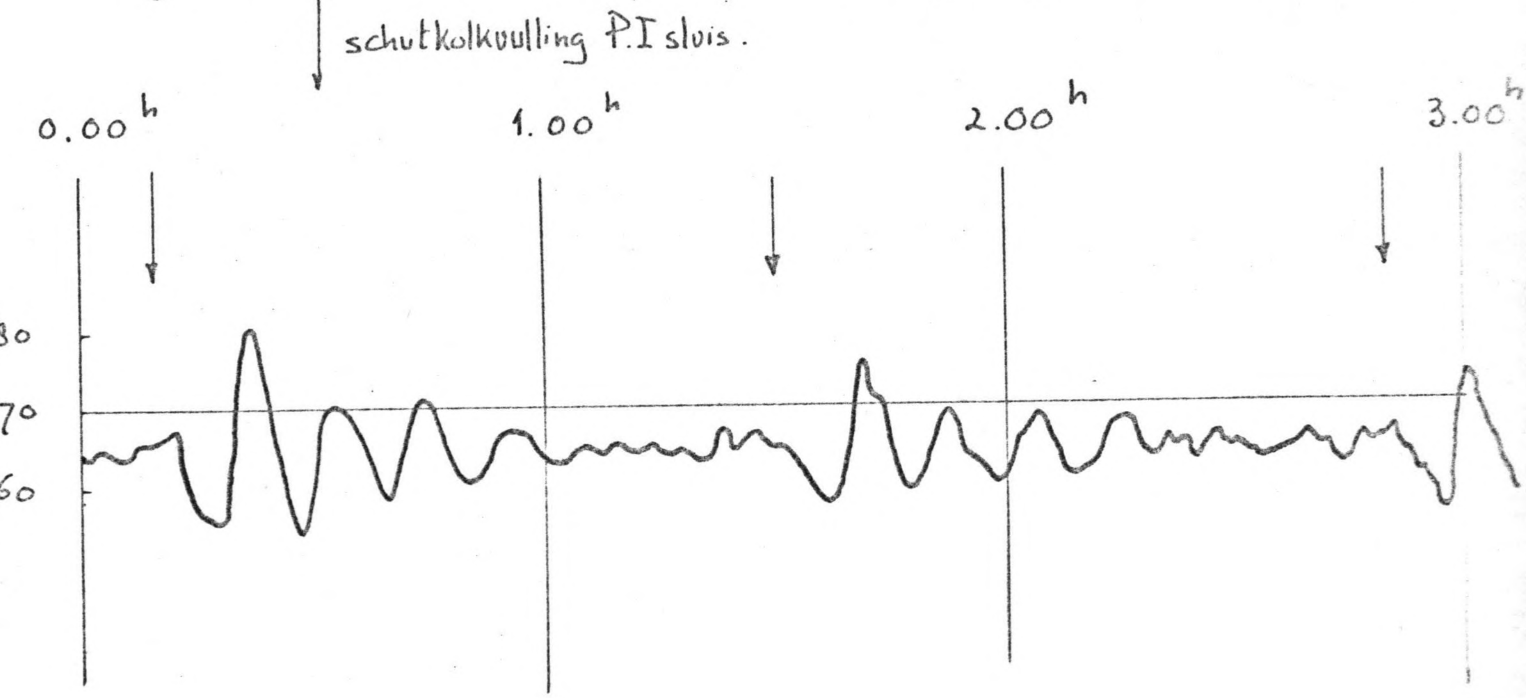


Fig 24.



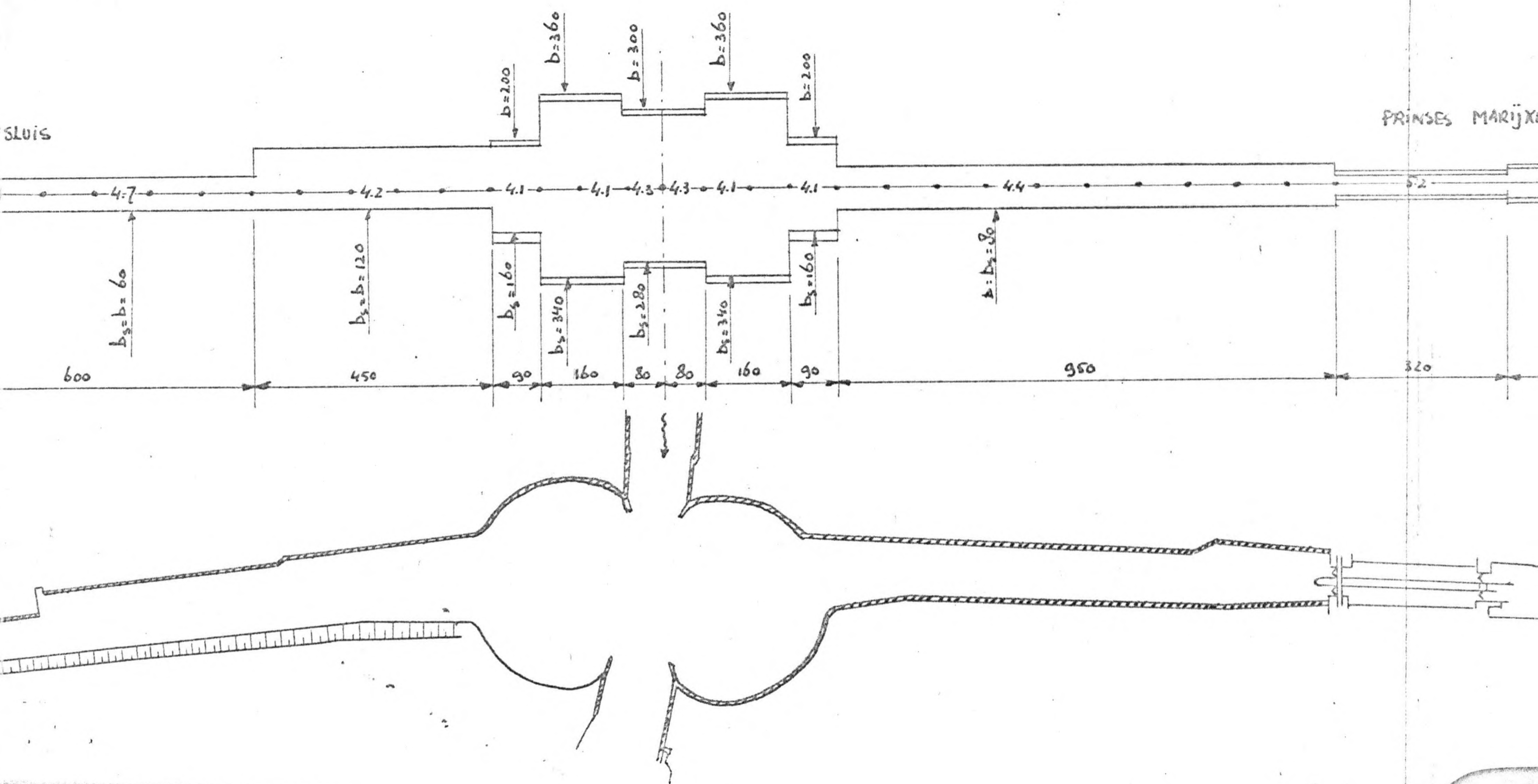
$$\left.\begin{aligned} H_1 &= L H_o + M \varphi_o \\ \varphi_1 &= N \varphi_o + O \cdot H_o \end{aligned}\right\}$$

Fig. 26 Voorbeeld gemeten slingering bij P.I sluis



5. Schematisatie prototype naast werkelijkheid.

schaal 1 : 10.000



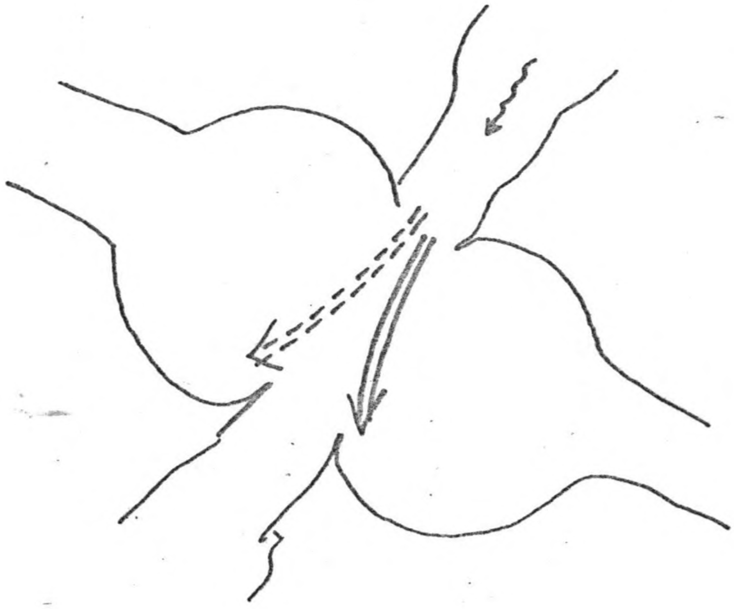
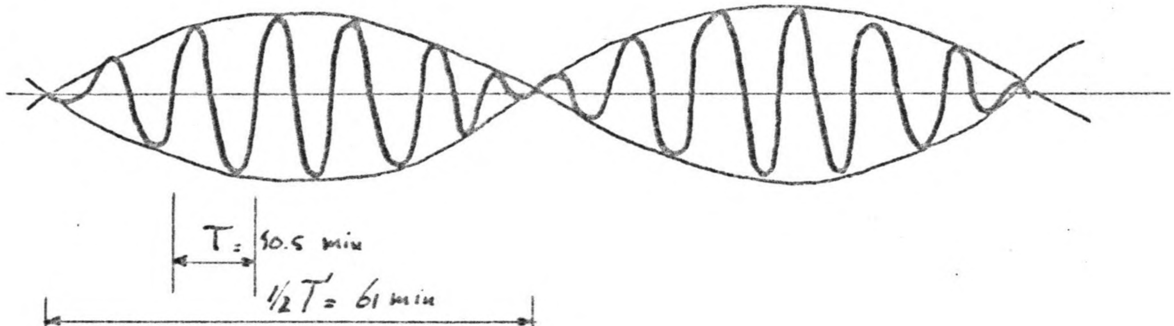


Fig. 27

Fig. 28



T_5	H : 0.184 a φ : 717 · a	0.138 a 753 a	0.091 a 778 a	[m] [m^3/sec]
T_6	H : −0.036 a φ : 562 a	−0.077 a 547 a	−0.116 a 522 a	[m] [m^3/sec]

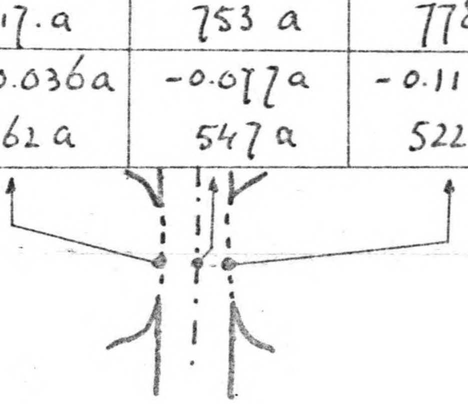
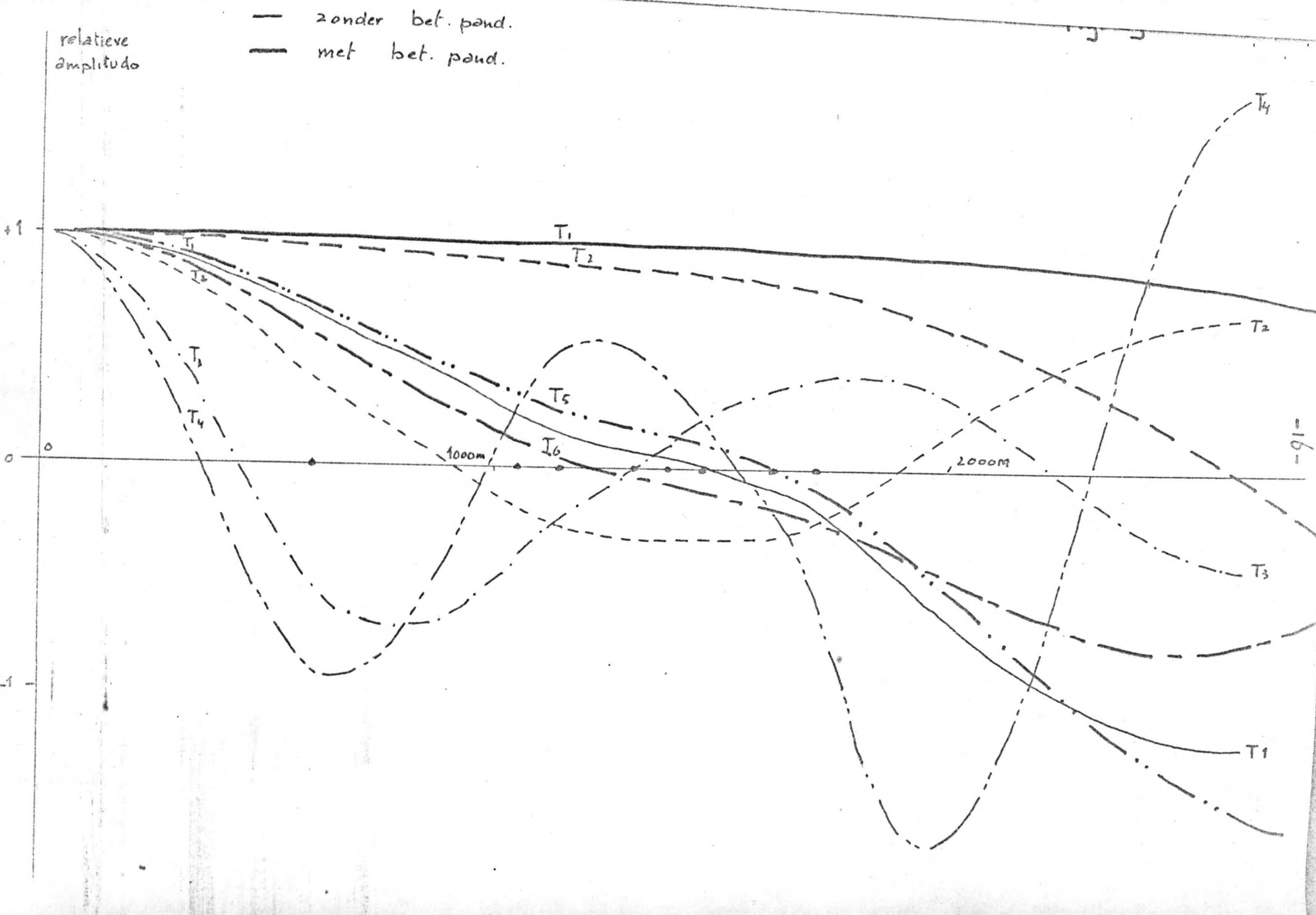


