MINISTERUL EDUCATIEI SI INVATAMINTULUI
INSTITUTUL POLITEHNIC „TRAIAN VUIA" TIMISOARA
FACULTATEA DE MECANICA

Ing. MARIUS MARINA

CONTRIBUTII LA STUDIUL OPTIMIZARII DISTRIBUTIEI MOTOARELOR CU ARDERE INTERNA IN PATRU TIMPI

VOLUMUL II

Teză pentru obținerea titlului științific de doctor inginer

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UNIVERSITATEA "POLITEHNICA"
TIMIŞOARA

CONDUCATOR STIINTIFIC
Prof.dr.ing. VASILE BERINDEAN

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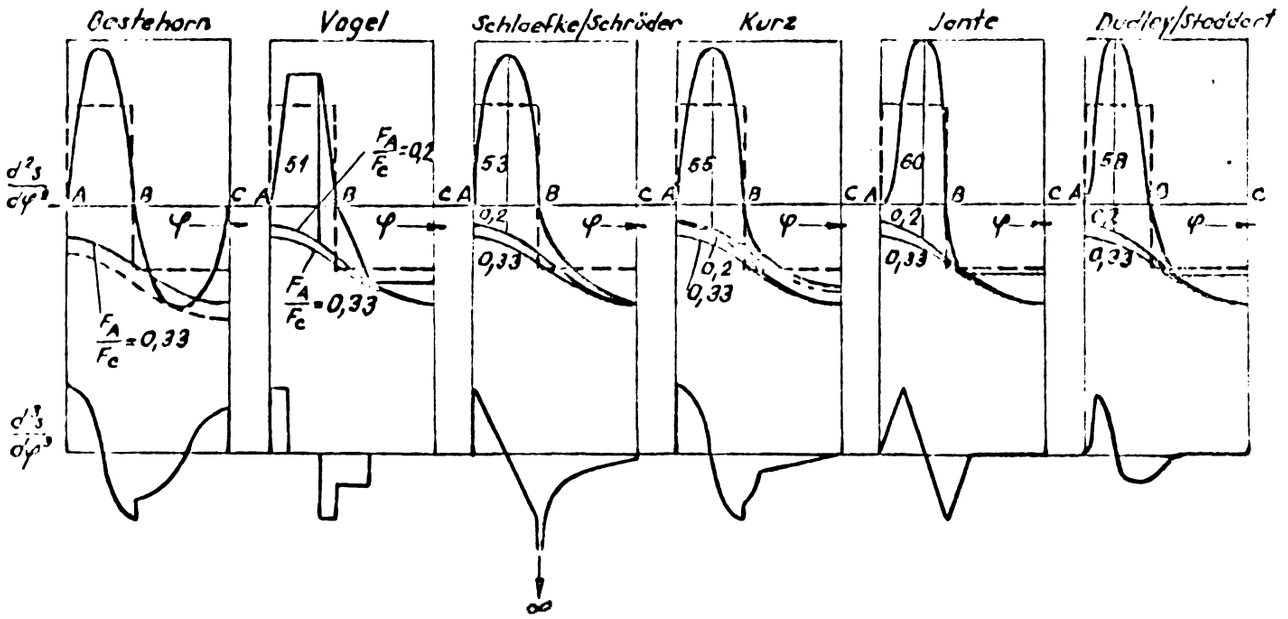

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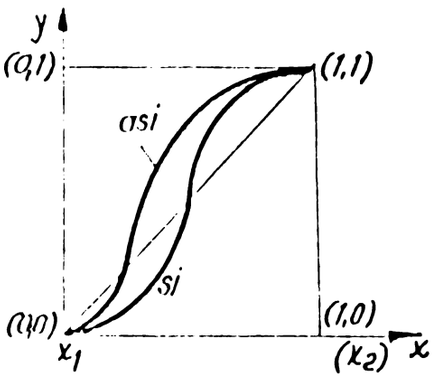

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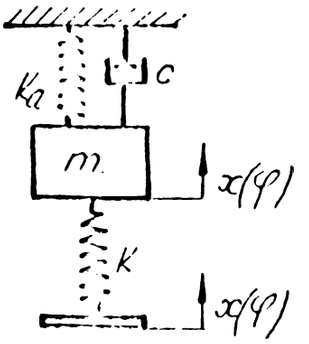

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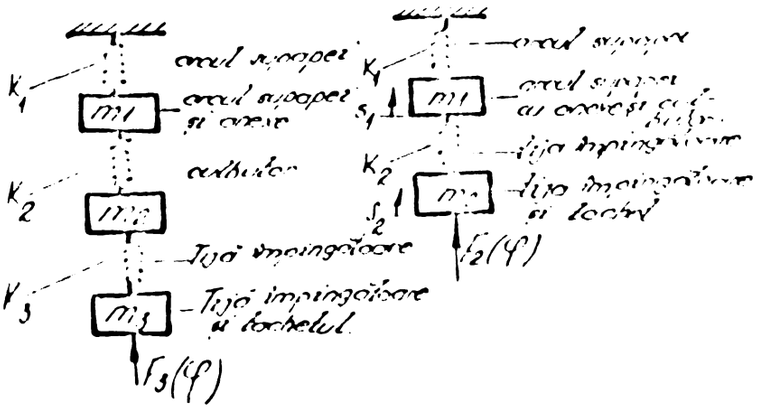

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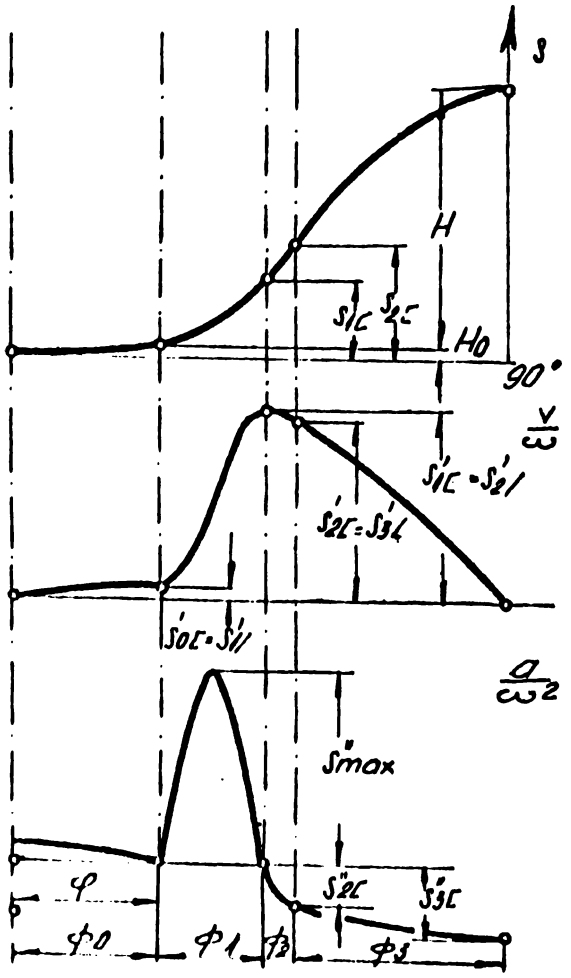

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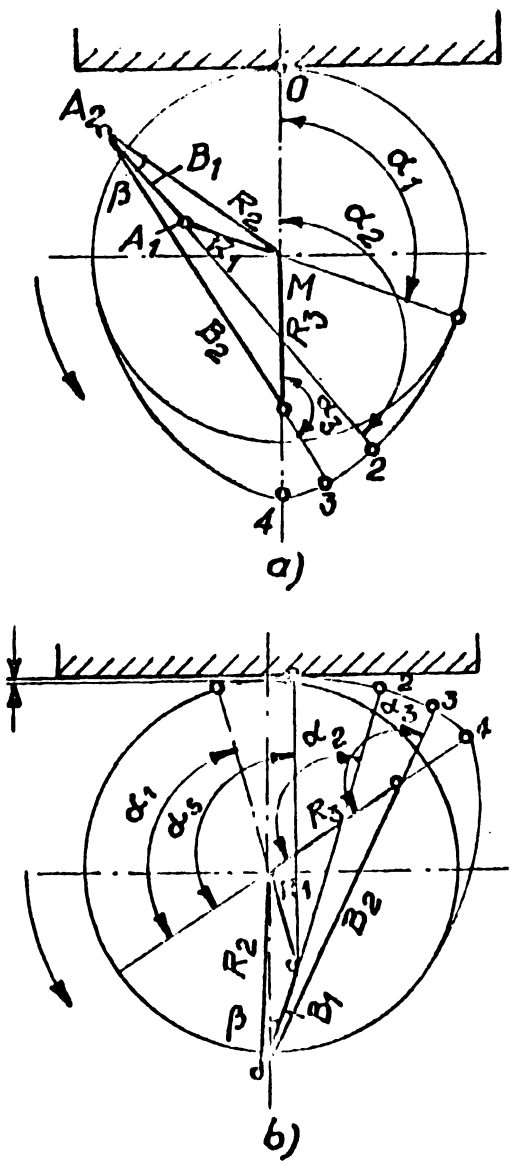

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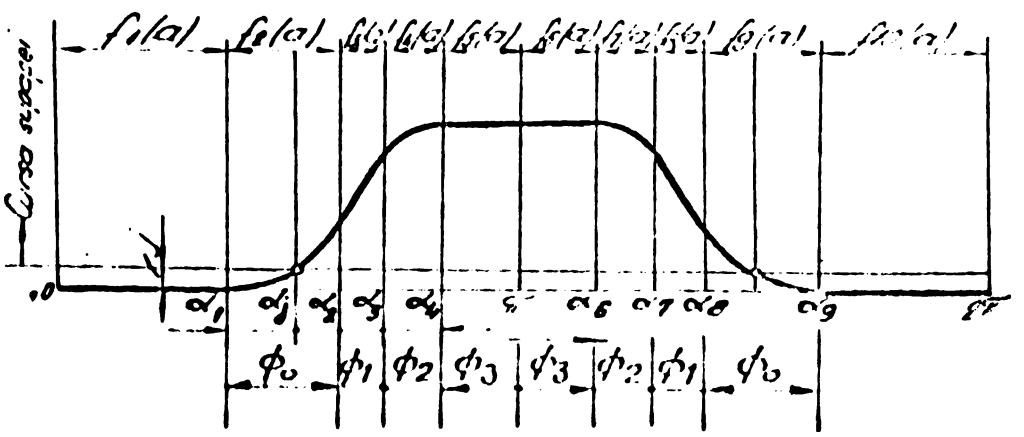

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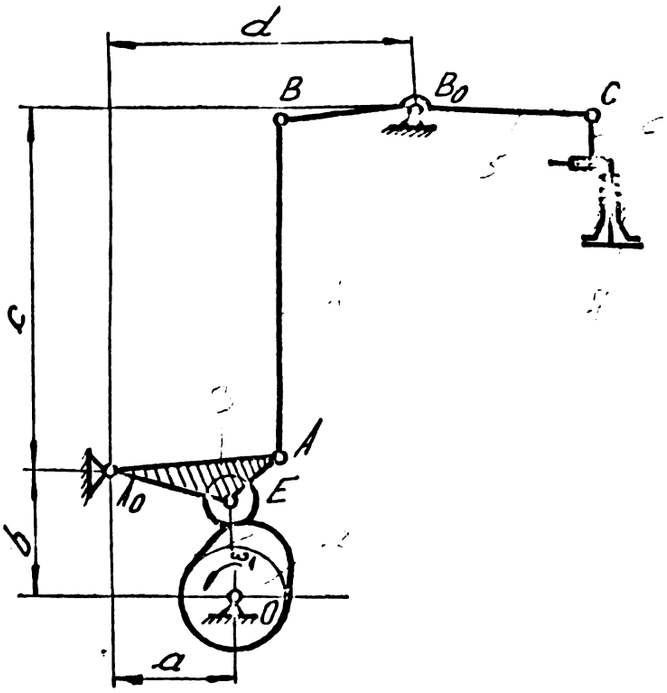

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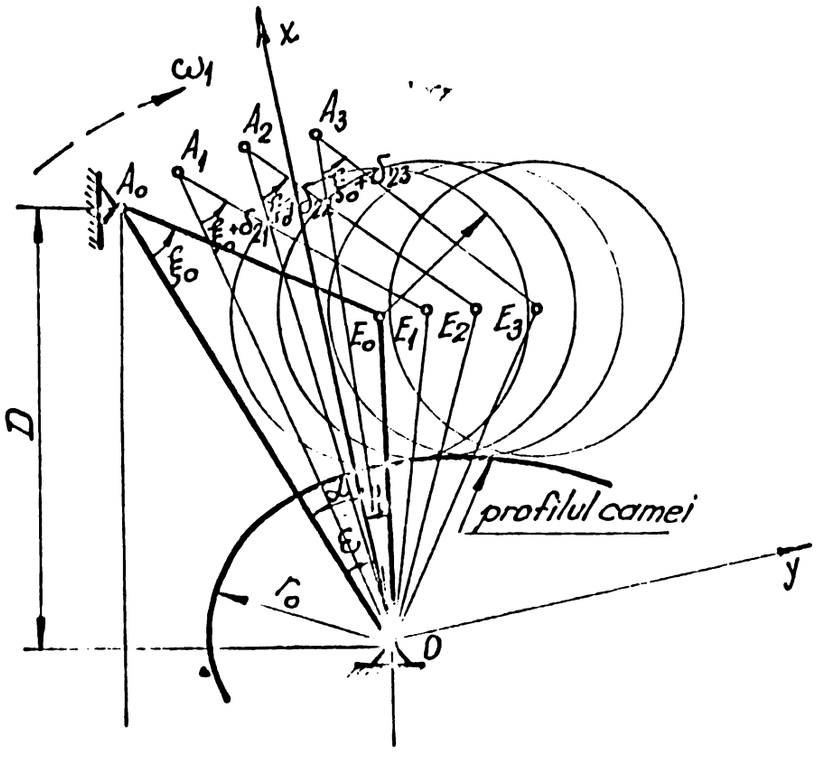