Fig. 30


zonder bet. pand.
met bet. pand.
relatieve amplitudo
+1
0
-1
0
1000m
2000m
T1
T2
T3
T4
T5
T6

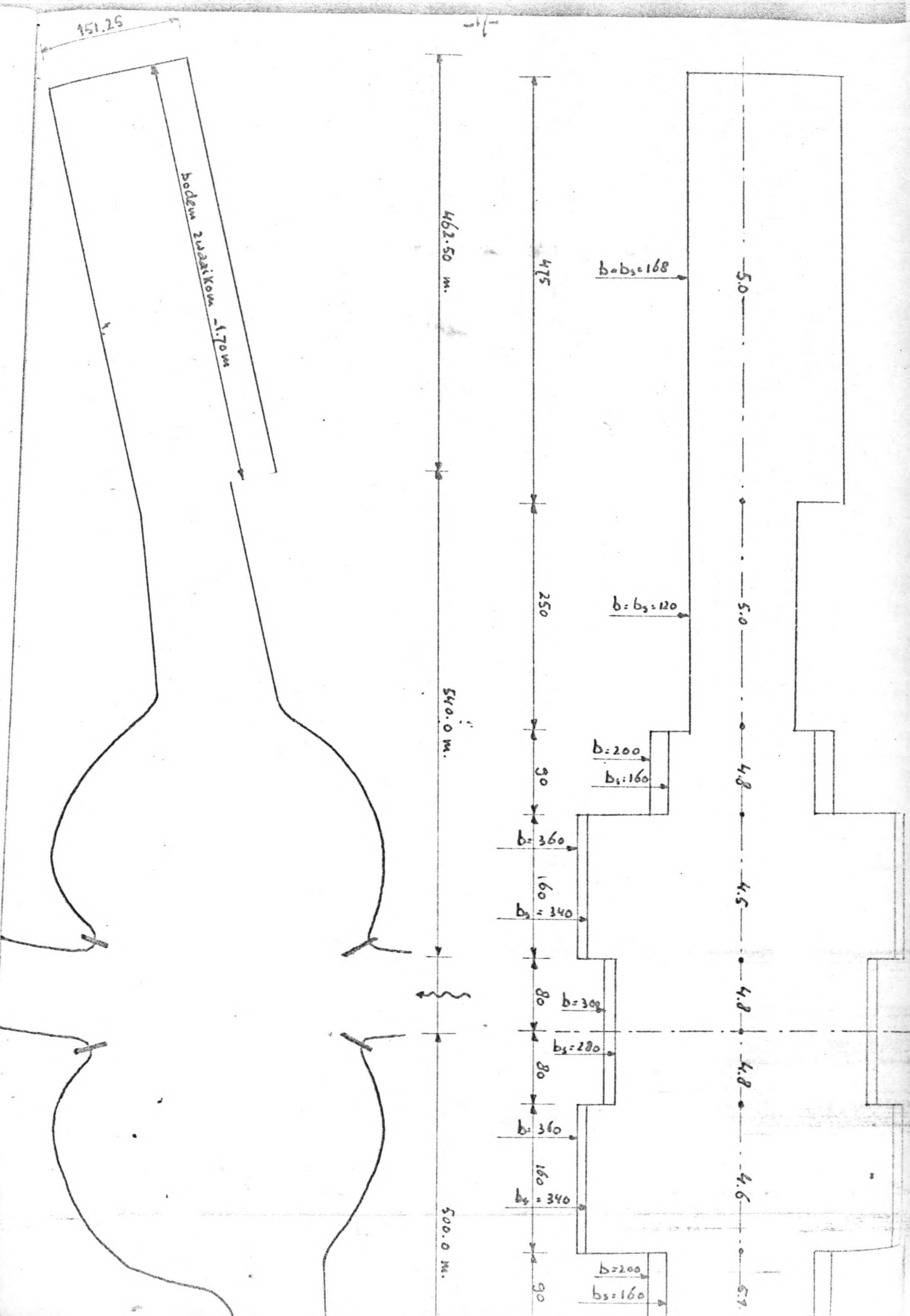
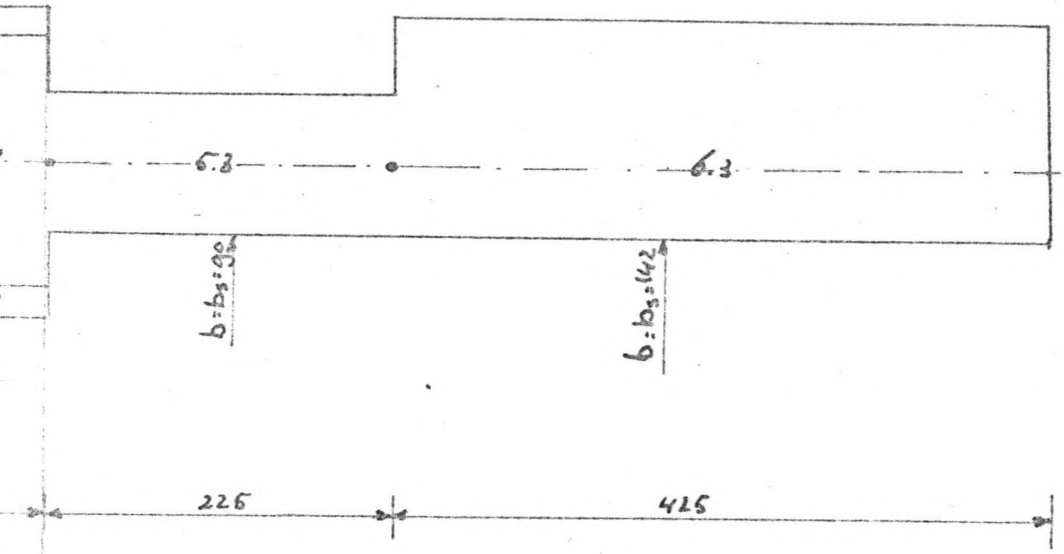

151.25
bodem zwaaikom -1.70m
462.50 m.
540.0 m.
500.0 m.
475
250
30
160
80
80
160
90
b=bs=168
b=bs=120
b=200
bs=160
b=360
bs=340
b=300
bs=280
b=360
bs=340
b=200
bs=160
5.0
5.0
4.8
4.5
4.8
4.8
4.6
4.7

Fig. 32 Schematisatie model de Voorst.



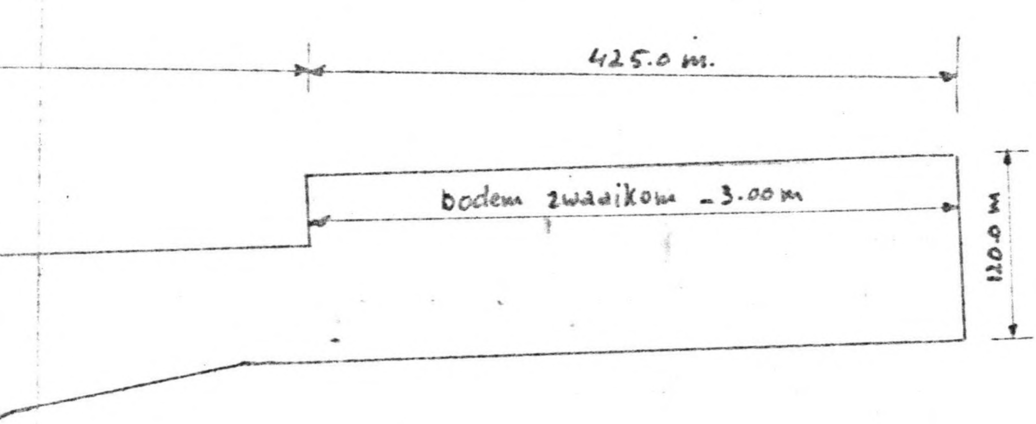


Fig. 31 Model de Voorst

Schalen : 1 : 5000

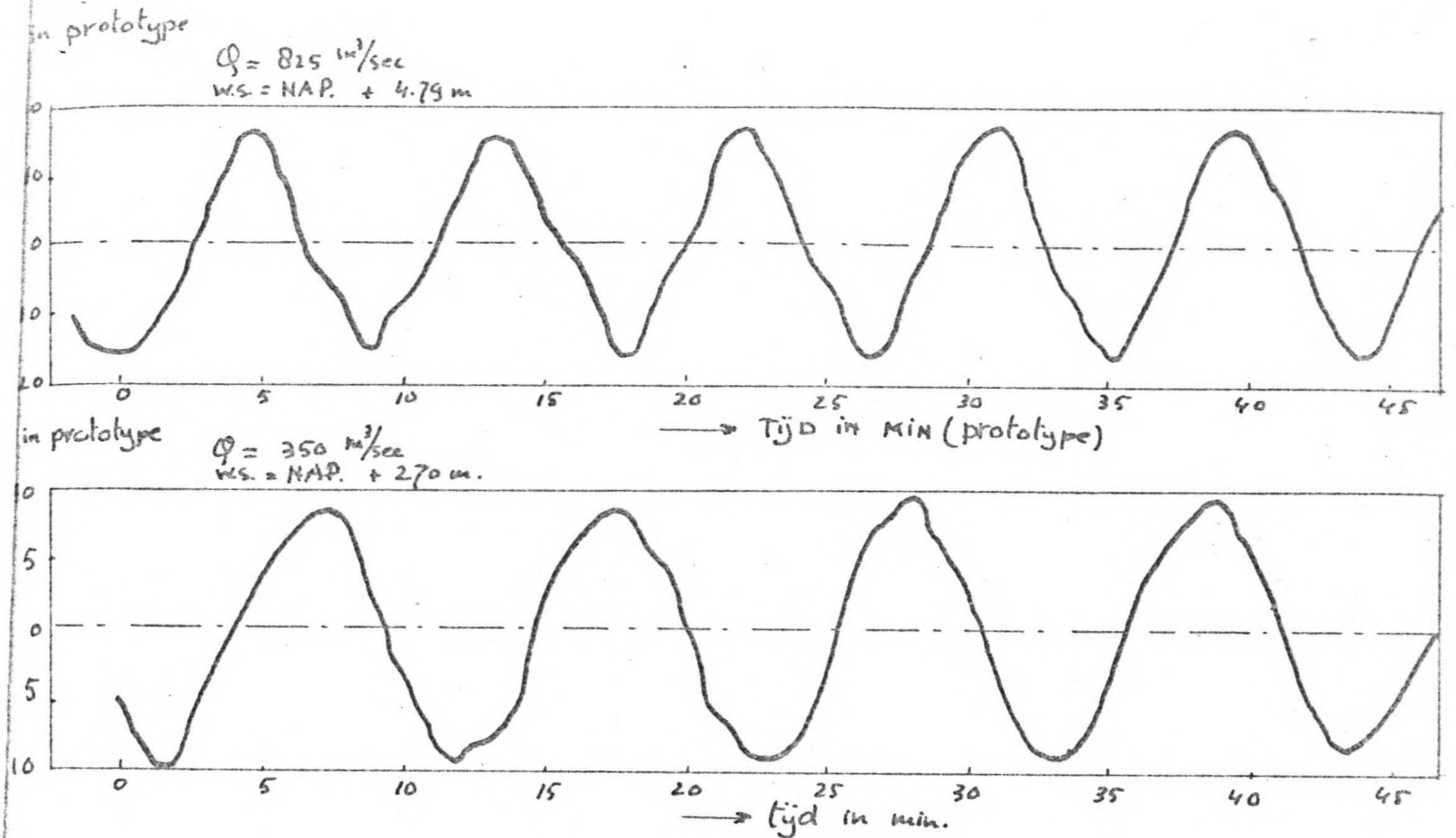


Fig. 33 Slingering in model de Voorst.