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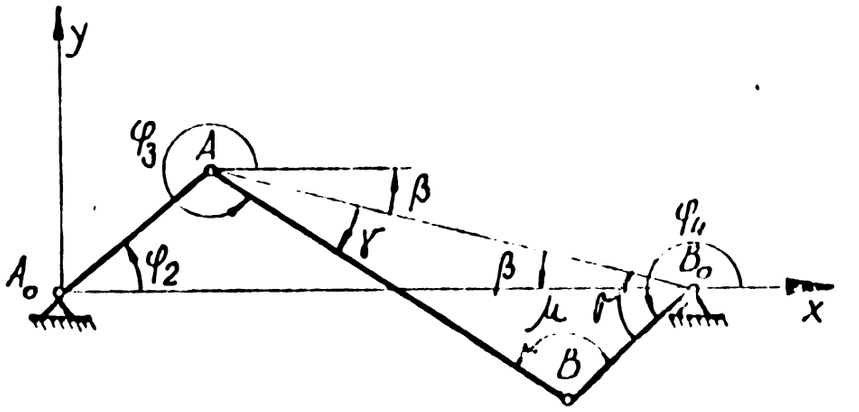

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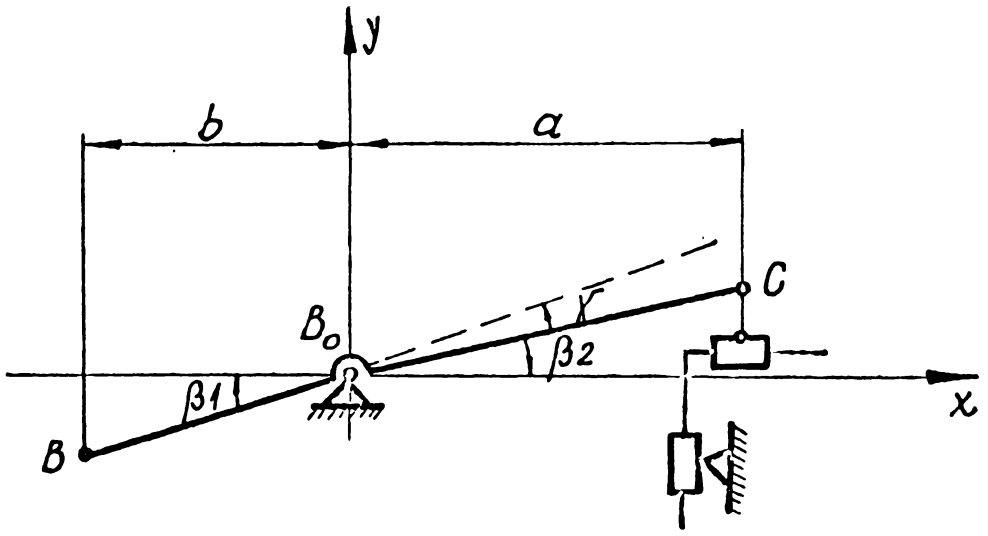

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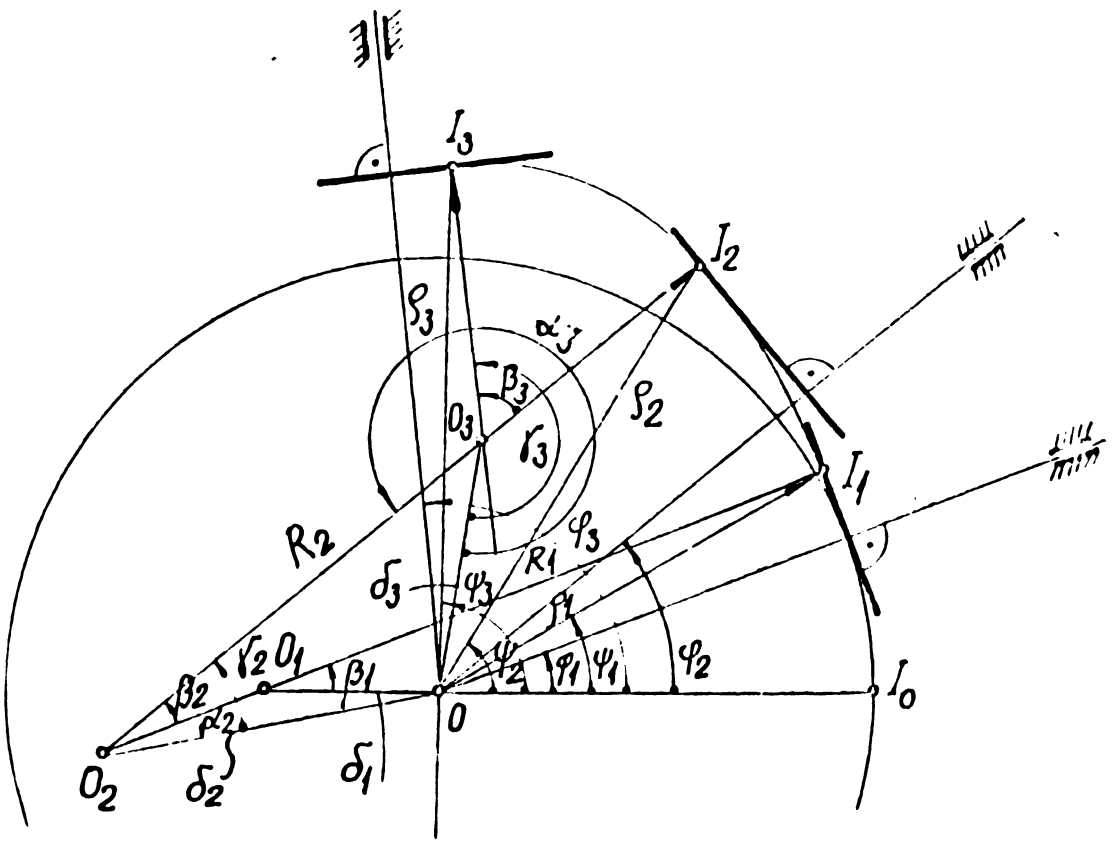

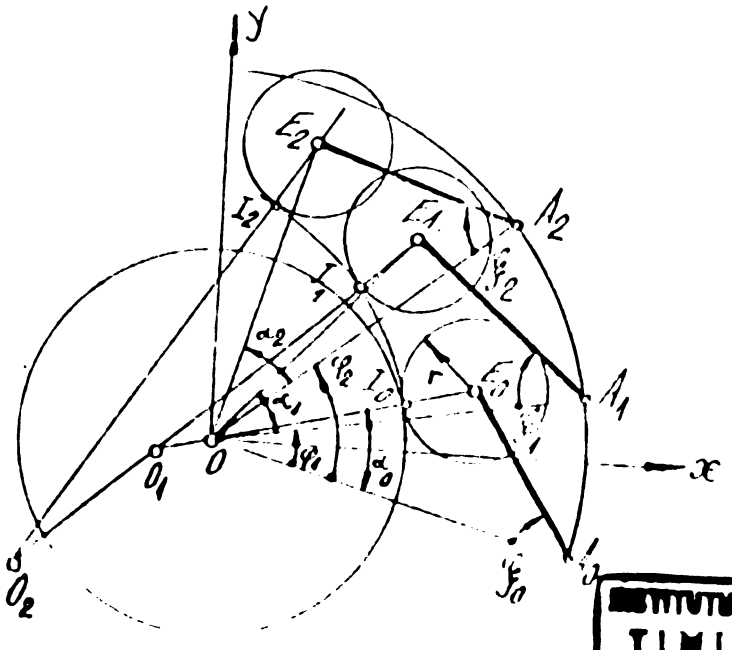

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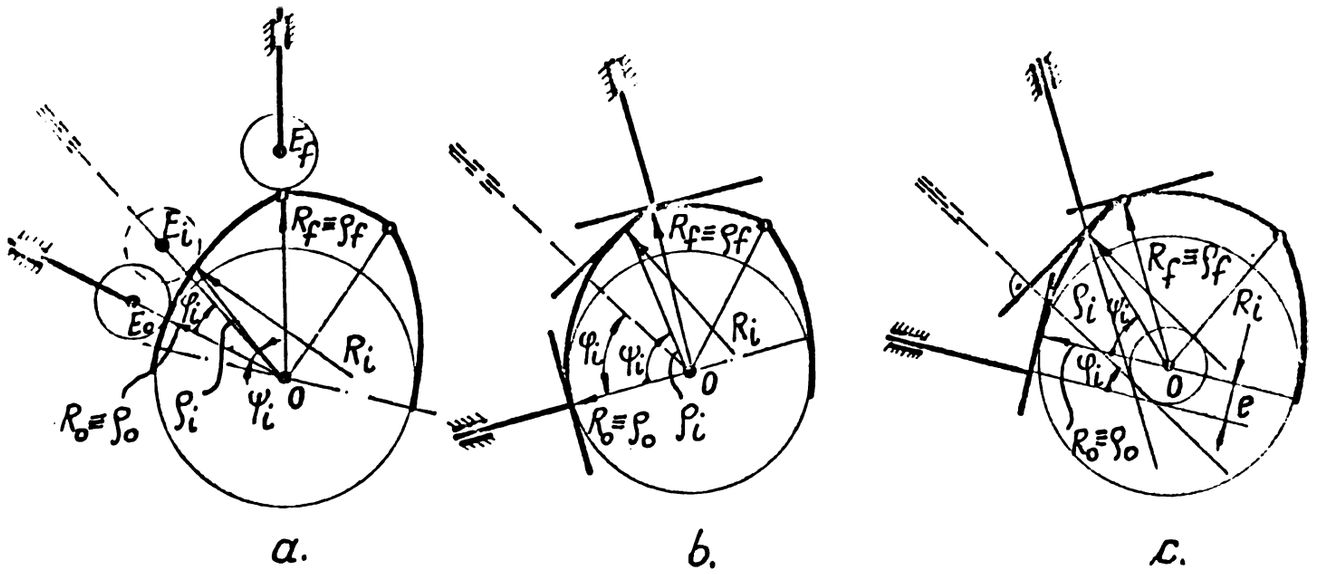

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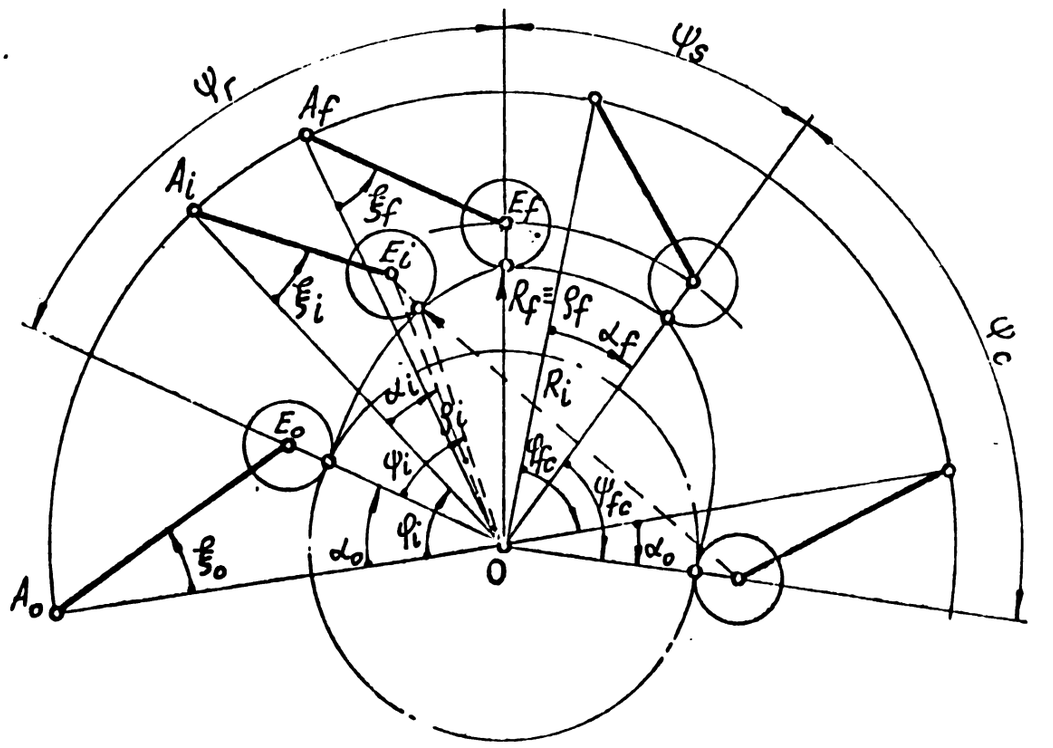

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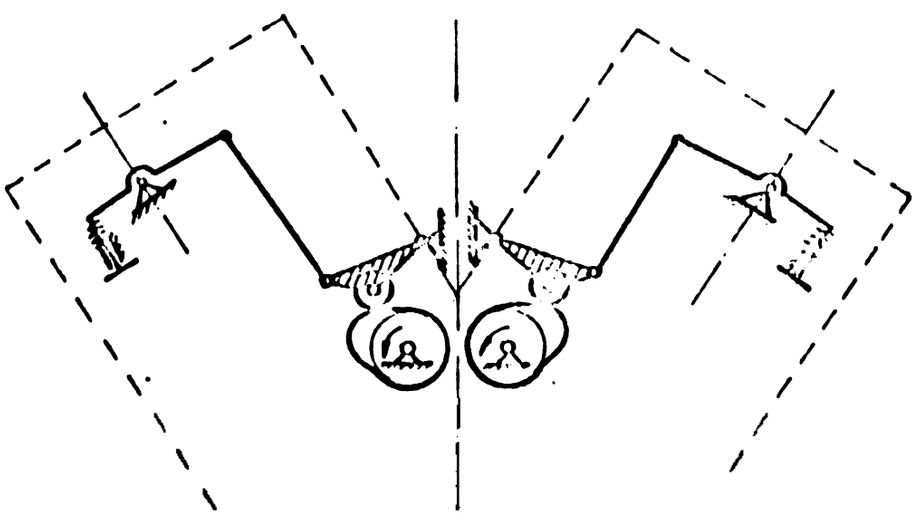

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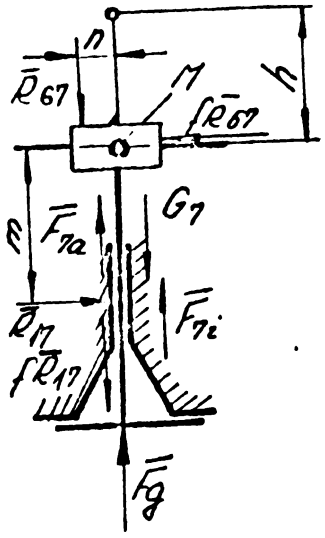

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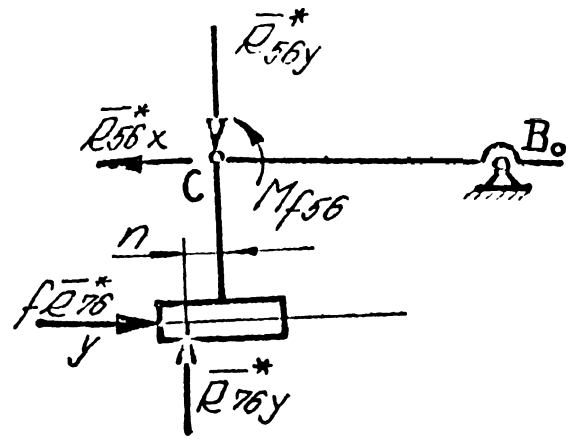

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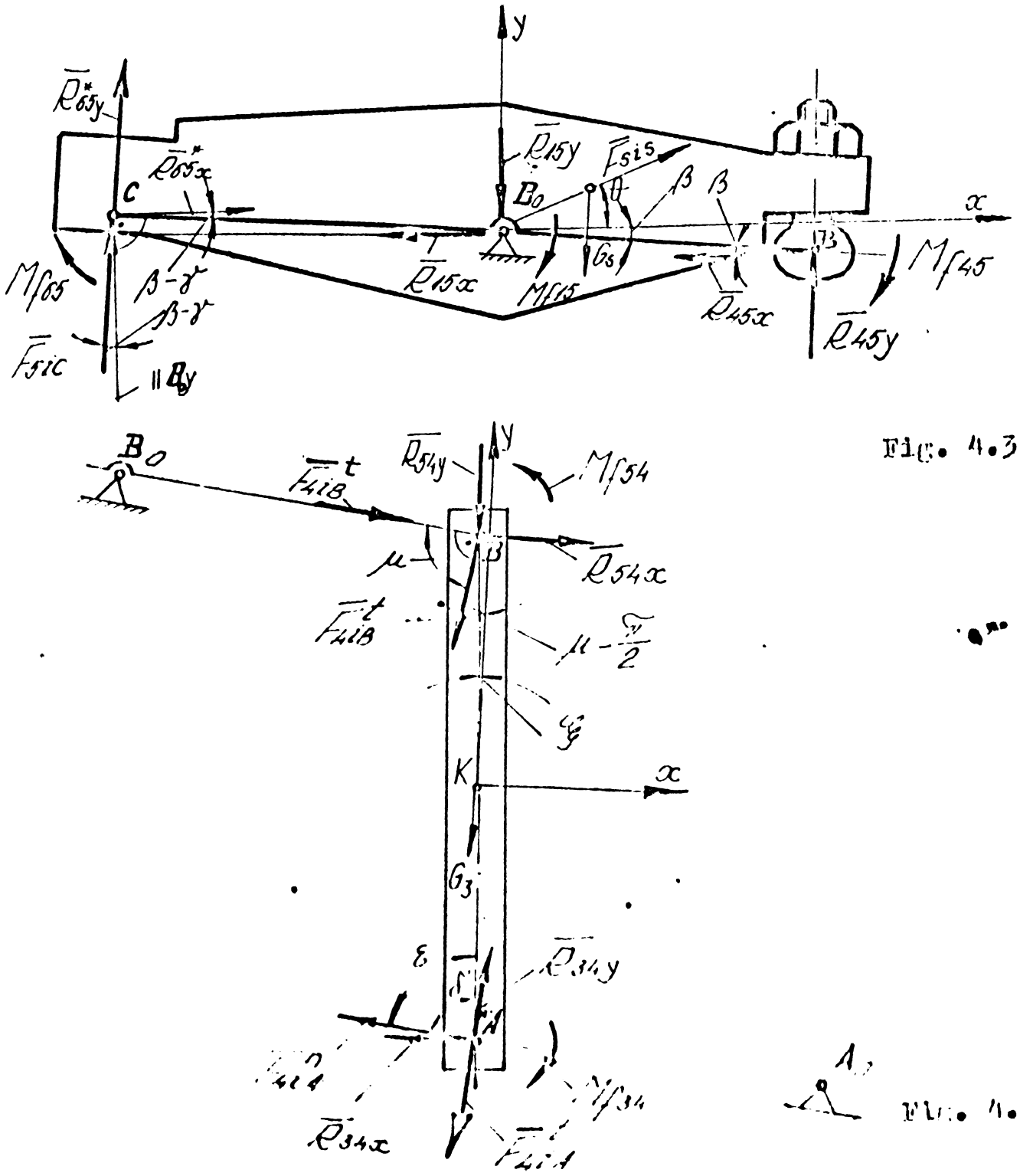
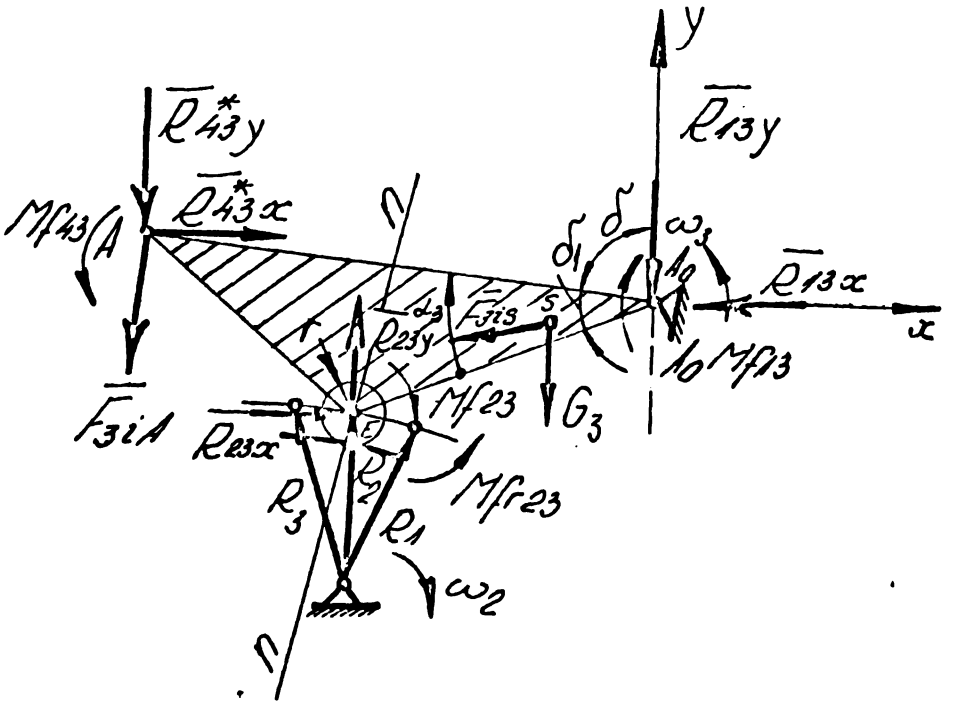


Fig. 4.3

Fig. 4.4



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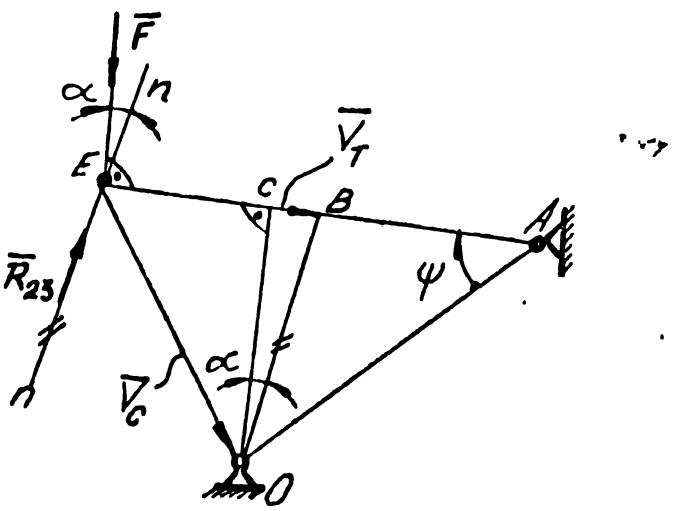

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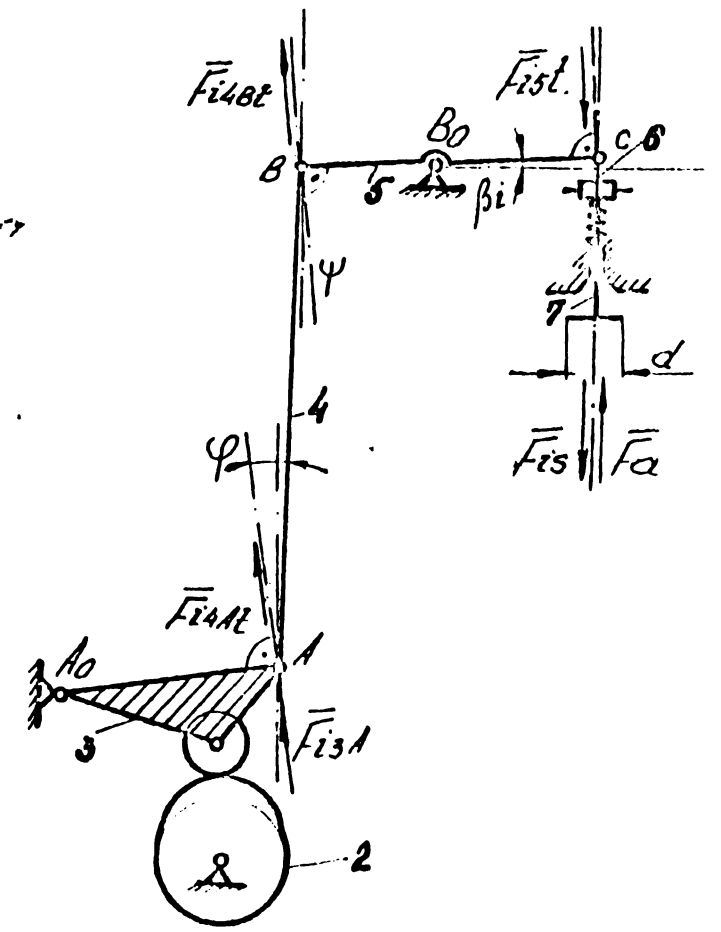

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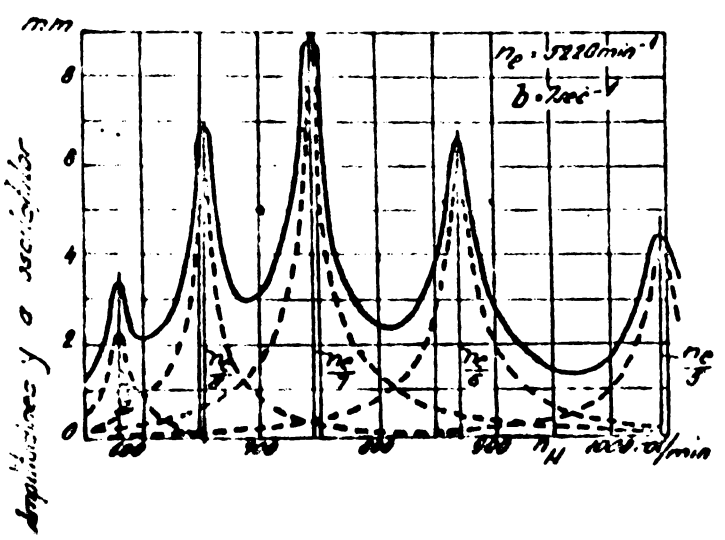

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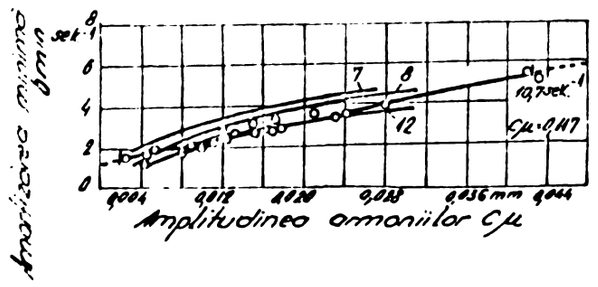

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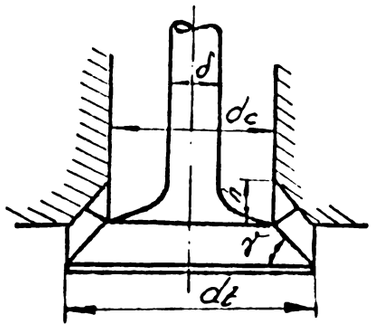

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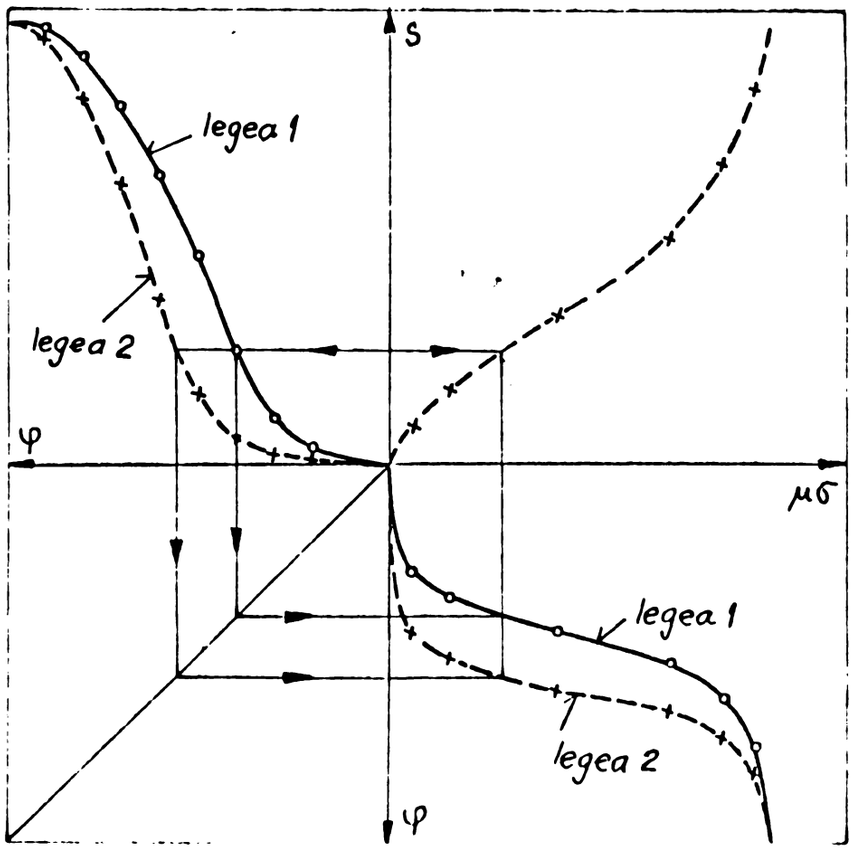