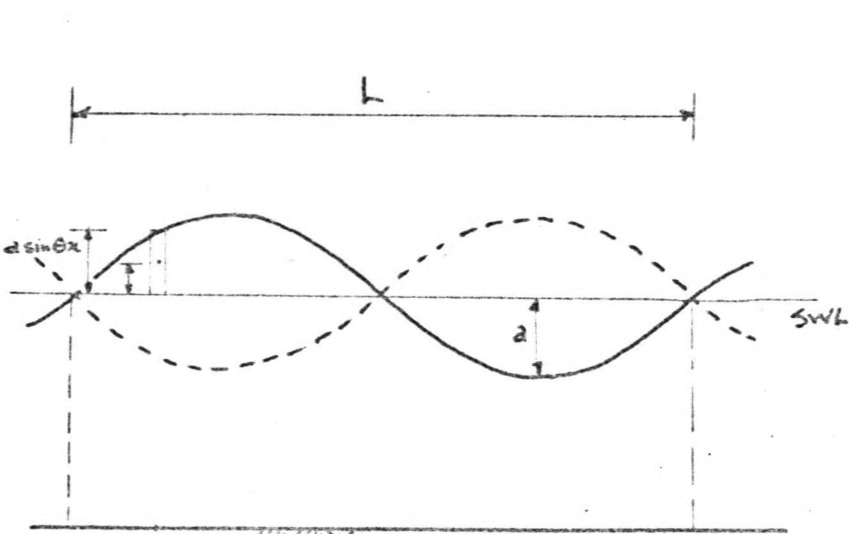
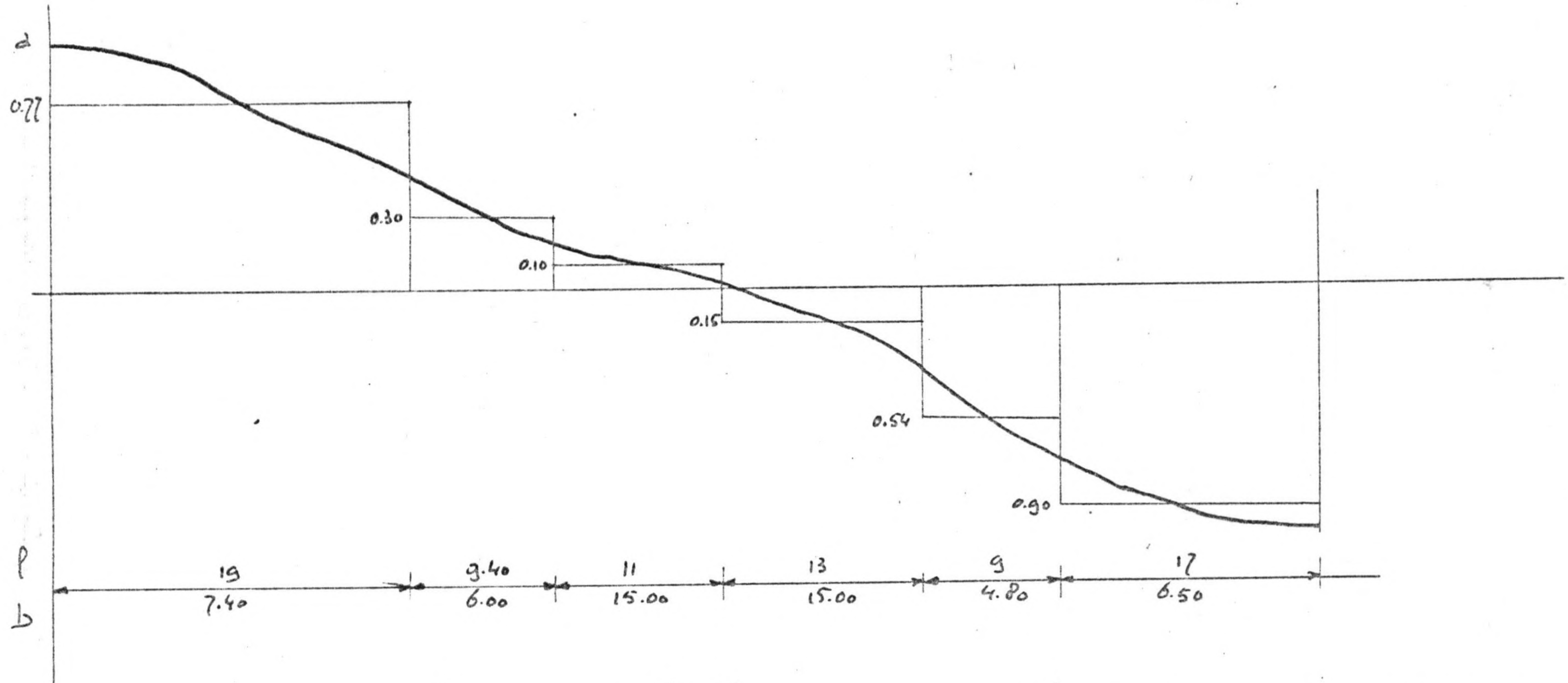


Fig. 34

Fig. 35 Model de Voorst $T_1 = 110$ sec



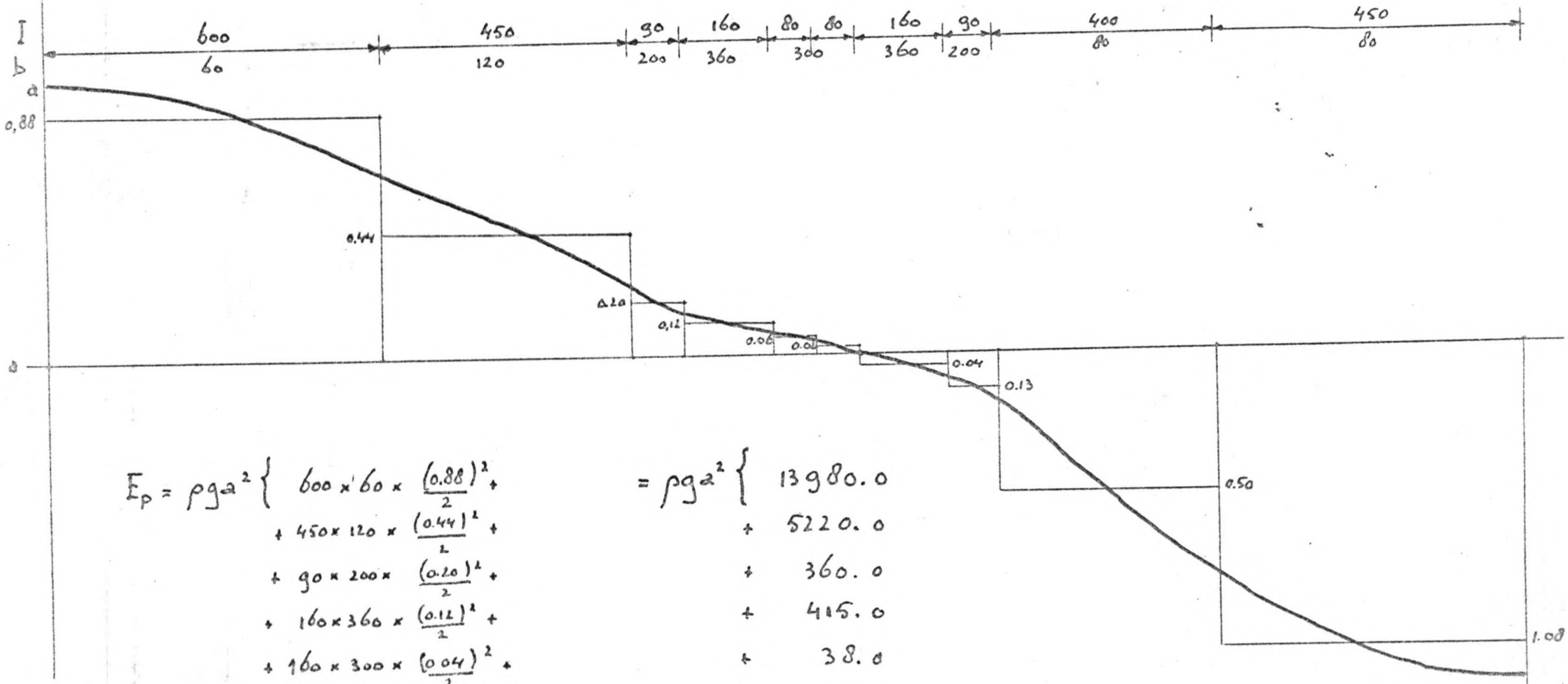
$$E_p = \rho g a^2 \left\{ 19 \times 7.40 \times \frac{(0.77)^2}{2} + 9.4 \times 6.00 \times \frac{(0.30)^2}{2} + 11 \times 15.00 \times \frac{(0.10)^2}{2} + 13 \times 15.00 \times \frac{(0.15)^2}{2} + 9 \times 4.80 \times \frac{(0.54)^2}{2} + 17 \times 6.50 \times \frac{(0.90)^2}{2} \right\} =$$

$$= \rho g a^2 \{ 41.80 + 2.54 + 0.83 + 1.95 + 6.30 + 43.80 \} =$$

$$= \rho g a^2 \times 97.22 \approx$$

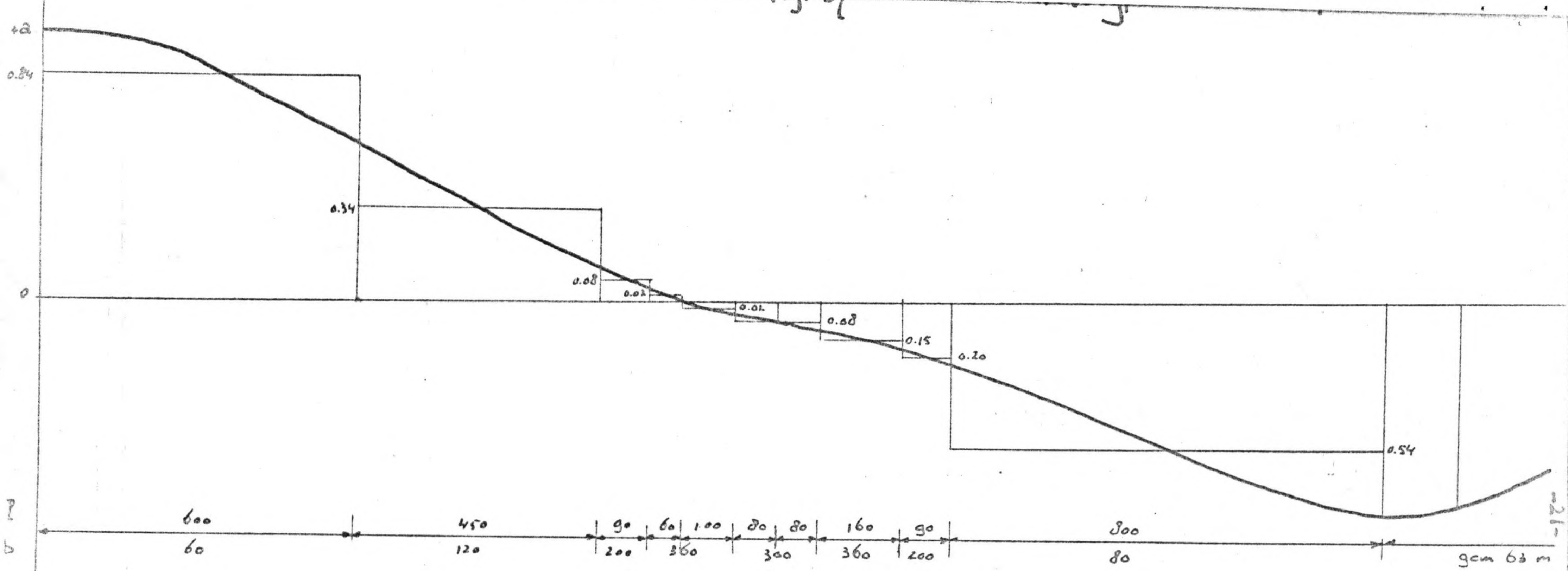
$$\approx 95\, a^2 \times 10^4 \text{ Nm}$$

Fig. 36 Prototype zonder Betuwepand $T_1 = 640$ sec.



$$E_p = \rho g a^2 \left\{ 600 \times 60 \times \frac{(0.88)^2}{2} + 450 \times 120 \times \frac{(0.44)^2}{2} + 90 \times 200 \times \frac{(0.20)^2}{2} + 160 \times 360 \times \frac{(0.12)^2}{2} + 160 \times 300 \times \frac{(0.04)^2}{2} + 160 \times 360 \times \frac{(0.04)^2}{2} + 90 \times 200 \times \frac{(0.13)^2}{2} + 400 \times 80 \times \frac{(0.50)^2}{2} + 450 \times 80 \times \frac{(1.08)^2}{2} \right\} =$$

$$= \rho g a^2 \left\{ 13980.0 + 5220.0 + 360.0 + 415.0 + 38.0 + 46.0 + 152.6 + 4000.0 + 20900.0 \right\} = \rho g a^2 \times 45111.0 = \underline{\underline{450 \times 10^6 \times a^2 \text{ Nm}}}$$



$$E_{p_1} = \rho g a^2 \left\{ 600 \times 60 \times \frac{(0.84)^2}{2} + 450 \times 120 \times \frac{(0.34)^2}{2} + 90 \times 200 \times \frac{(0.08)^2}{2} + 60 \times 360 \times \frac{(0.02)^2}{2} + 100 \times 360 \times \frac{(0.02)^2}{2} + 160 \times 300 \times \frac{(0.08)^2}{2} + 160 \times 360 \times \frac{(0.15)^2}{2} + 90 \times 200 \times \frac{(0.20)^2}{2} + 800 \times 80 \times \frac{(0.54)^2}{2} \right\} =$$

$$= \rho g a^2 \left\{ 12750.0 + 3120.0 + 58.0 + 4.3 + 7.2 + 154.0 + 649.0 + 360.0 + 9320.0 \right\} =$$

$$= \rho g a^2 \cdot 26422.5$$

$$= \underline{260 \times 10^6 a^2} \text{ Nm.}$$

(voor de eerste $\frac{1}{2}L$ m.)