Fig. 4.11

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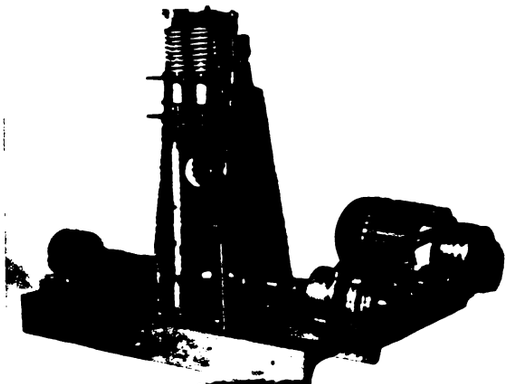

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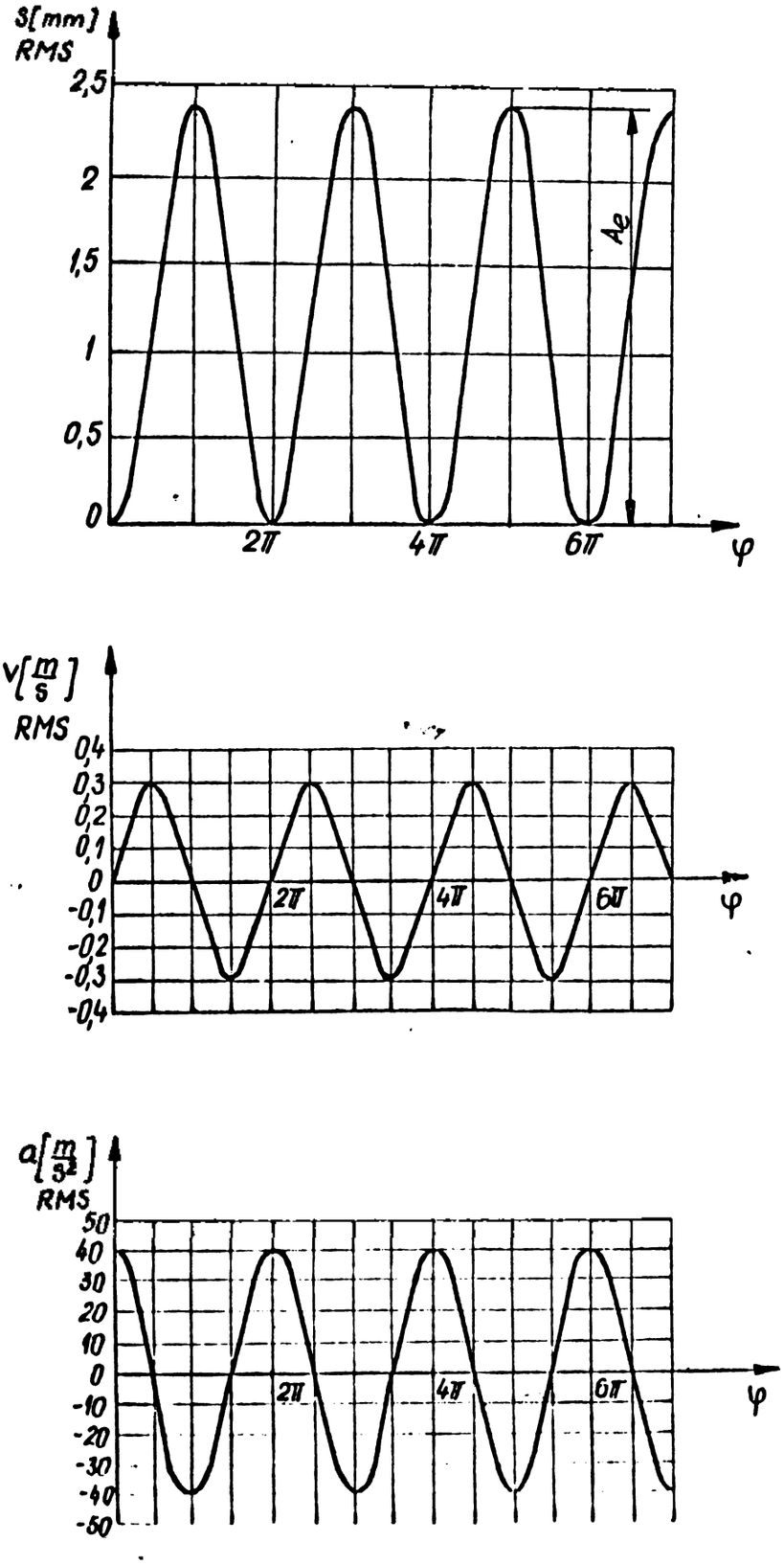
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1
0,5
0
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4π
6π
φ
Ae
v[m/s]
RMS
0,4
0,3
0,2
0,1
0
-0,1
-0,2
-0,3
-0,4
2π
4π
6π
φ
a[m/s²]
RMS
50
40
30
20
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0
-10
-20
-30
-40
-50
2π
4π
6π
φ

Fig. 5.3

BUPT

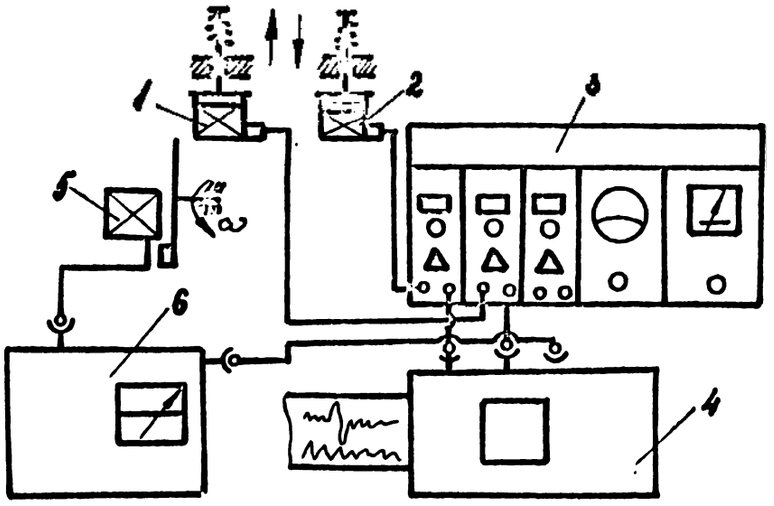
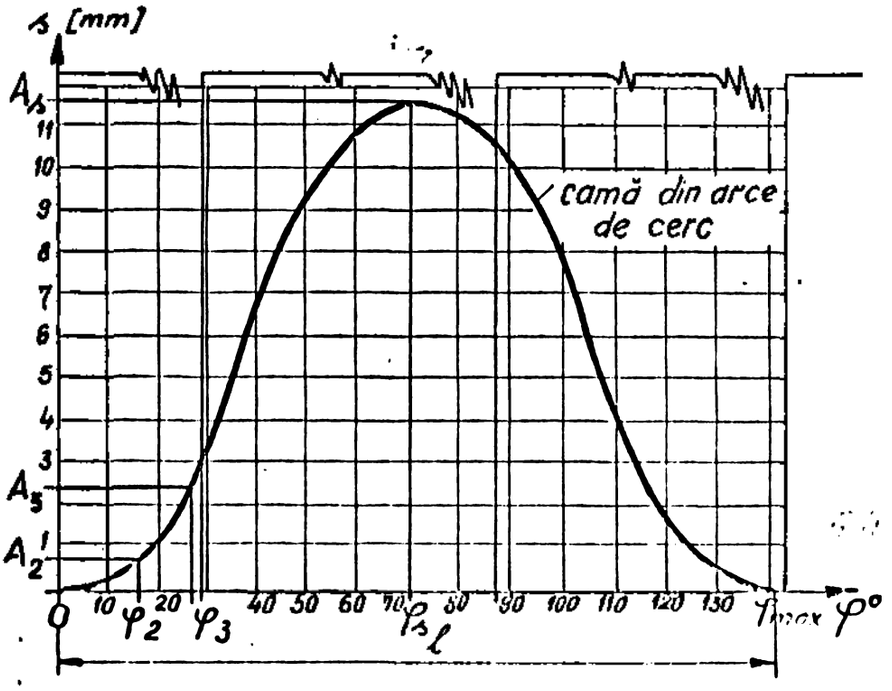


Fig. 5.2

1;2 - traductori piezoelectrici,de acceleraţie; 3 - aparat de măsurat vibraţii SDM - 132; 4 - osciloscraf cu bucle 12 LS - 1; 5 - traductor inductiv fără contact; 6 - aparat de măsurat vibraţii SM - 213.



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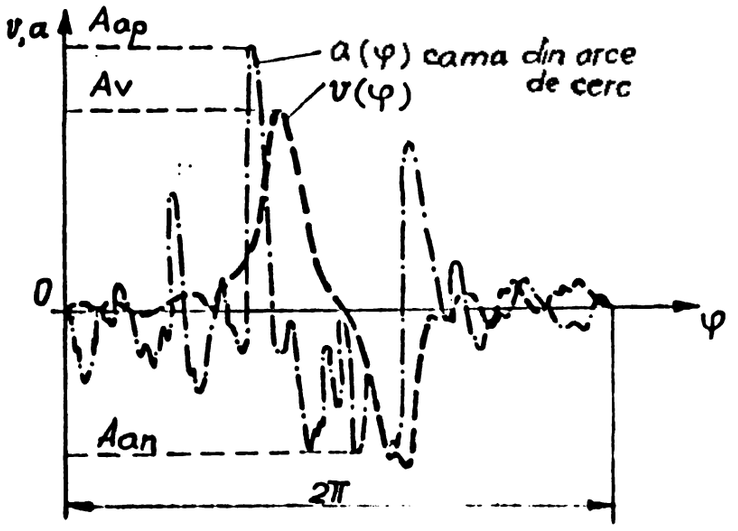

Fig. 5.5

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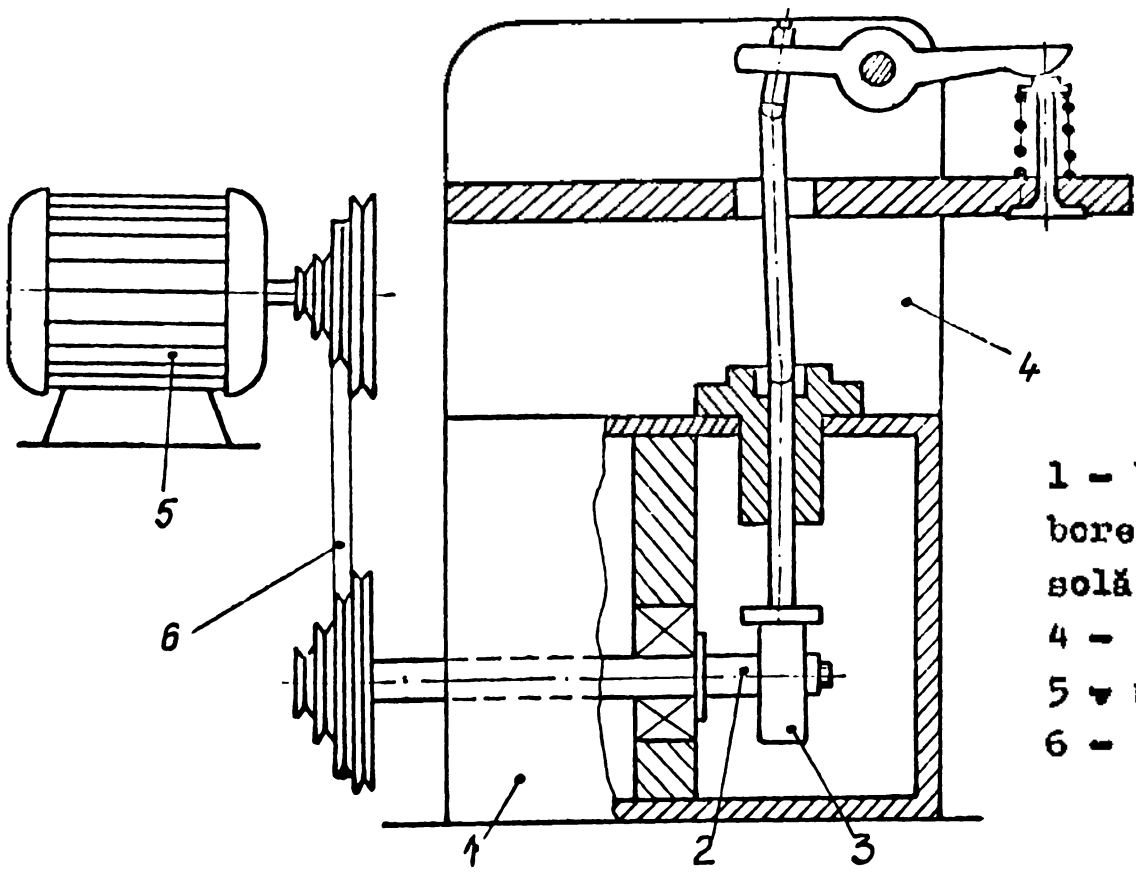
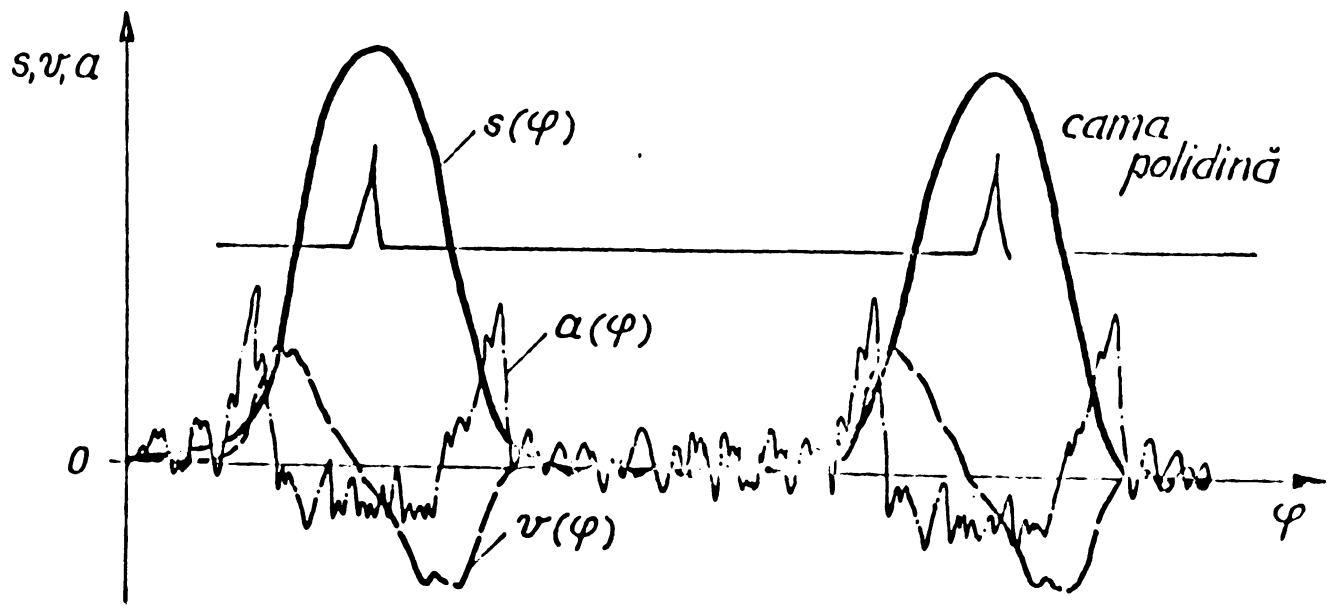


Fig. 5.6

1 - batiu; 2 - ax-
bore cu fus în co-
solă; 3 - camă;
4 - suprastructură;
5 - motor electric;
6 - curea.