Hierna volgen in het Bel. pand nog $2\frac{1}{2}$ golflengte met $L \approx 3600$ m

$$\therefore E_{p_2} = 2.5 \times 3600 \times 63 \times \frac{1}{4} \rho g a^2 =$$

$$= \underline{1390 \times 10^6 a^2} \text{ Nm.}$$

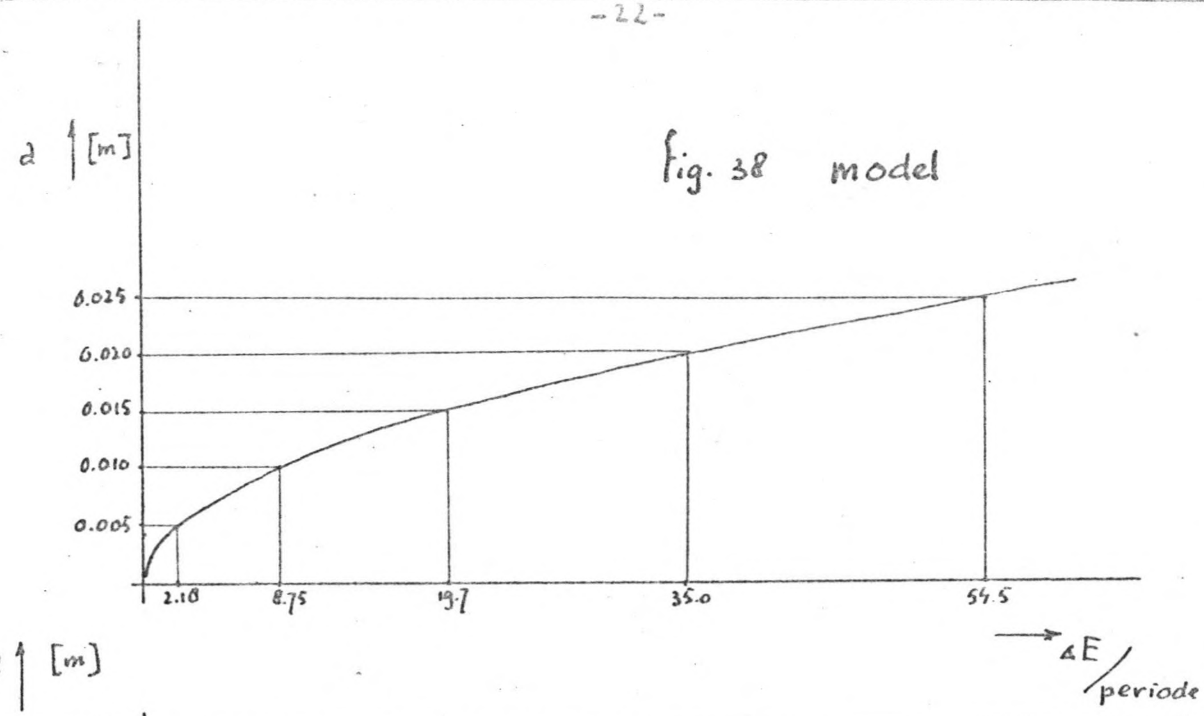


Fig. 38 model

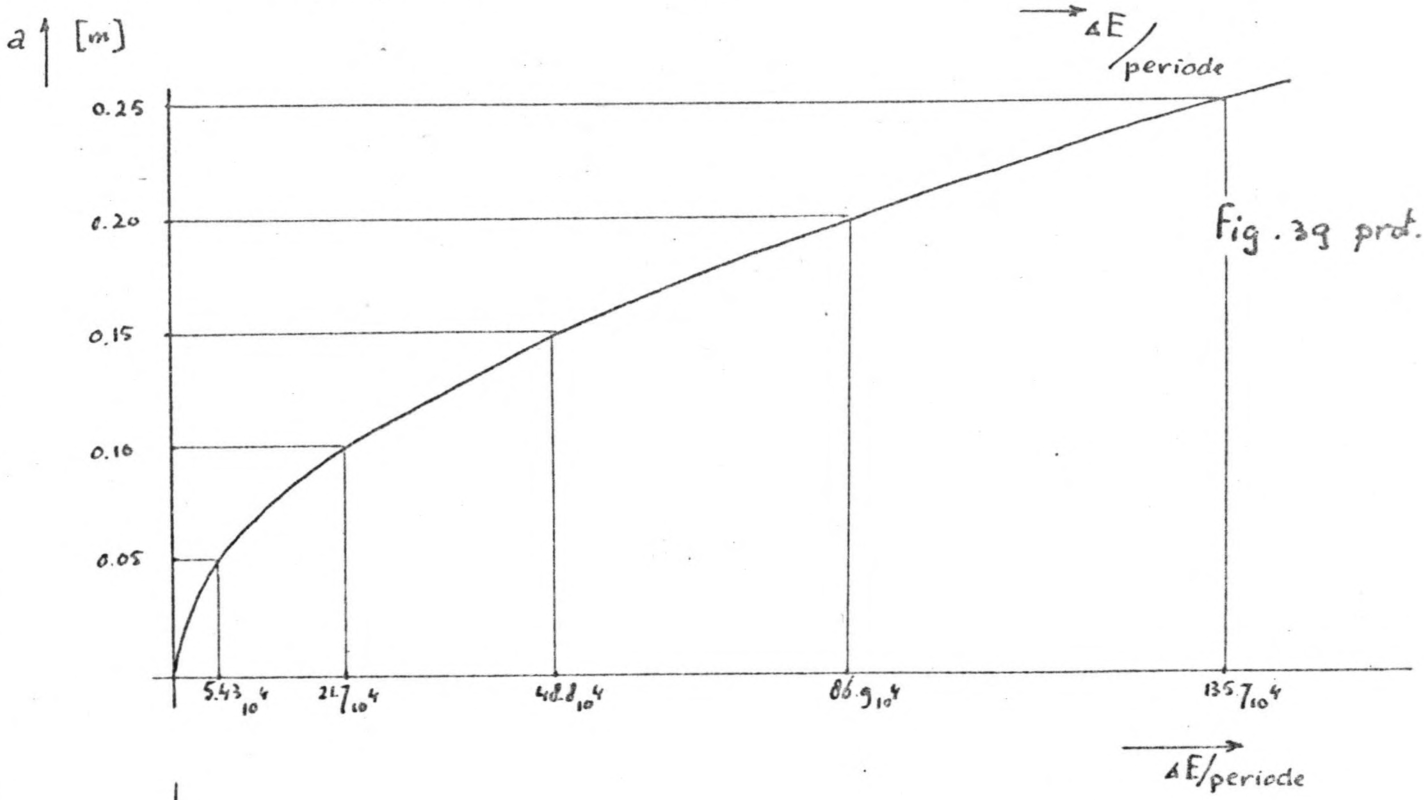


Fig. 39 prot. 2.B

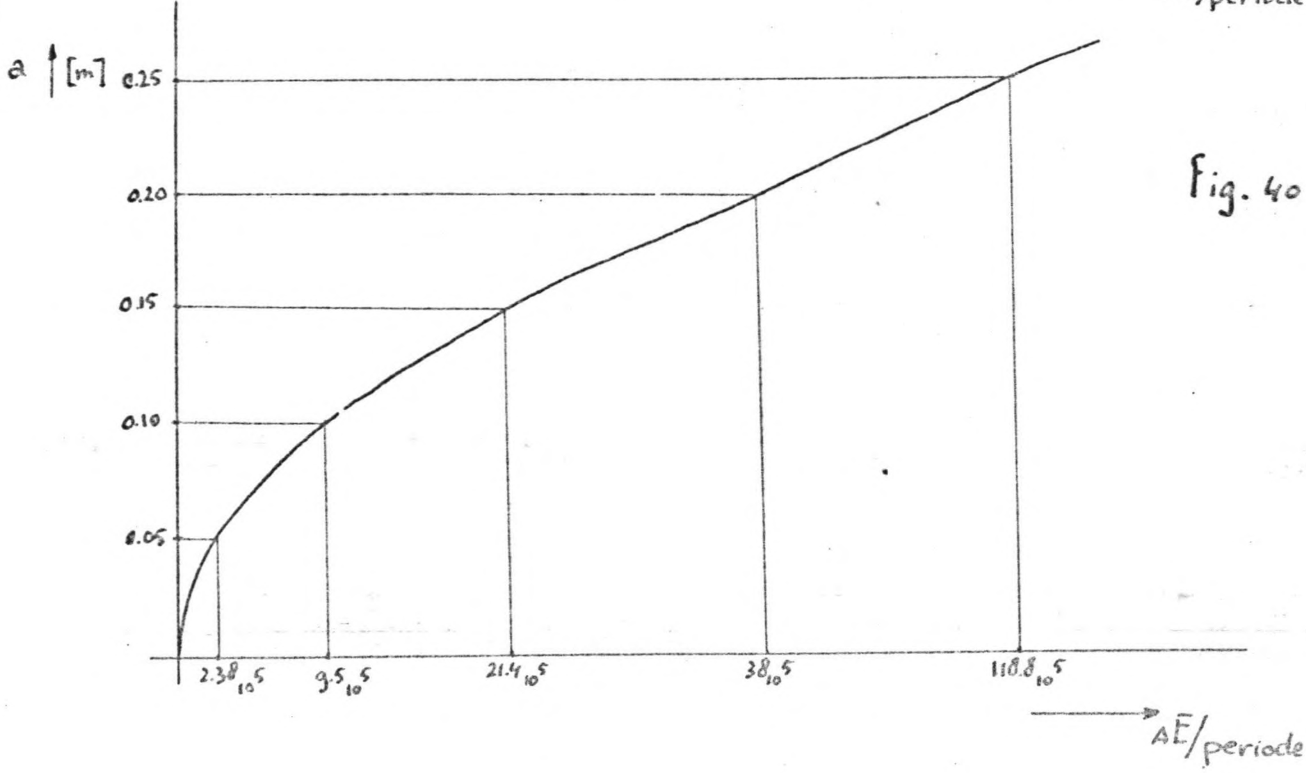
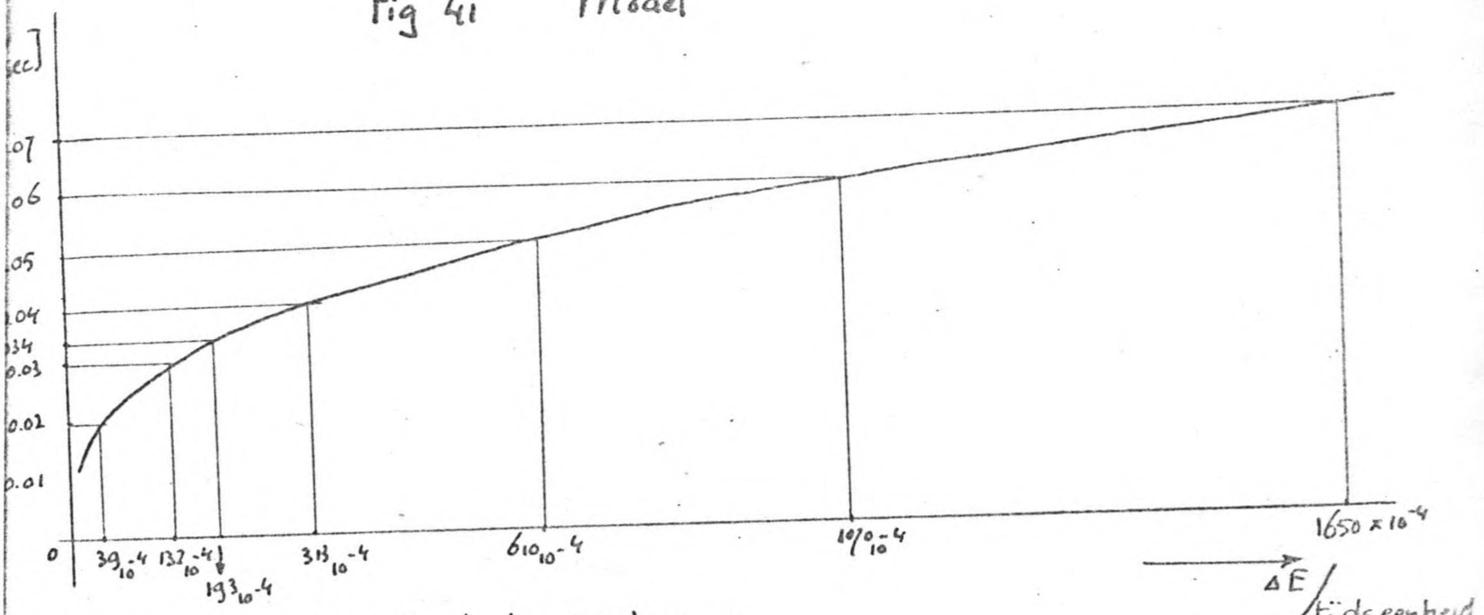


Fig. 40 prot. incl
Bet. pand

Fig 41 Model



eneden deze snelheid wordt de stroming laminair.

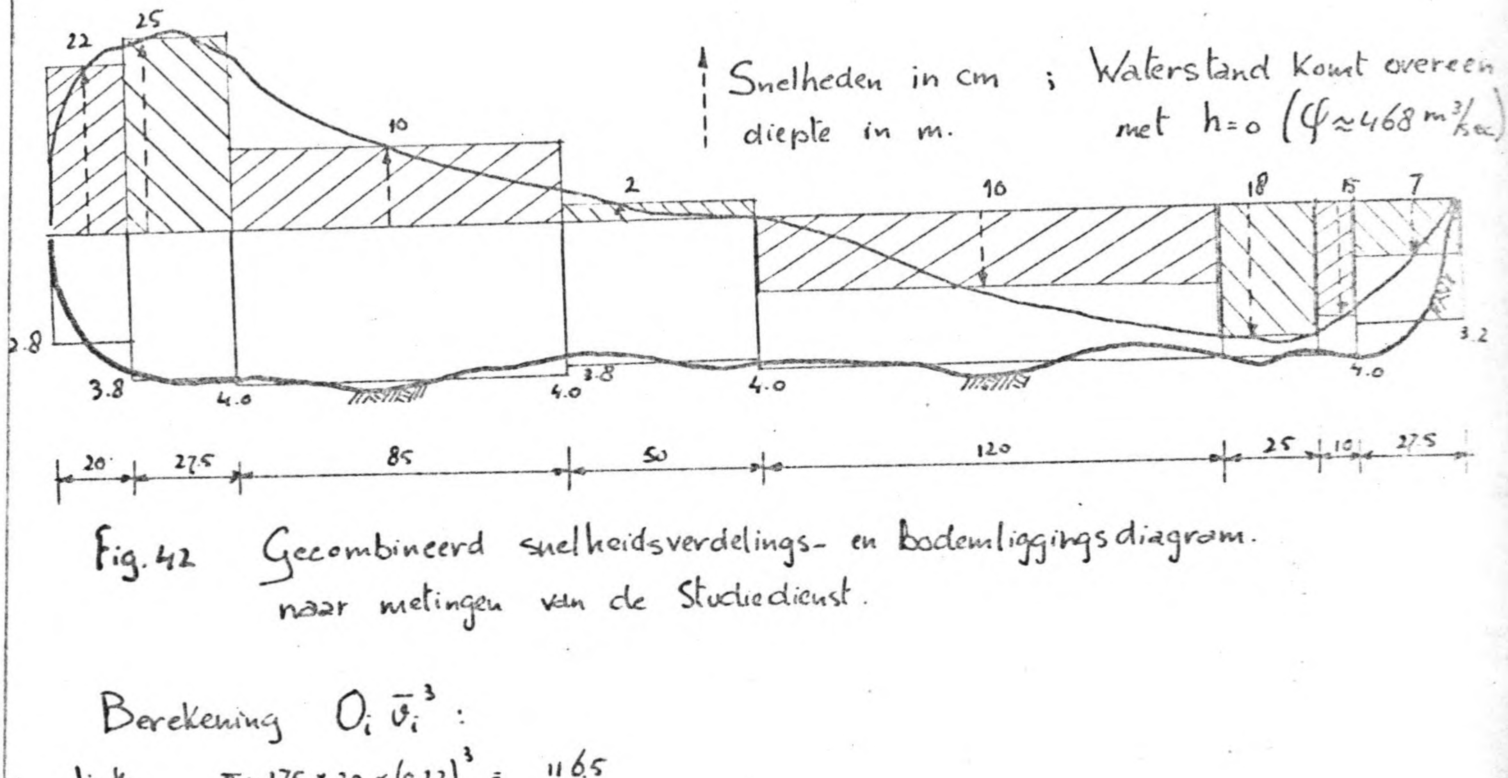


Fig. 42 Gecombineerd snelheidsverdelings- en bodemliggingsdiagram.
naar metingen van de Studiedienst.

Berekening $O_i \bar{v}_i^3$:

links
$$\pi \times 175 \times 20 \times (0{,}22)^3 = 116.5$$
$$\pi \times 150 \times 27.5\,(0.25)^3 = 202.0$$
$$\pi \times 92.5 \times 85 \times (0.10)^3 = 24.7$$
$$\tfrac{1}{2}\pi\,(50)^2 \times (0.02)^3 = 0.06 \; + \quad = 343.2 \text{ Nm}$$

rechts
$$\tfrac{1}{2}\pi\,(120)^2 \times (0.1)^3 = 21.0$$
$$\pi \times 130 \times (0.18)^3 \times 25 = 59.1$$
$$\pi \times 153 \times (0.15)^3 \times 10 = 33.5$$
$$\pi \times 175 \times (0.07)^3 \times 27.5 = 5.2 \; + \quad = 118.8 \text{ Nm}$$

totaal: 462 Nm.

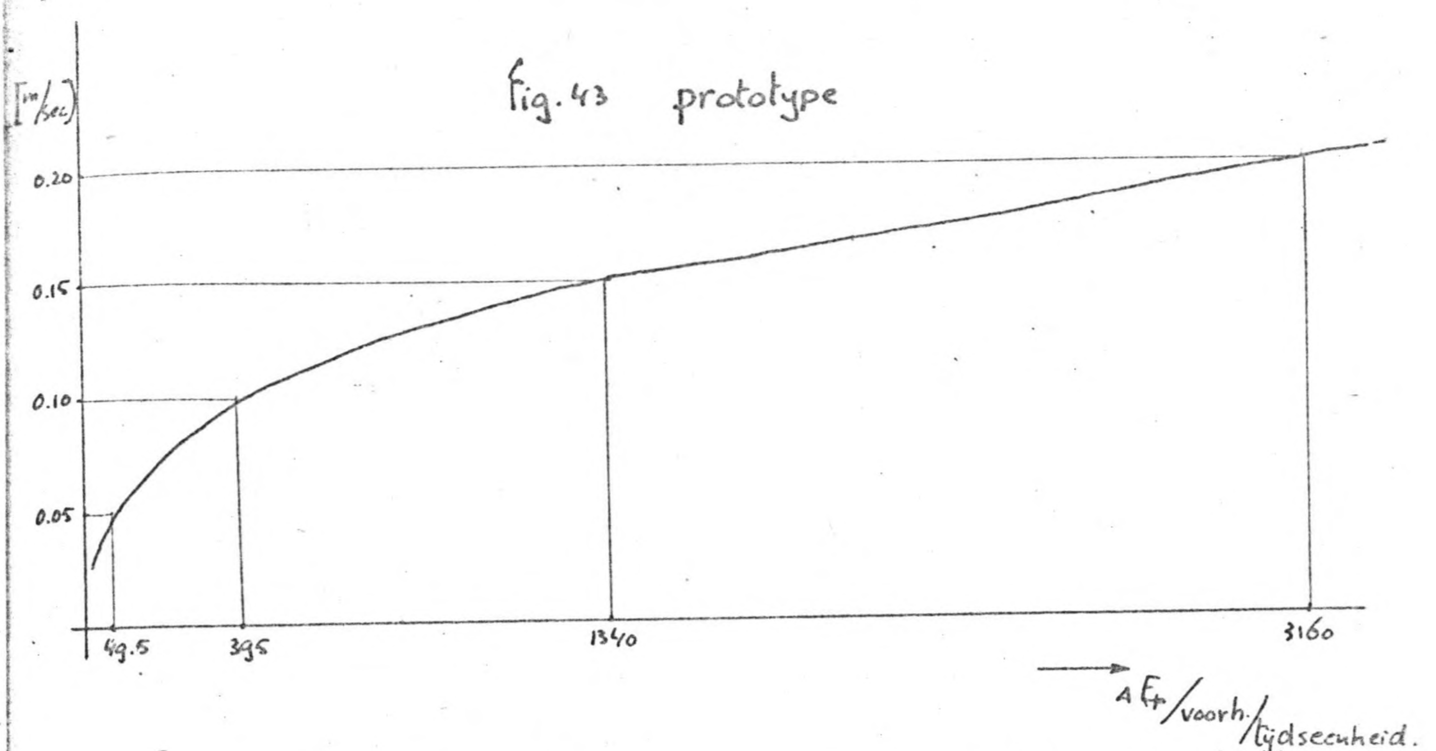


fig. 43 prototype
[m/sec]
0.20
0.15
0.10
0.05
49.5
395
1340
3160
ΔEp/voorh./tijdseenheid.

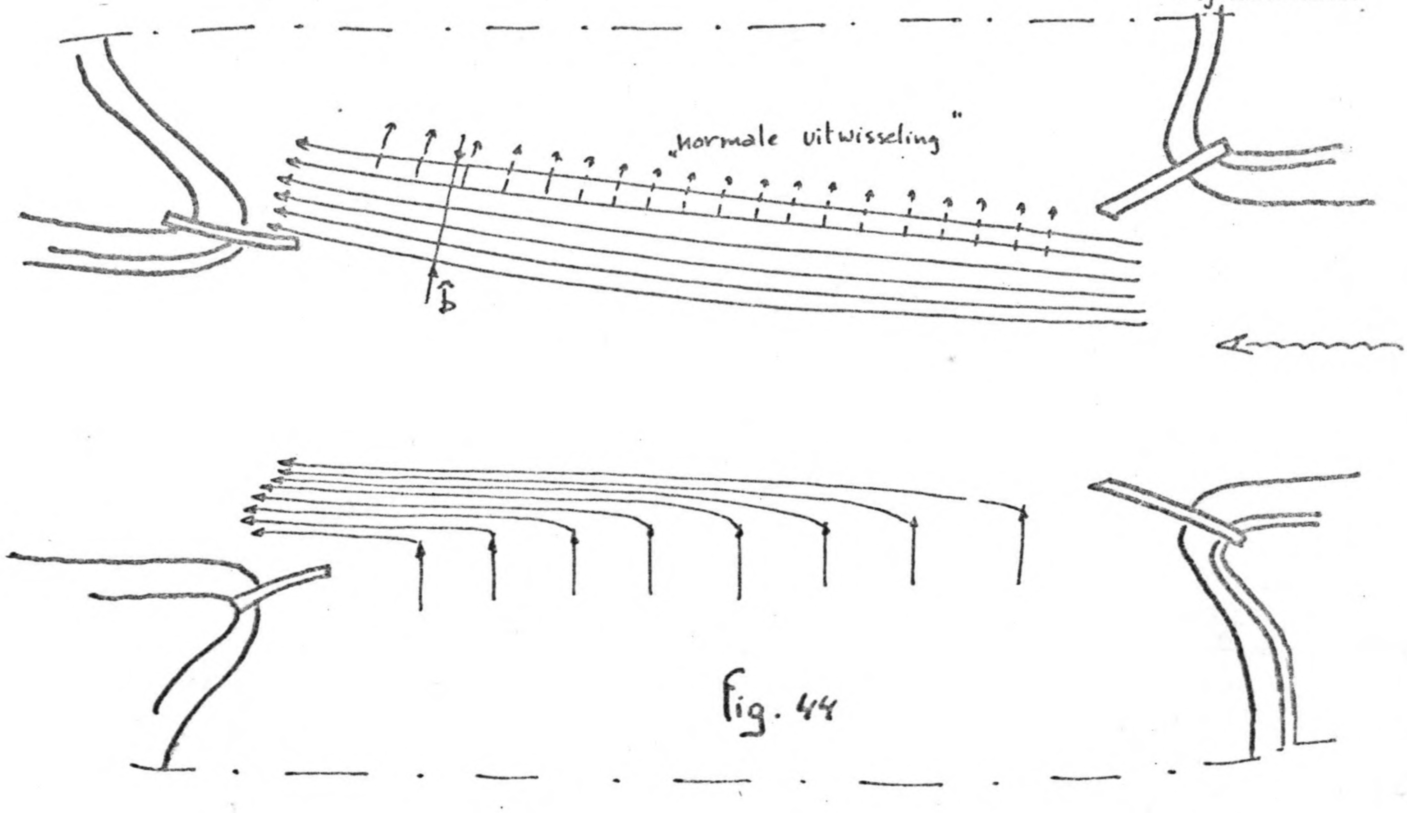

„normale uitwisseling"
b̂

fig. 44

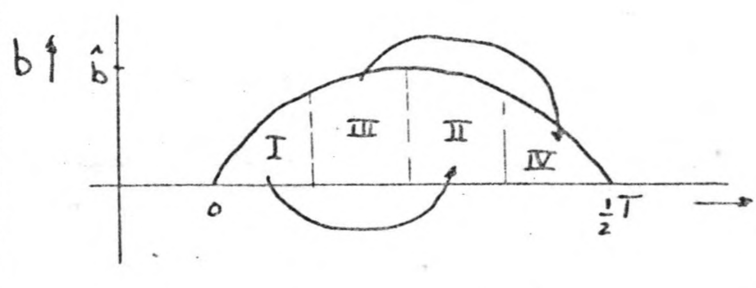
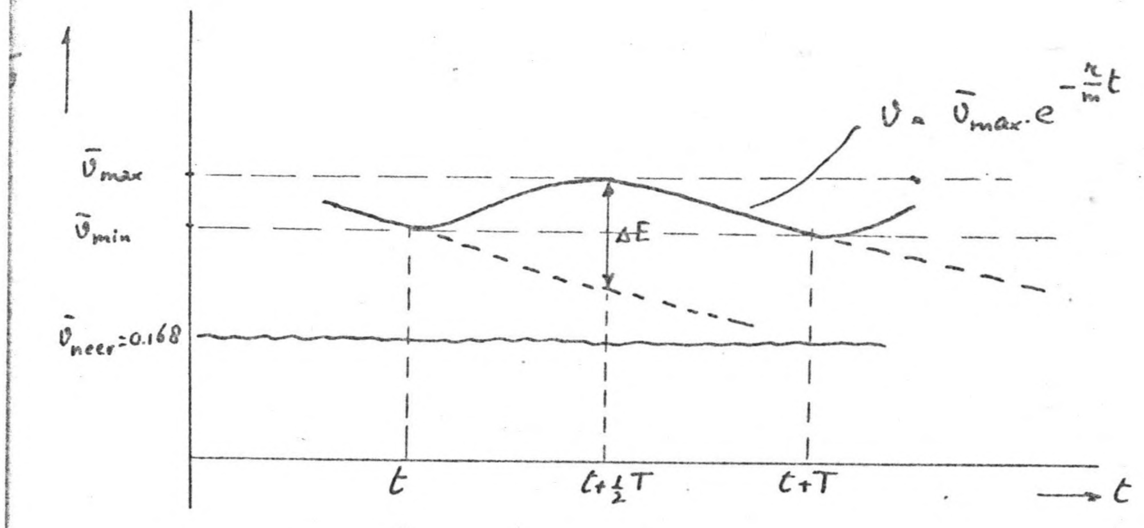

b
b̂
I
III
II
IV
0
½T
t

fig. 45

Fig 46.


$\bar{v}_{max}$
$\bar{v}_{min}$
$\bar{v}_{neer}=0.168$
$v = \bar{v}_{max} \cdot e^{-\frac{r}{m}t}$
ΔE
t
$t+\frac{1}{2}T$
$t+T$
$\rightarrow t$

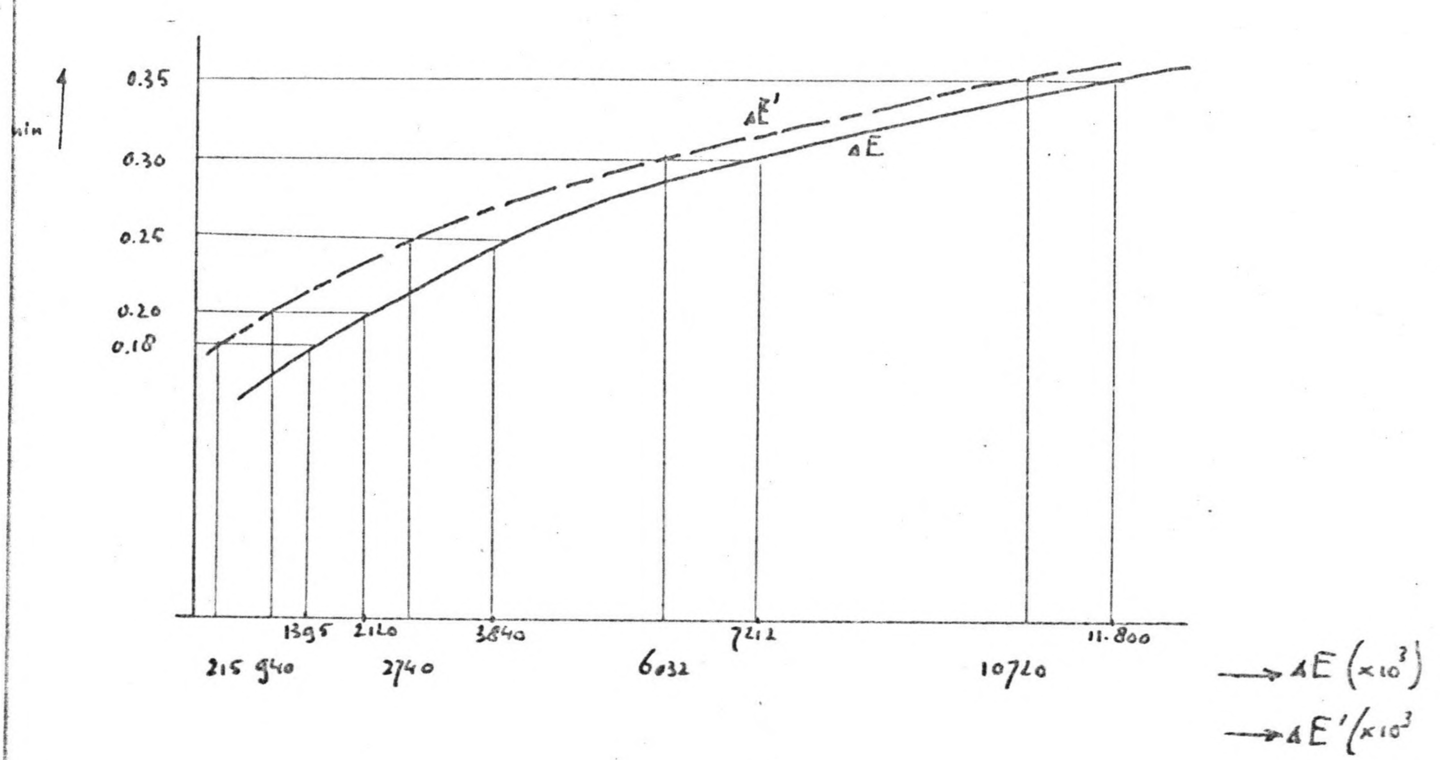

0.35
0.30
0.25
0.20
0.18
$\Delta E'$
ΔE
1395
2120
3840
7212
11.800
215
940
2740
6032
10720
$\rightarrow \Delta E\ (\times 10^3)$
$\rightarrow \Delta E'\ (\times 10^3$