1 - camă optimizată
2 - camă armonică (de referinţă)

Fig. 5.7



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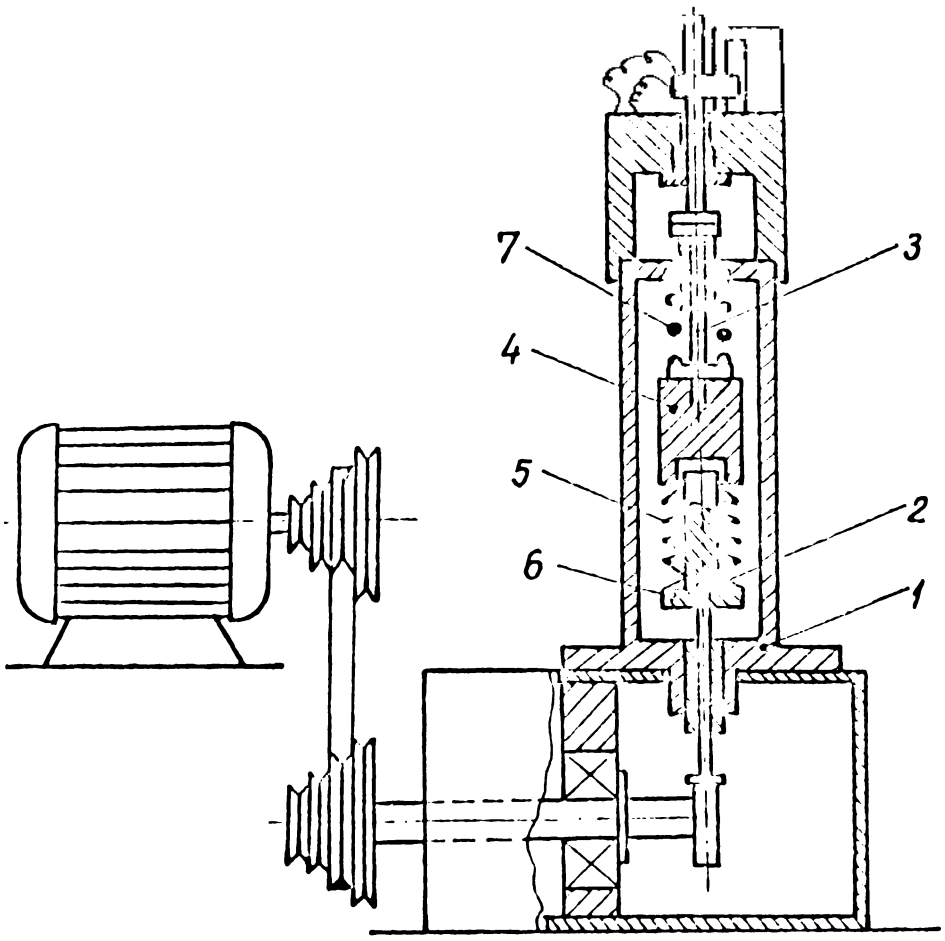
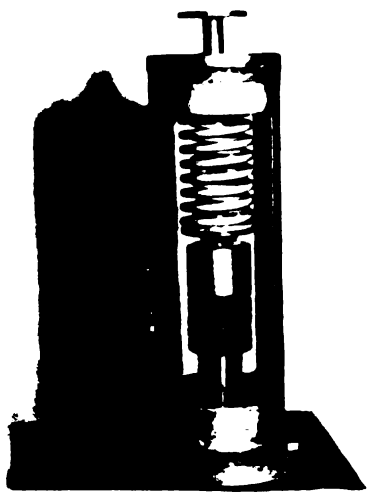


1 - corp tubular ... ghidaj; 2 - ... 3 - arc...; 4 - ... cilindru; 5 - ... cui tolar; 6 - ... dajul arcului; 7 - arcul ali... le.

Fig. 5.9



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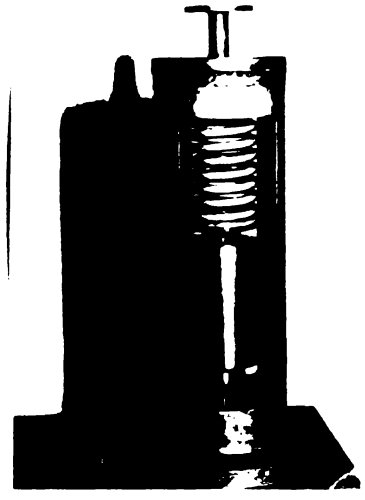

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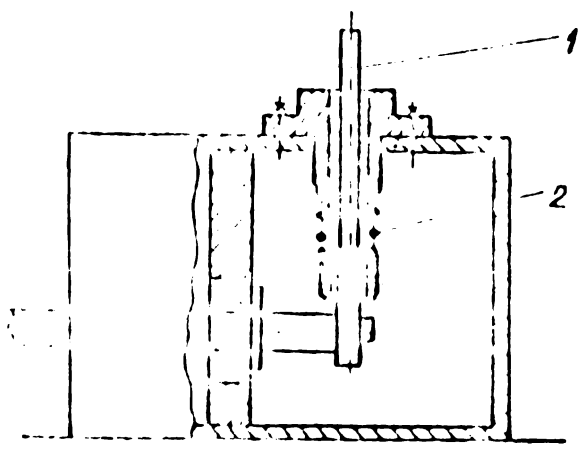

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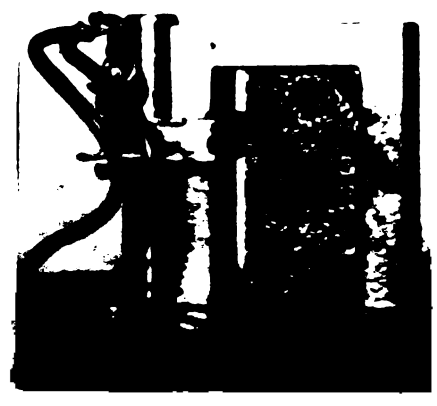

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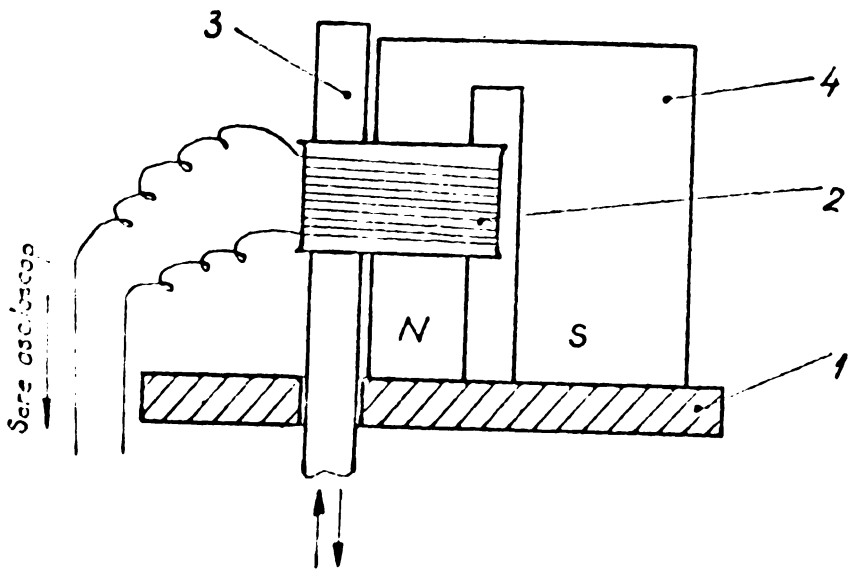
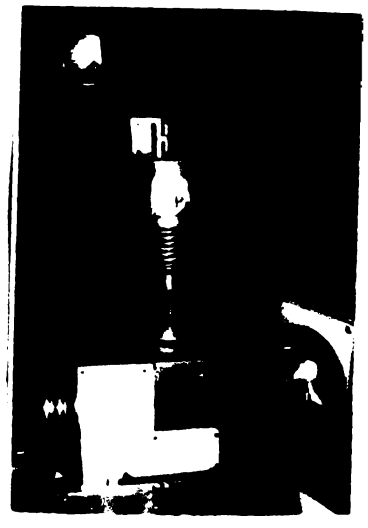


Fig. 5.13

1 - support; 2 - bobine; 3 - tige solidaire du support; 4 - aimant permanent



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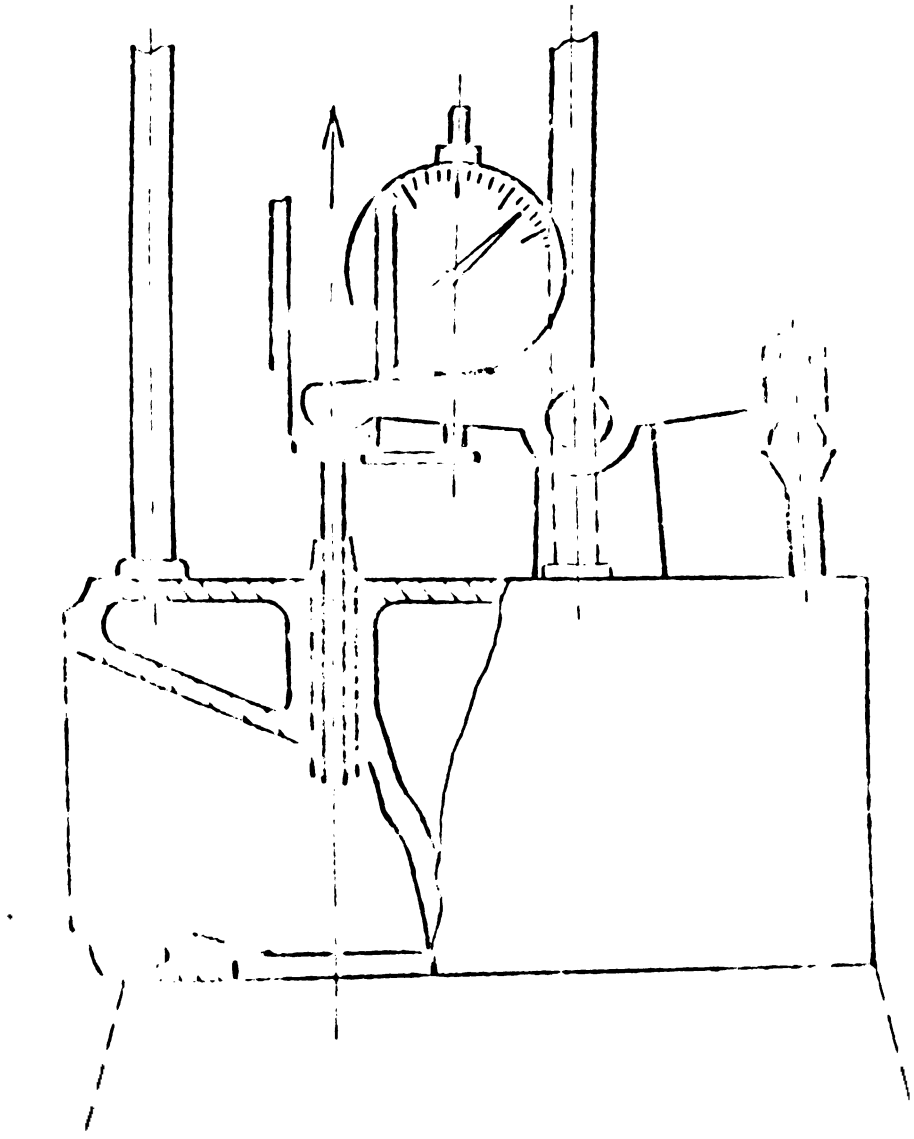