Fig. 47

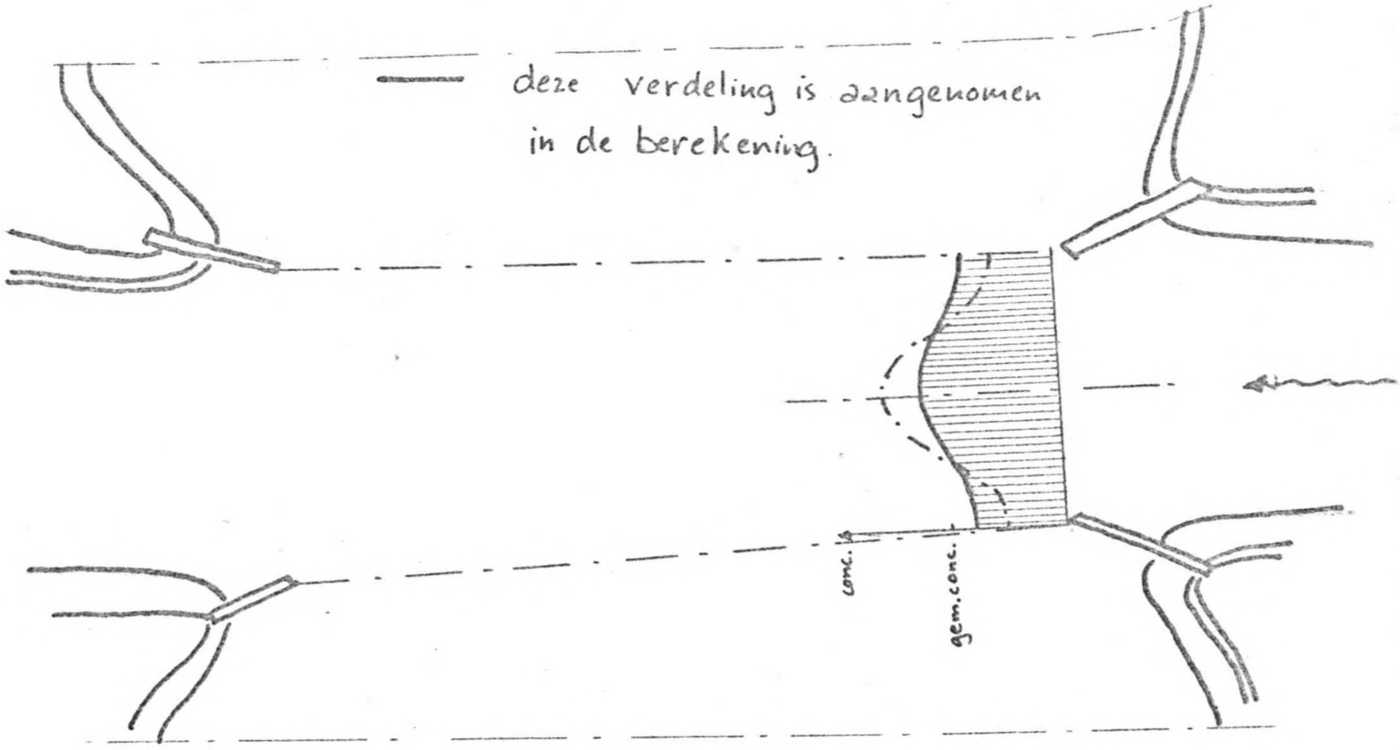

deze verdeling is aangenomen
in de berekening.
conc.
gem.conc.

Fig. 48

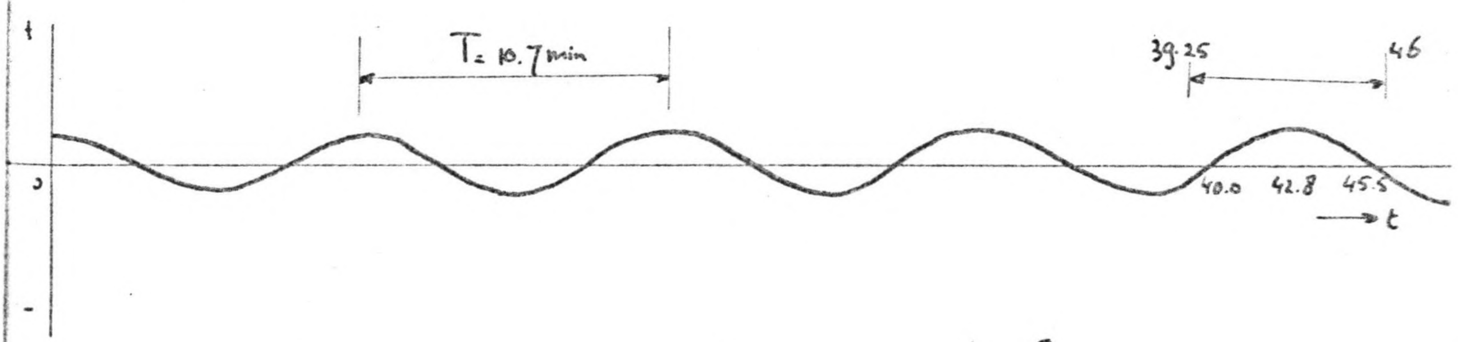

+
T= 10.7 min
39.25
46
0
40.0
42.8
45.5
t
-

Fig. 49


t=39.25
t=40 min
t=0
U=40 cm/sec


sluis
rivier

Fig.50

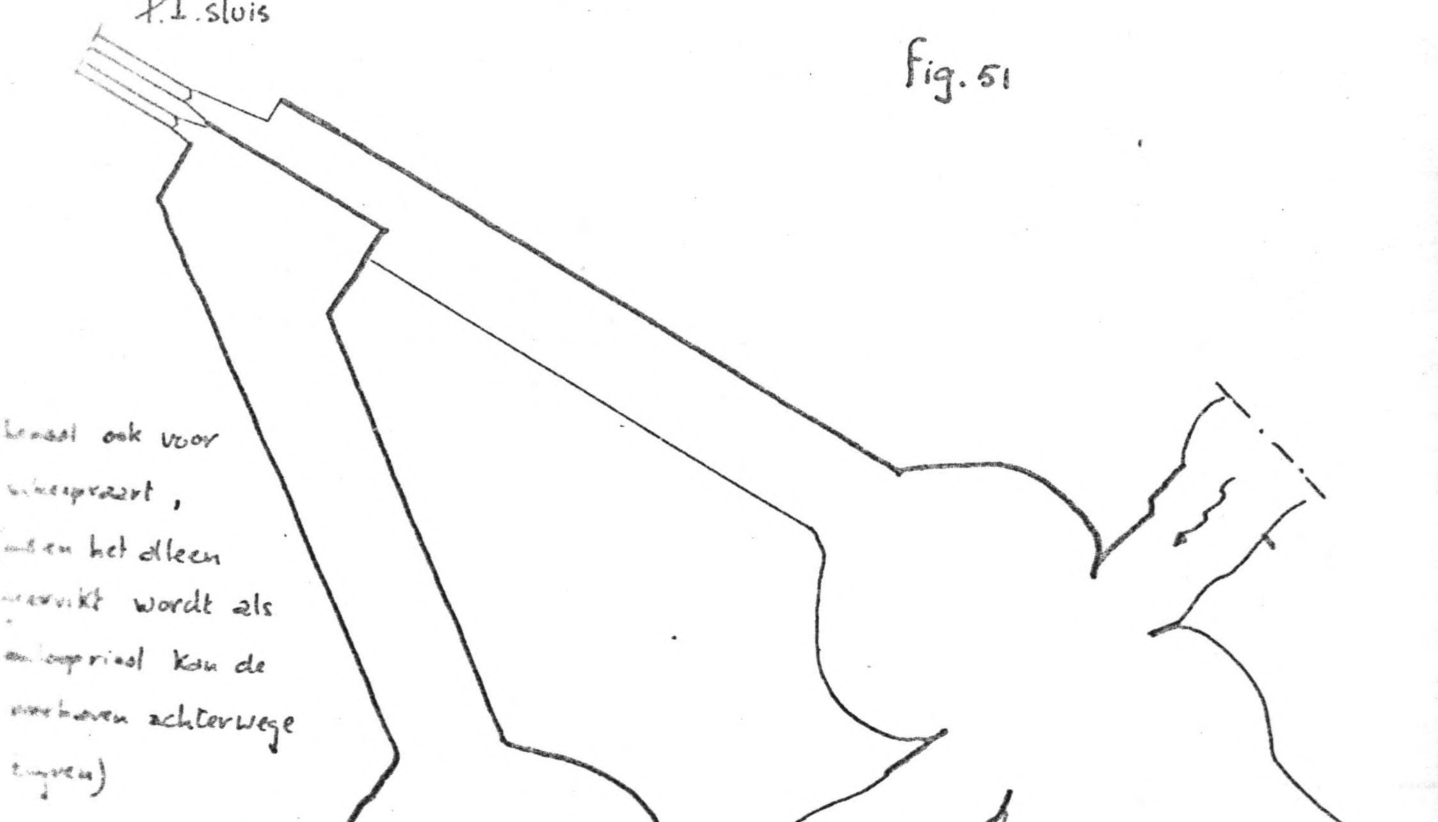

P.I. sluis
kanaal ook voor
scheepvaart,
wanneer het alleen
gebruikt wordt als
aanloopriool kan de
voorhaven achterwege
blijven)