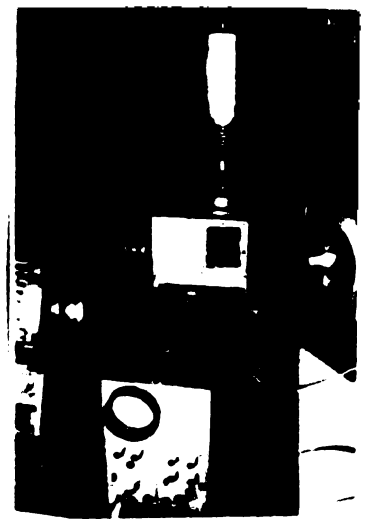

Fig. 5.15

Fig. 5.17

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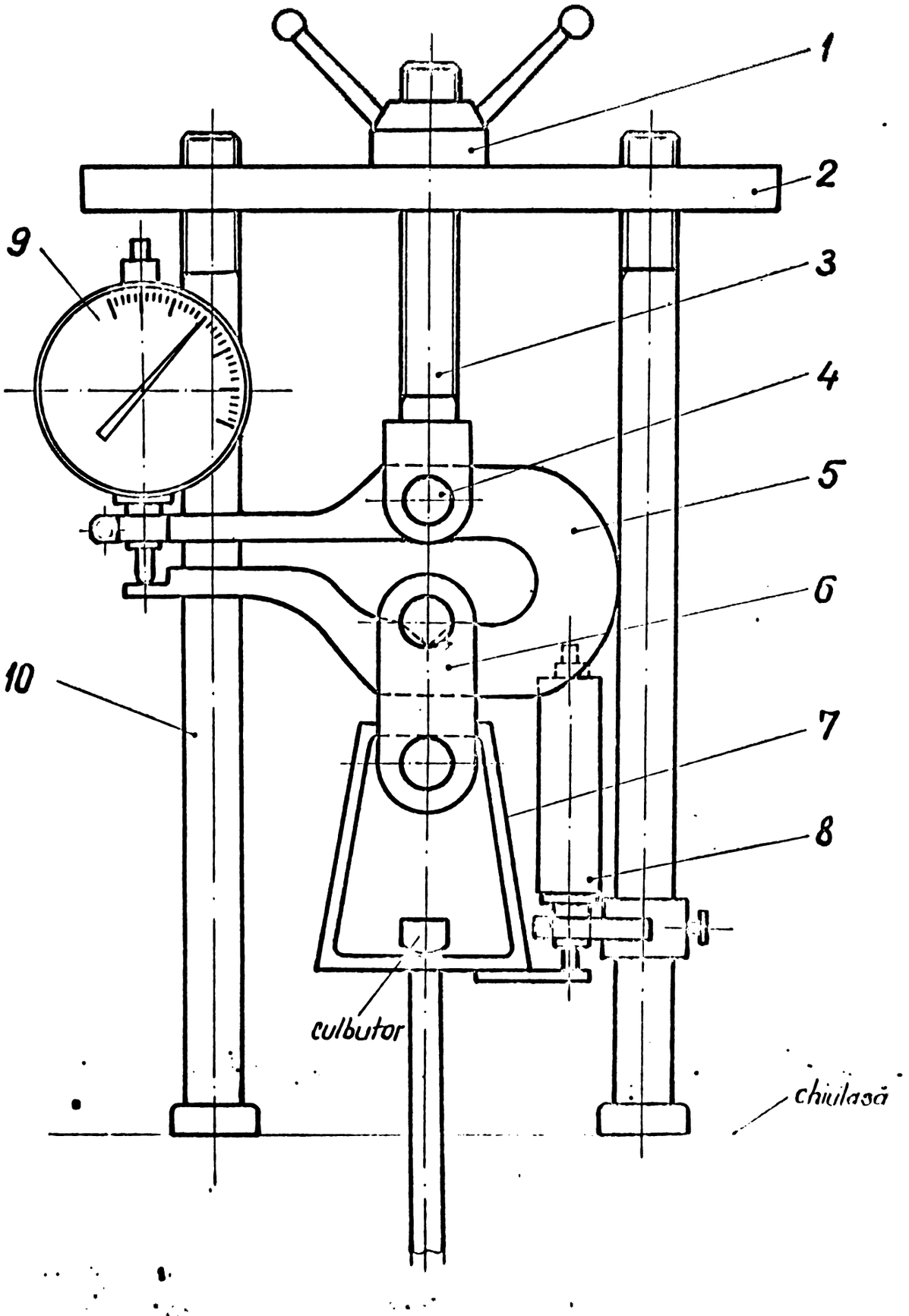

Fig. 5.16

1 - pluliţi de încărcare; 2 - placă suport; 3 - cuplu de transmisie; 4 - bolţuri; 5 - dinamometru poligonal; 6 - celule; 7 - celule cu tija de ghidare; 8 - compensator pentru măsurarea deformaţiei mecanismului; 9 - compensator pentru măsurarea deformaţiei dinamometrului; 10 - montanţi.

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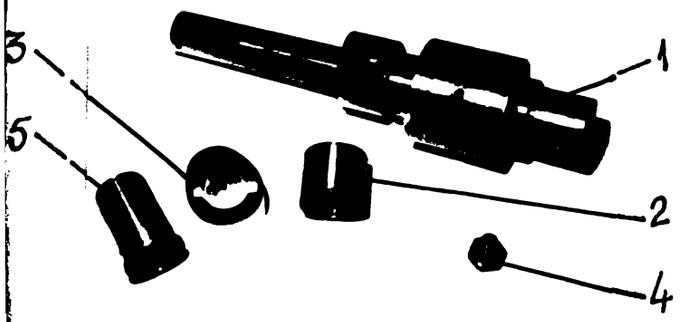


Fig. 5.18 a

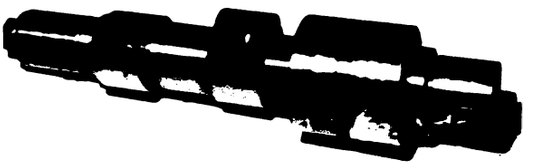
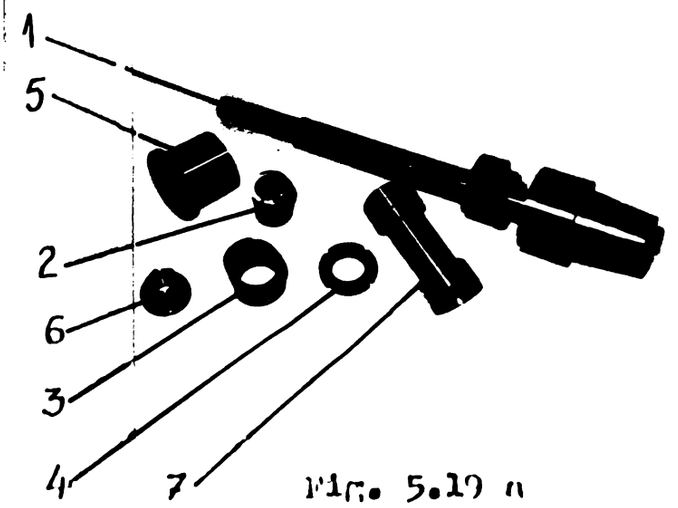


Fig. 5.18 b

1 - arbore; 2 - bucşă distanţieră; 3 - came amovibile;
4 - şurub de fixare axială; 5 - fus de capăt.



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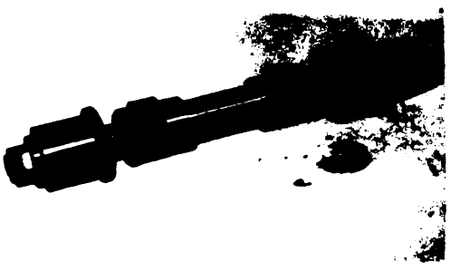

Fig. 5.19 b

1 - arbore; 2 - bucşă olanţată; 3 - came amovibile;
4 - pluliţă de ghidare radială; 5 - fus de capăt;
6 - pluliţă de capăt; 7 - bucşă intermediară.

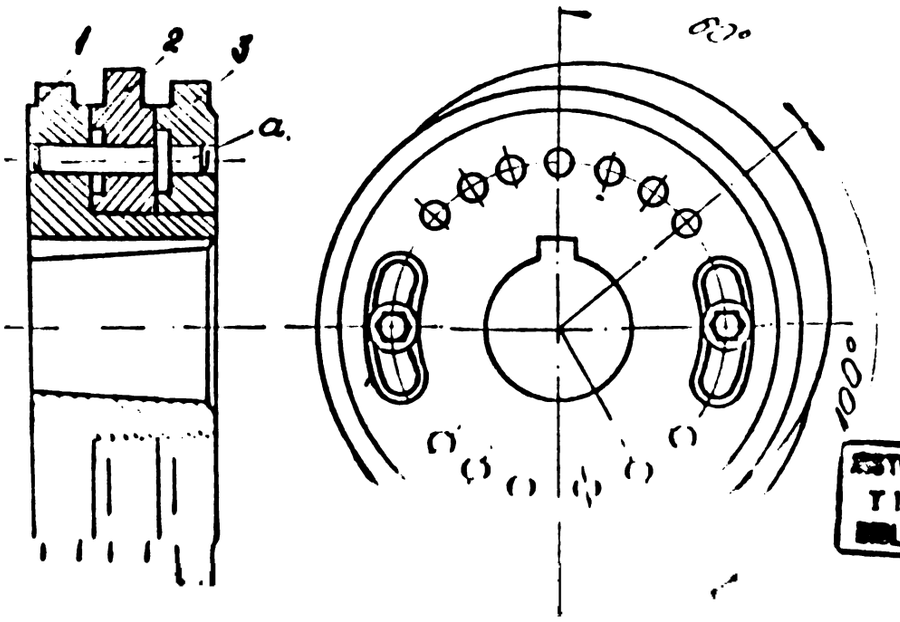

Fig. 5.20

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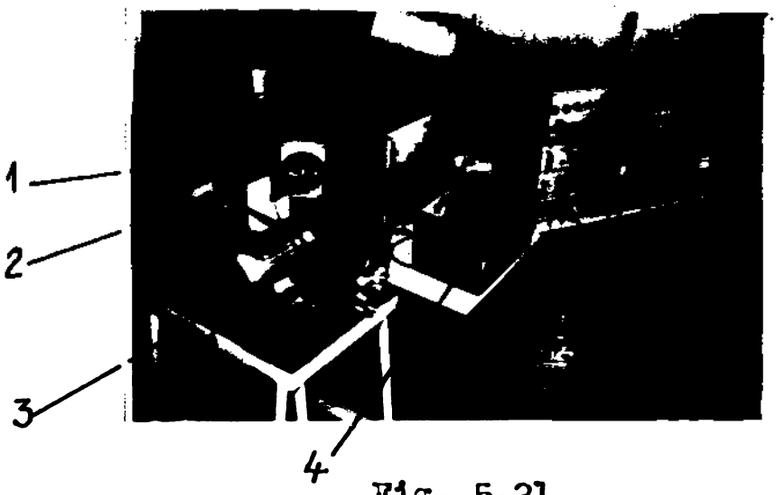

Fig. 5.21

1 - dispozitiv de modelare mecanică; 2 - cutia standului dinamic; 3 - motor electric; 4 - oscilograf cu bucle.

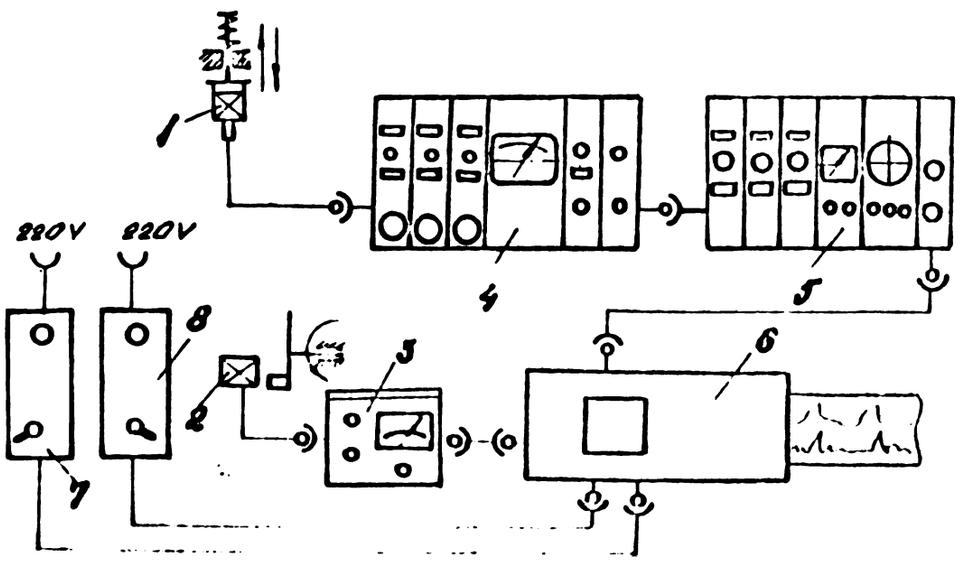

Fig. 5.22

1 - traductor (deplasare, viteză, accelerație); 2 - traductor inductiv fără contact; 3 - punte tensometrică U1 III; 4 - amplificator cu un canal pentru măsurat vibrații, tip 2125; 5 - aparat cu trei canale pentru măsurat vibrații, tip 2511; 6 - oscilograf cu bucle 12 I6-1; 7 - sursă NG 4; 8 - sursă NG 3.

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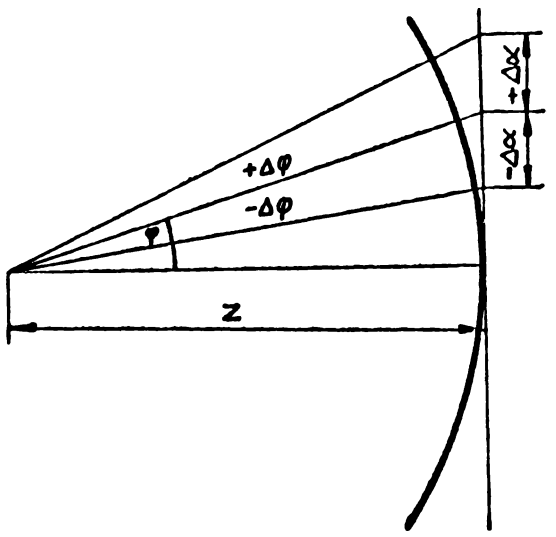

Fig. 5.23

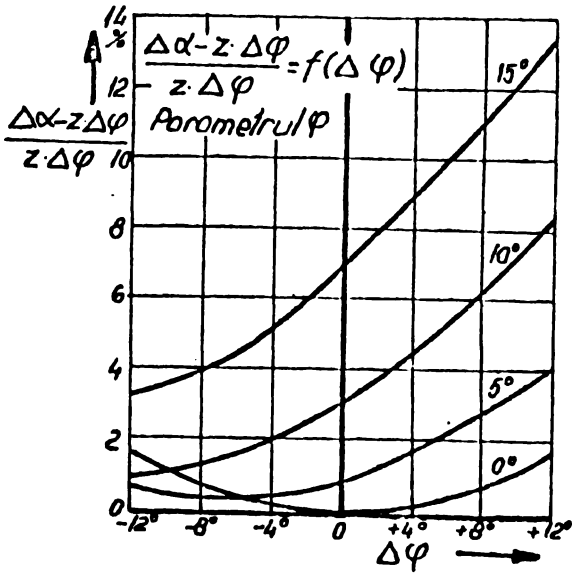

Fig. 5.24

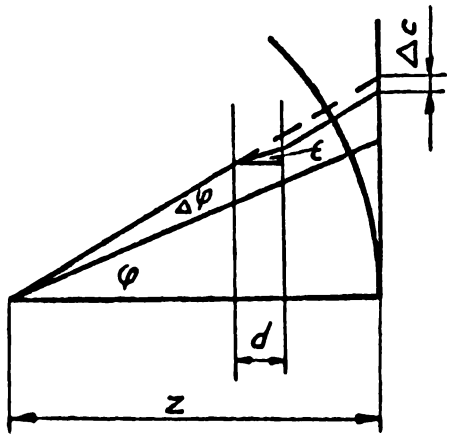

Fig. 5.25

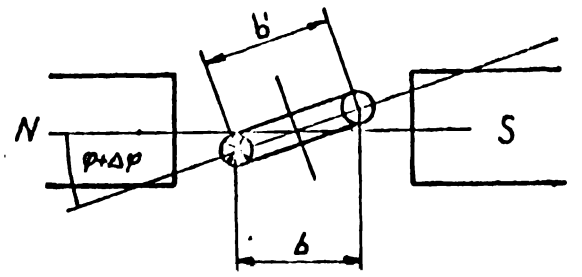

Fig. 5.26

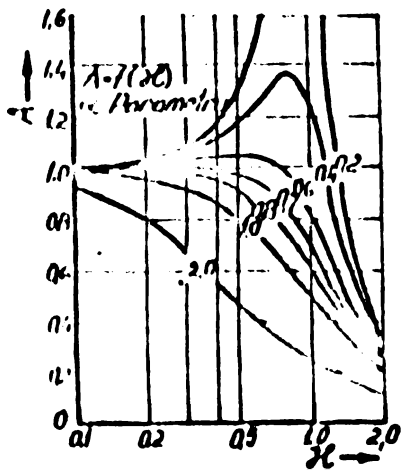

Fig. 5.27

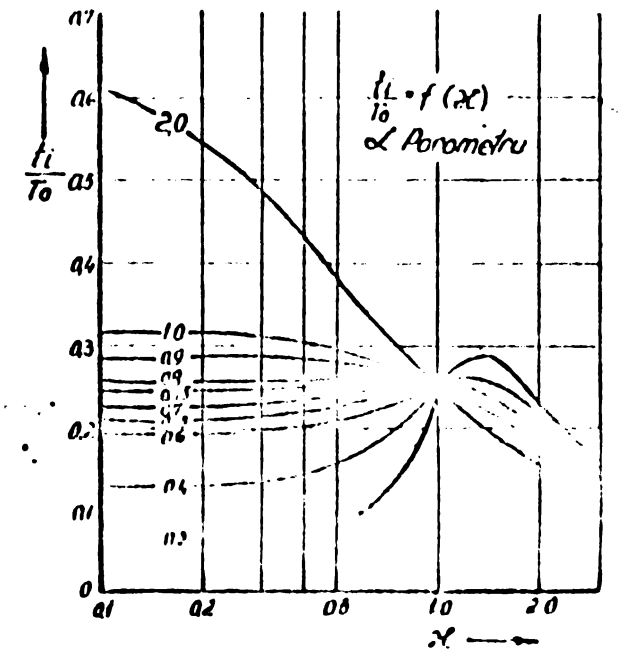

Fig. 5.28

BUPT

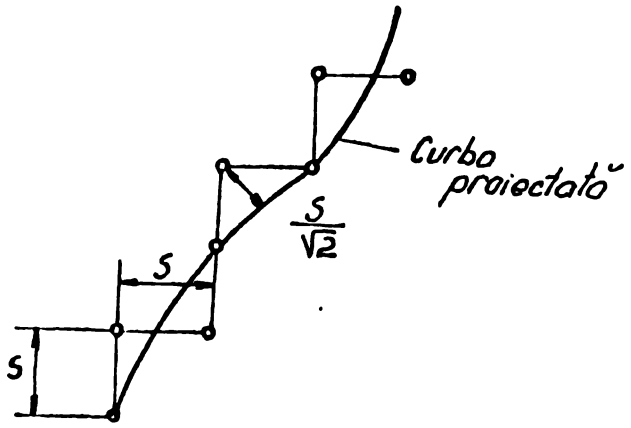

Fig. 5.29

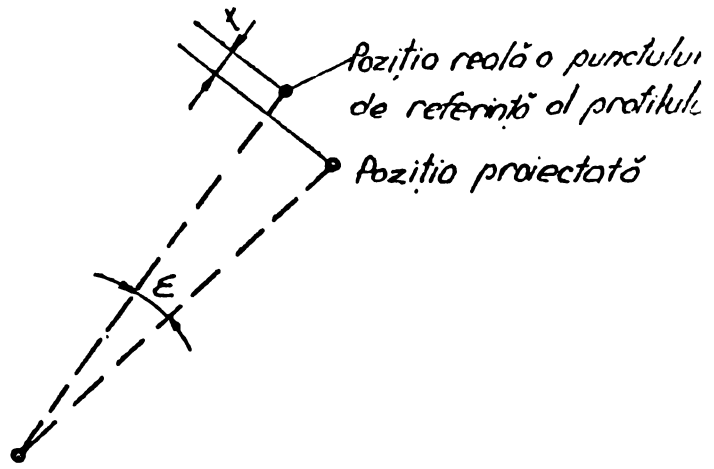

Fig. 5.30

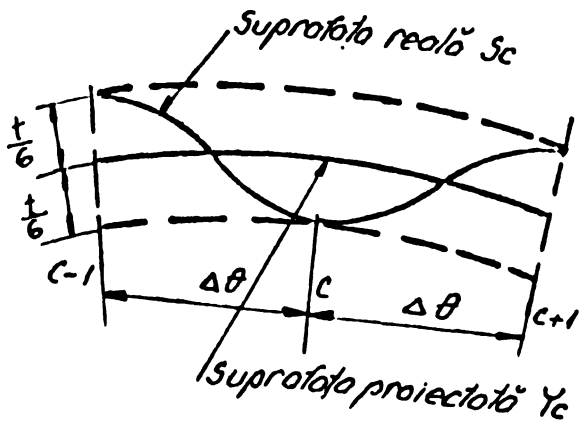

Fig. 5.31

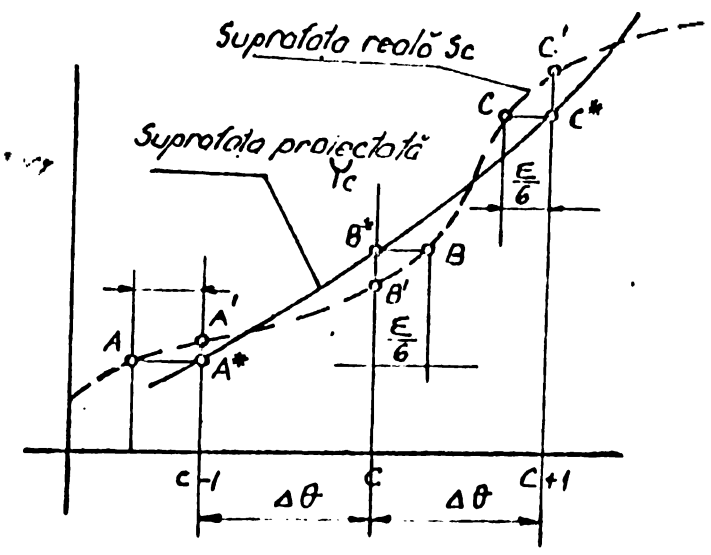

Fig. 5.32

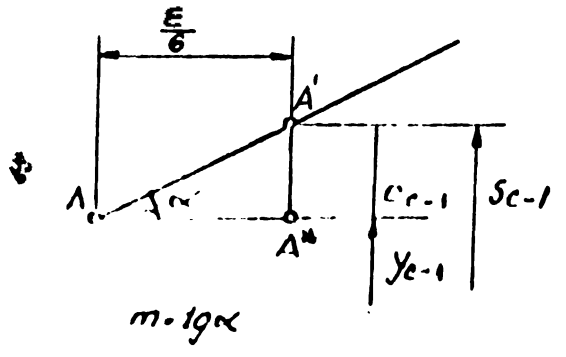

Fig. 5.33

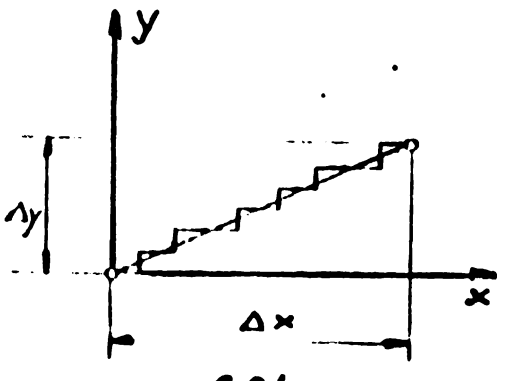

Fig. 5.34

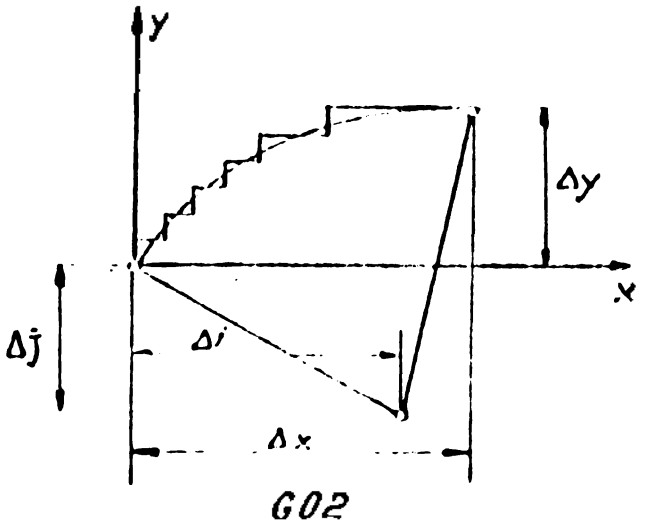

Fig. 5.35

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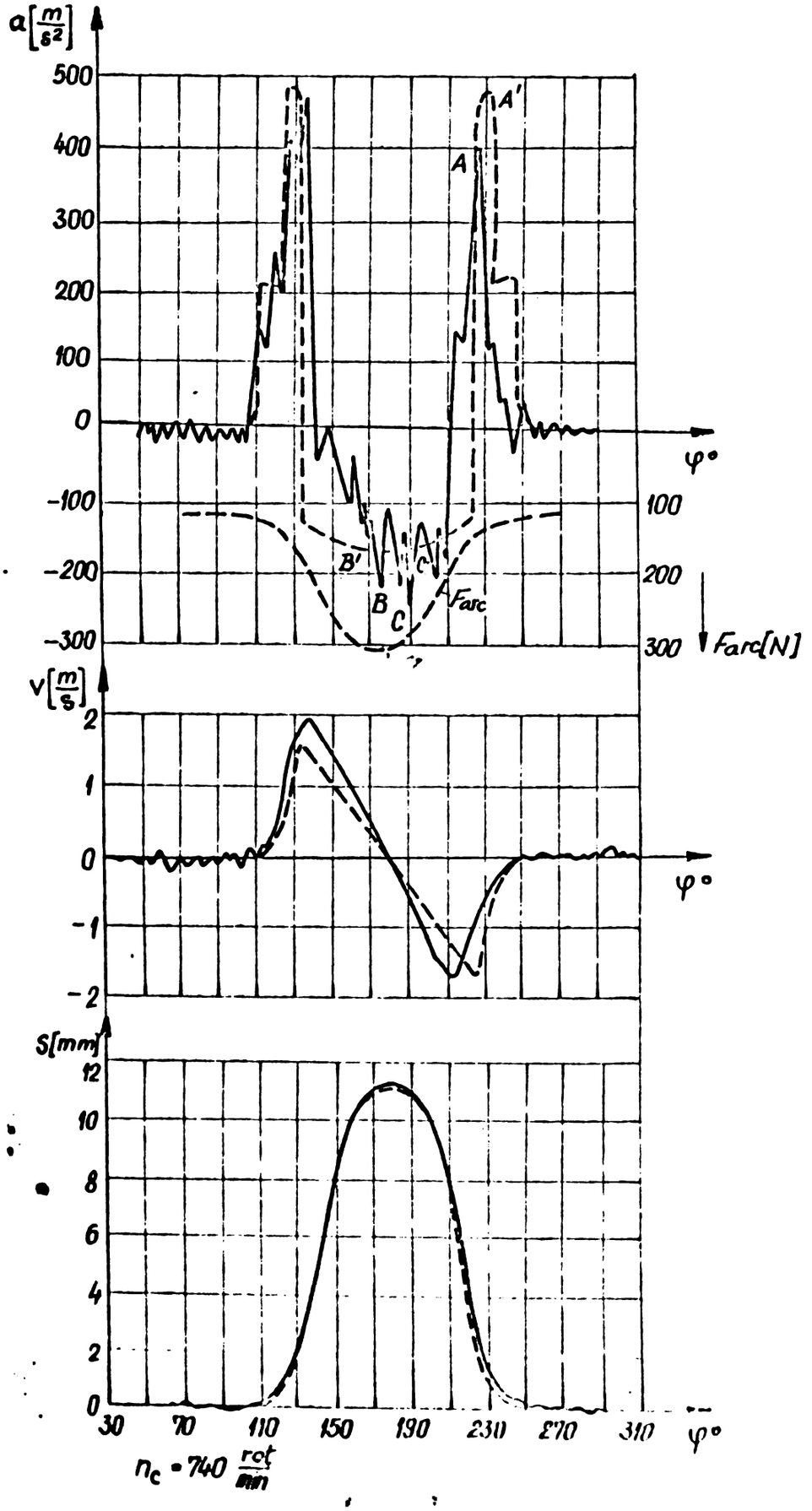
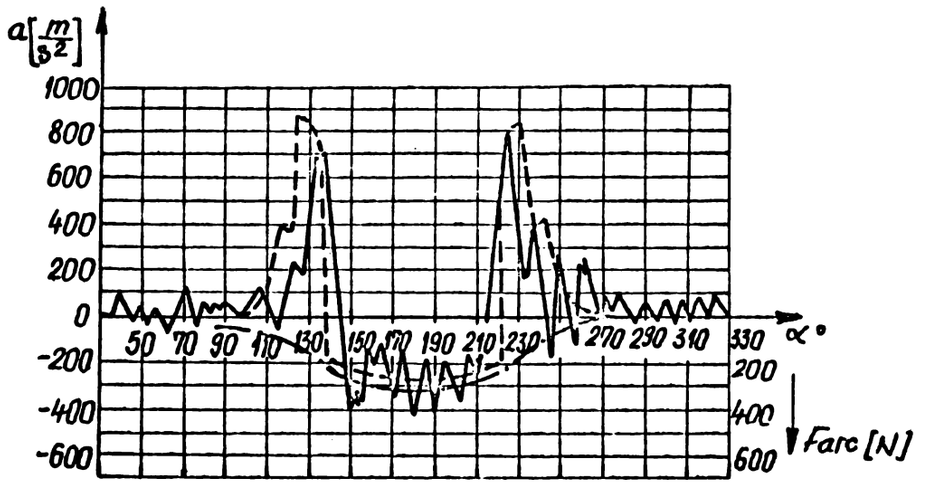

a[m/s²]
500
400
300
200
100
0
-100
-200
-300
A'
A
B'
B
C
C'
F_arc
φ°
100
200
300
F_arc[N]
v[m/s]
2
1
0
-1
-2
φ°
S[mm]
12
10
8
6
4
2
0
30
70
110
150
190
230
270
310
φ°
n_c = 740 rot/min