Fig. 51

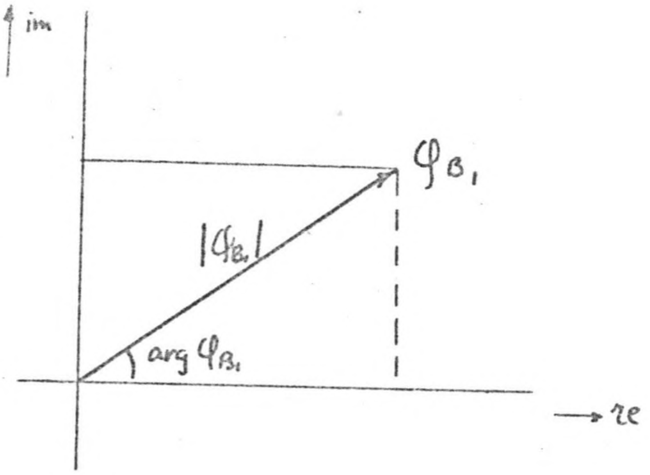


Fig. 52

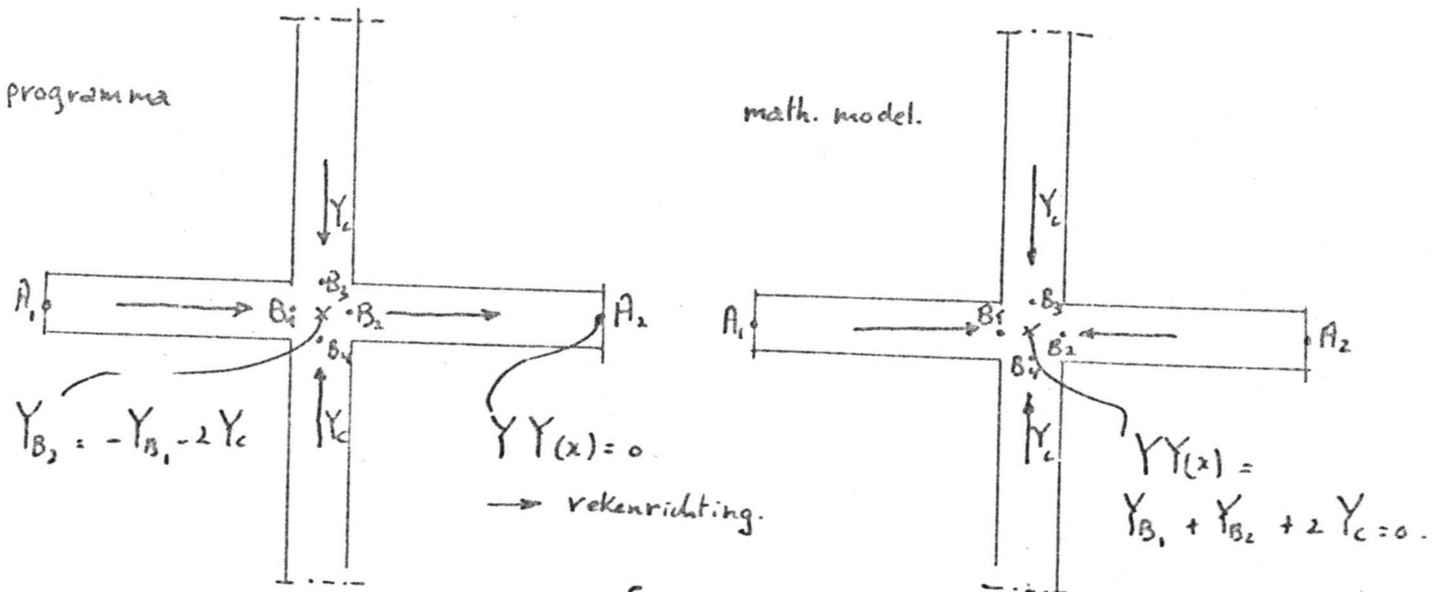


Fig. 53

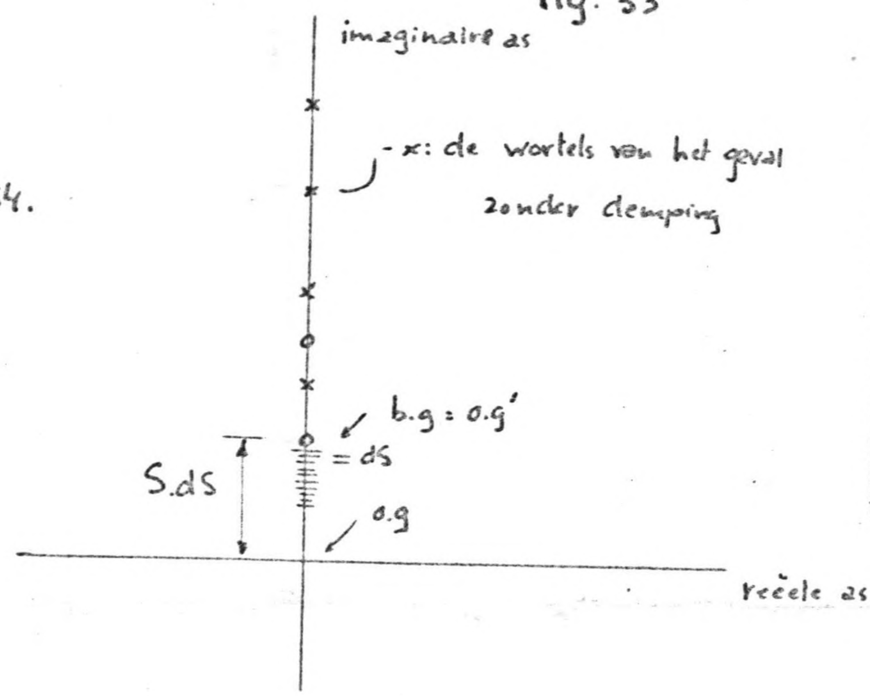


Fig54.

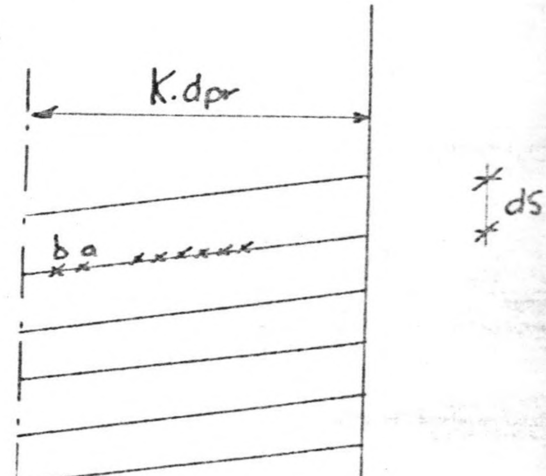
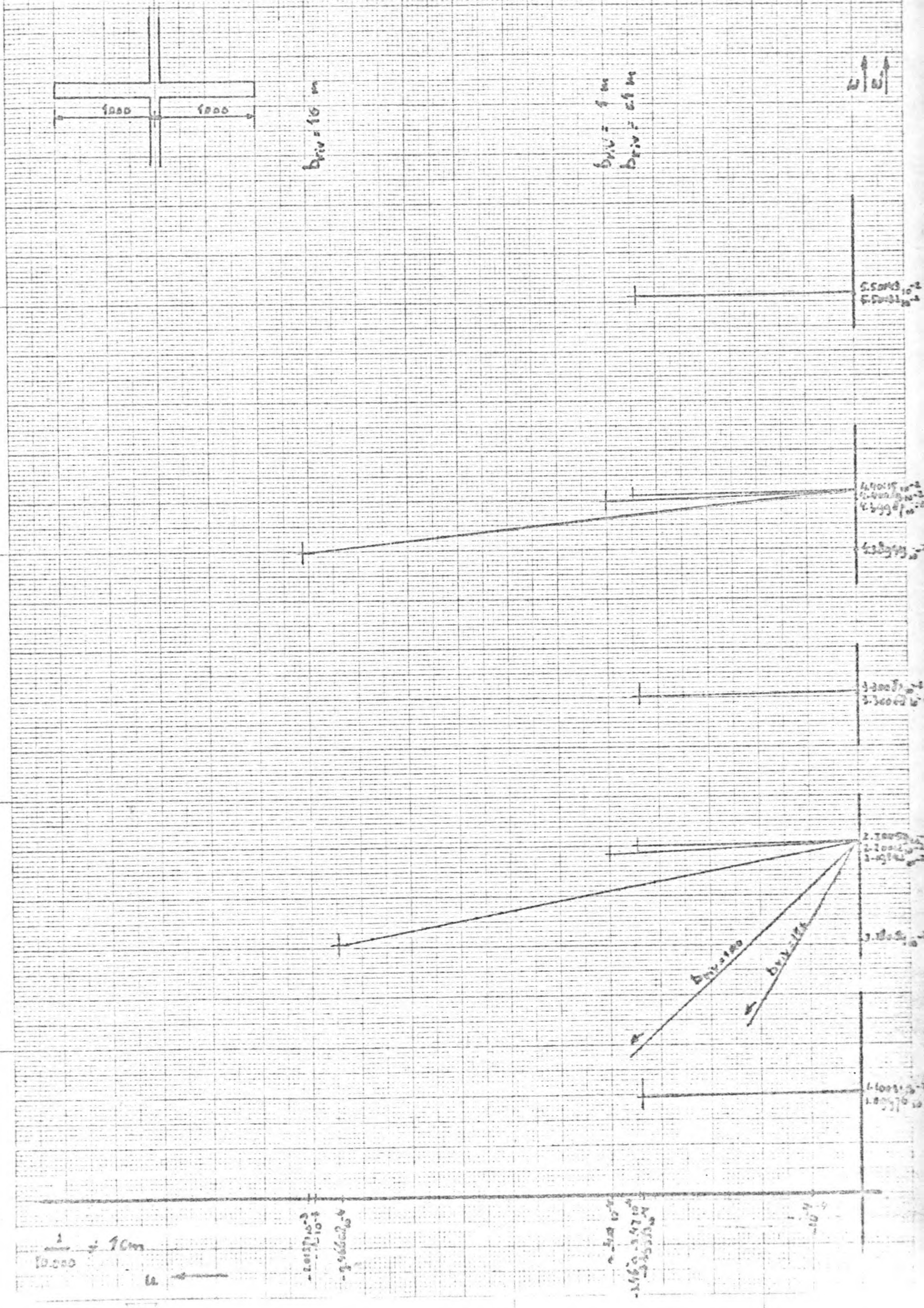


Fig. 55

Fig 5g

Voor Kruising-symmetrisch



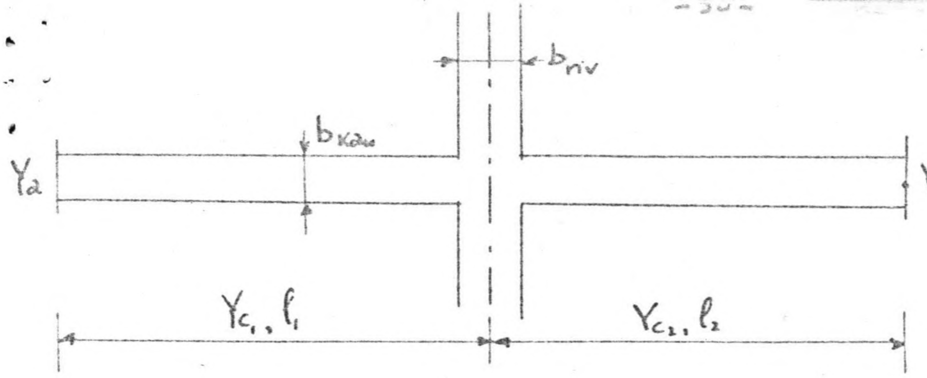


fig 56.

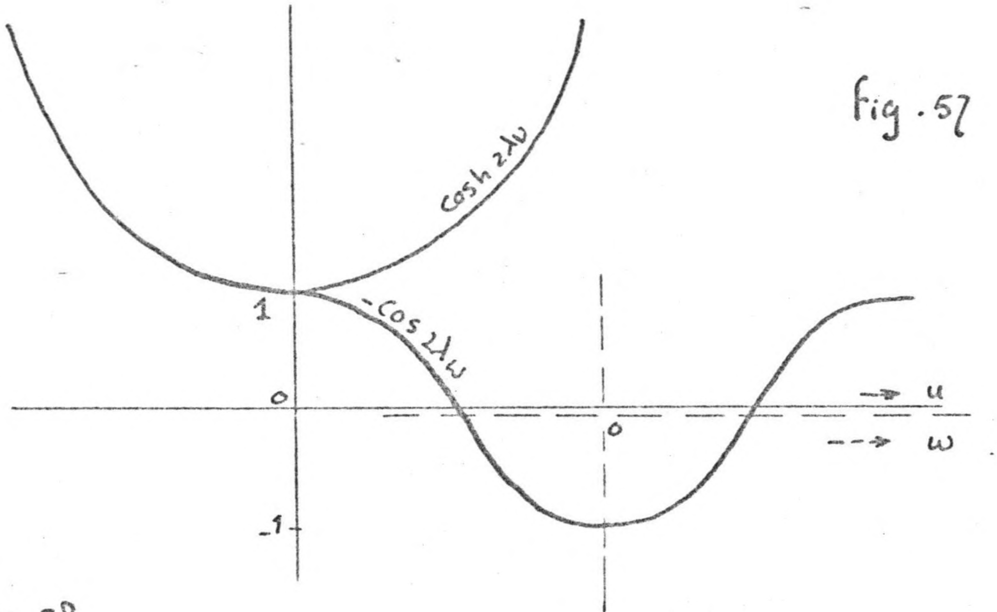
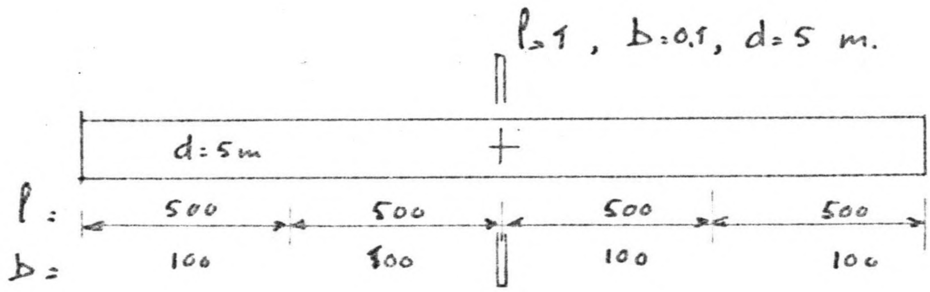


fig. 57

fig. 58



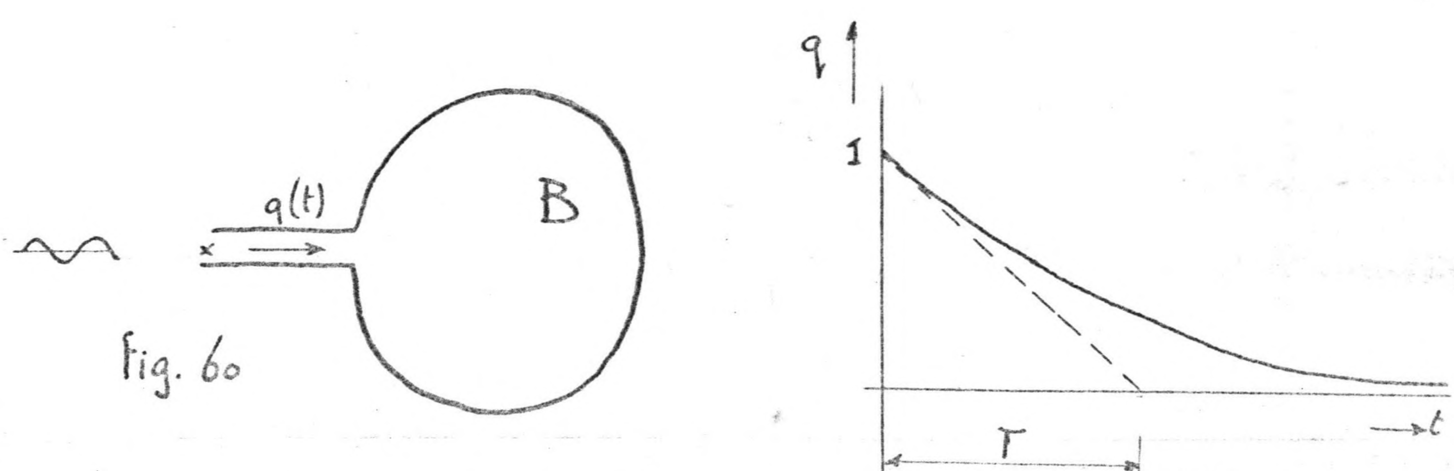


fig. 60

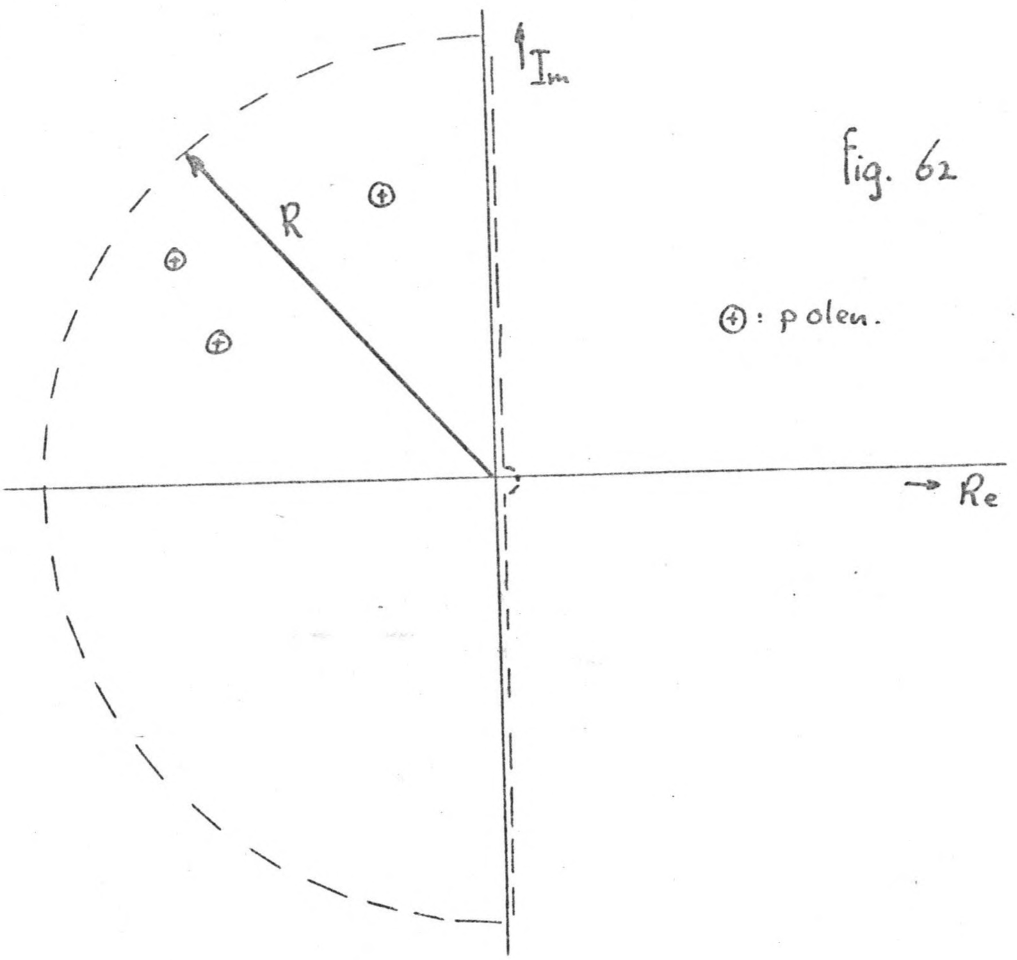
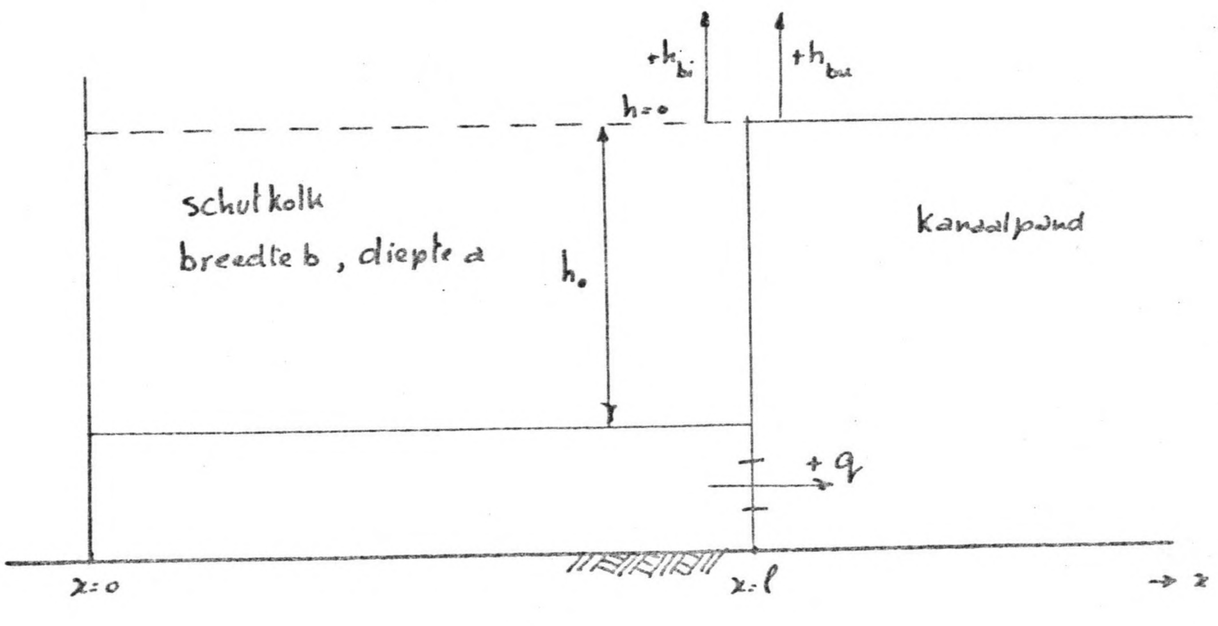

Im
R
Re
⊕ : polen.

fig. 62

Fig. 63


+h_bi
+h_bu
h=0
schutkolk
breedte b , diepte a
h₀
kanaalpand
+q
x=0
x=l
→ x

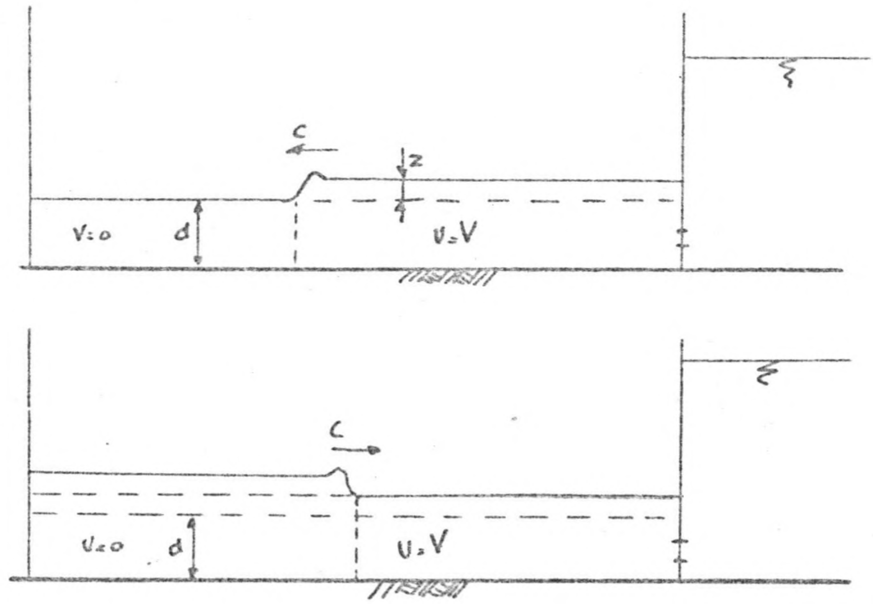


Fig. 64

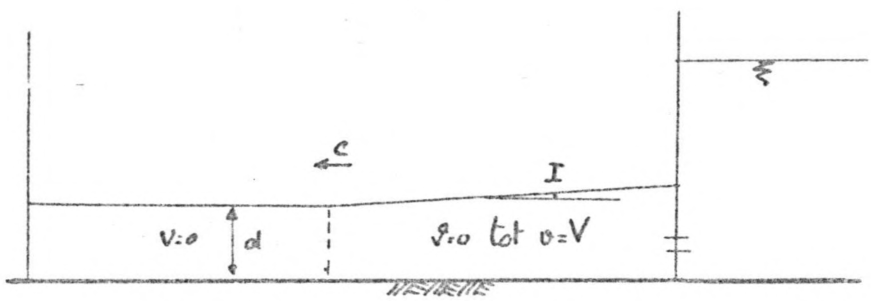


Fig. 65

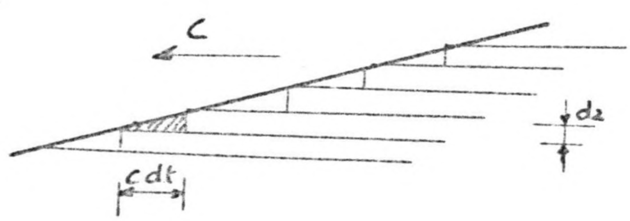


Fig. 66

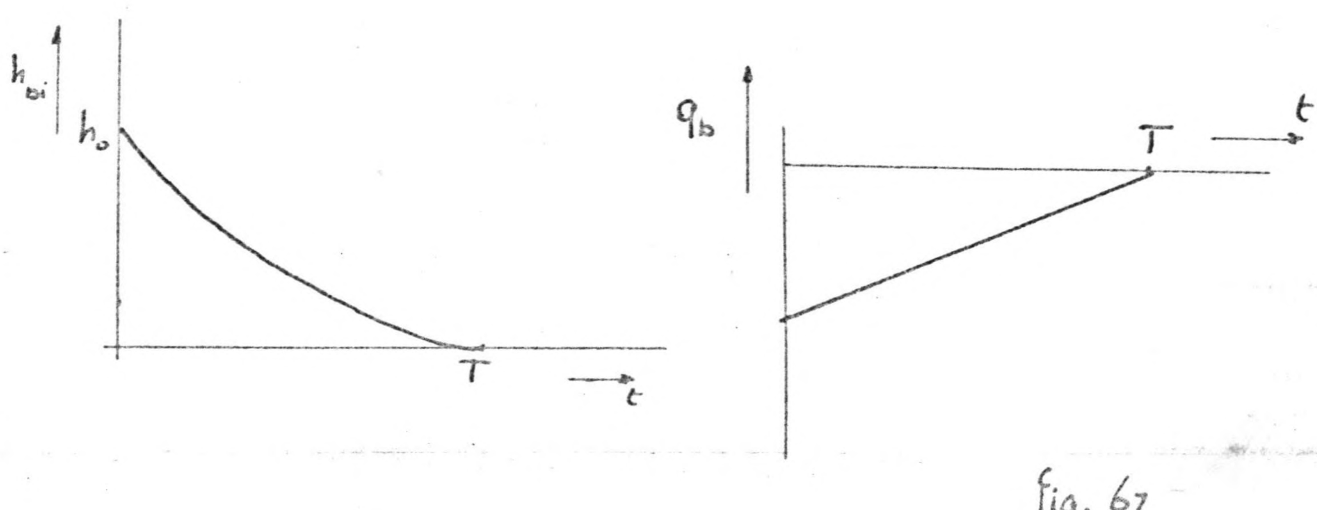


Fig. 67

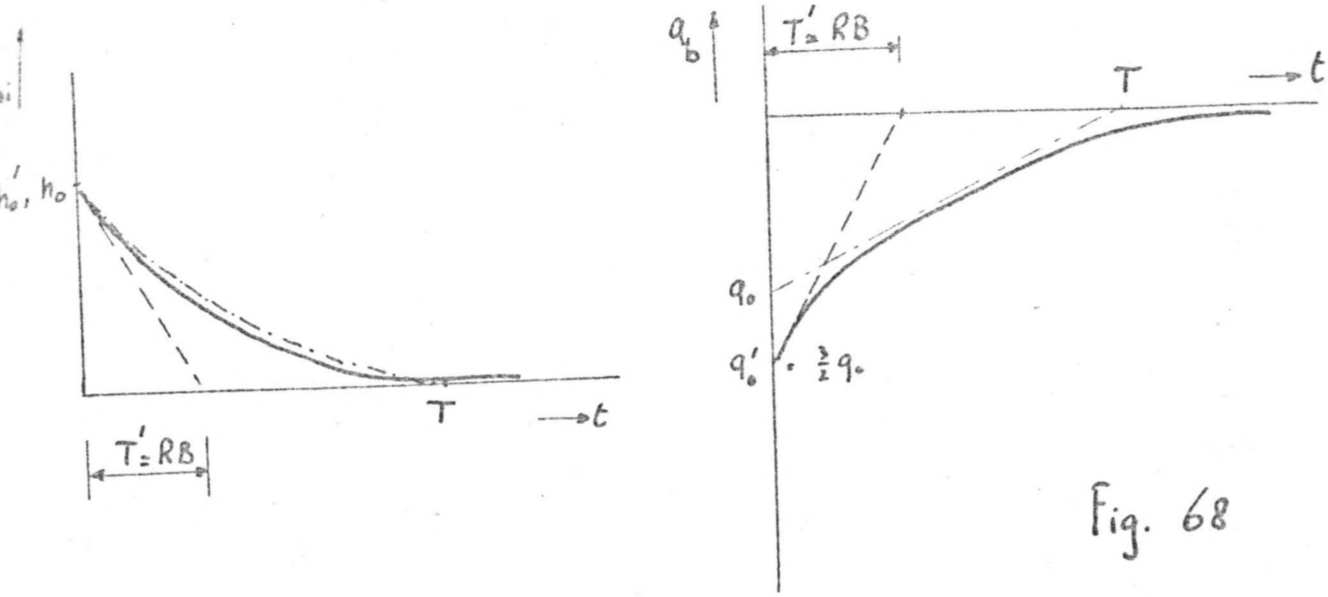


Fig. 68

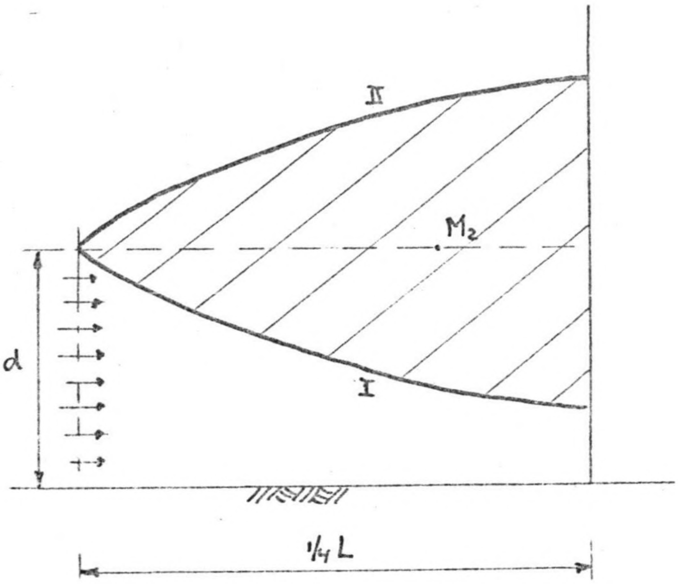


Fig. 69