Fig. 6.1

BUPT


a[m/s²]
1000
800
600
400
200
0
-200
-400
-600
50 70 90 110 130 150 170 190 210 230 270 290 310 330
α°
200
400
600
Farc [N]

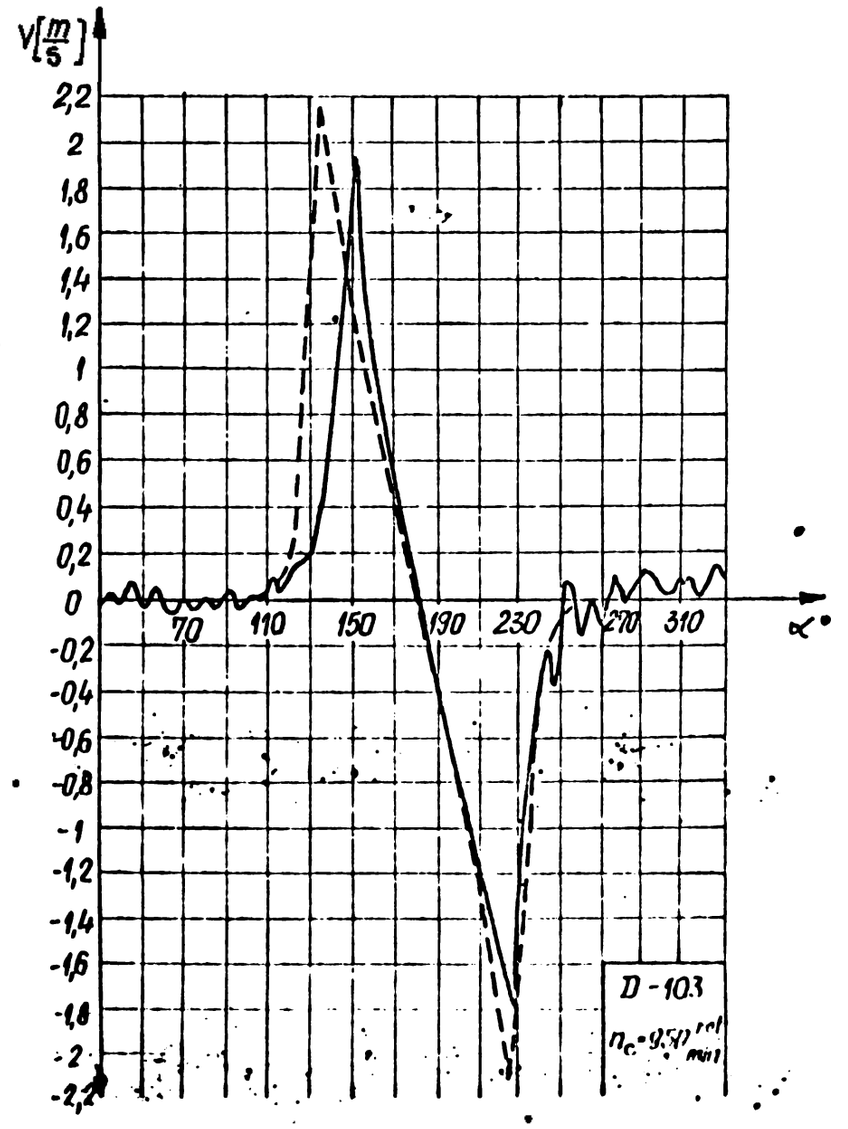
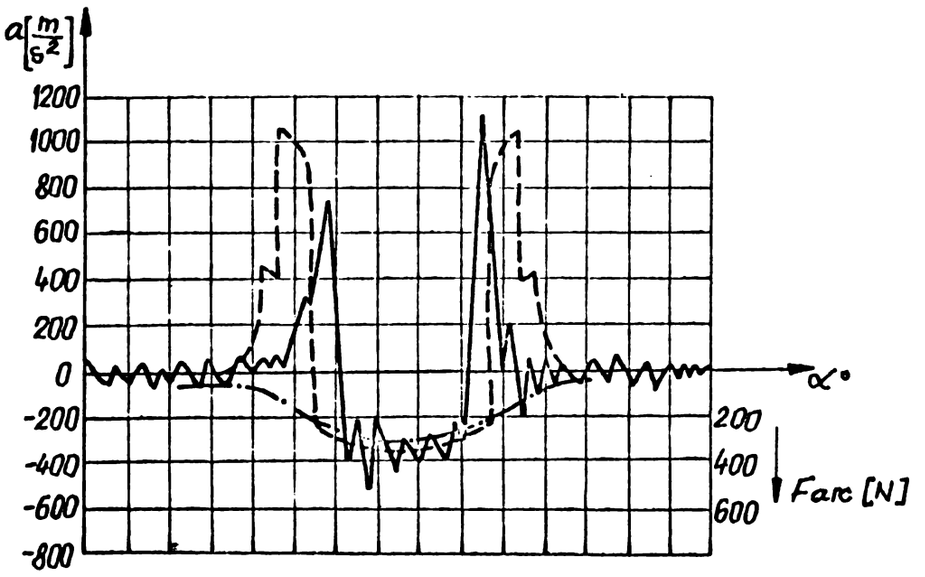

V[m/s]
2,2
2
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
-1
-1,2
-1,4
-1,6
-1,8
-2
-2,2
70 110 150 190 230 270 310
α°
D - 10.3

Fig. 6.2

BUPT



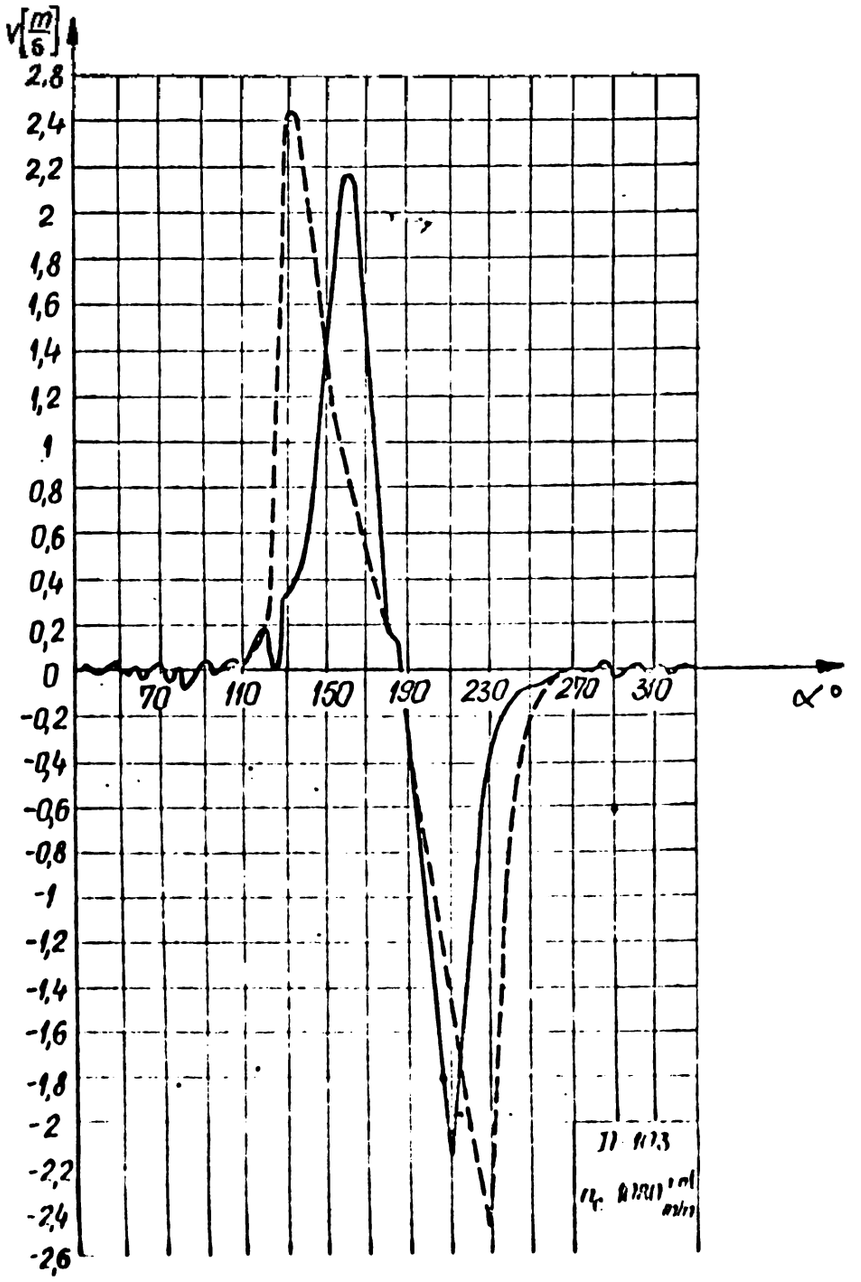


Fig. 6.3

INSTITUTUL POLITEHNIC TIMIŞOARA BIBLIOTECA CENTRALĂ

BUPT

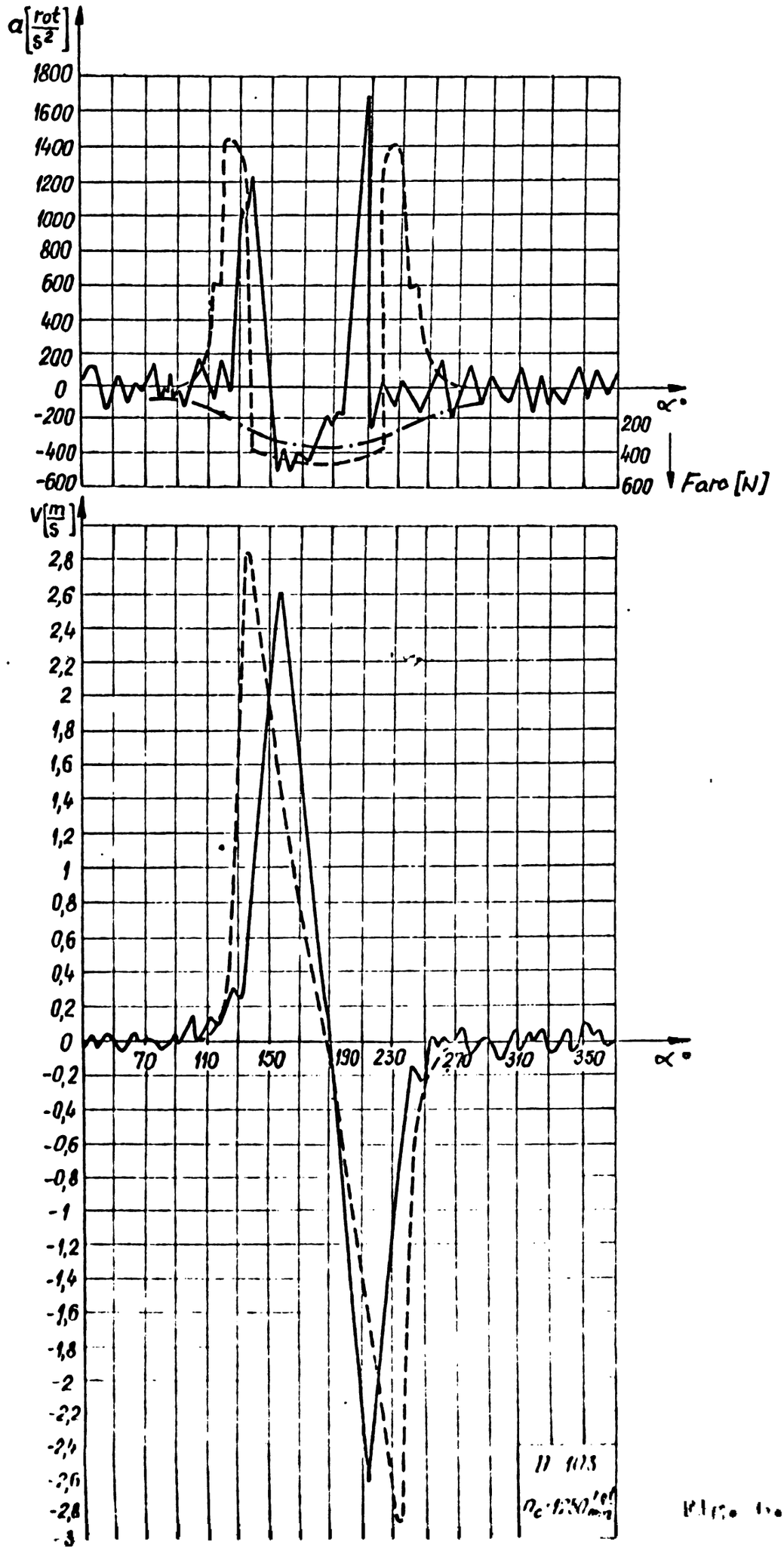

a [rot/s²]
1800
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
α°
200
400
600
Faro [N]
v [m/s]
2,8
2,6
2,4
2,2
2
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
-1
-1,2
-1,4
-1,6
-1,8
-2
-2,2
-2,4
-2,6
-2,8
-3
70
110
150
190
230
270
310
350
α°

Fig. 1.4

BUPT

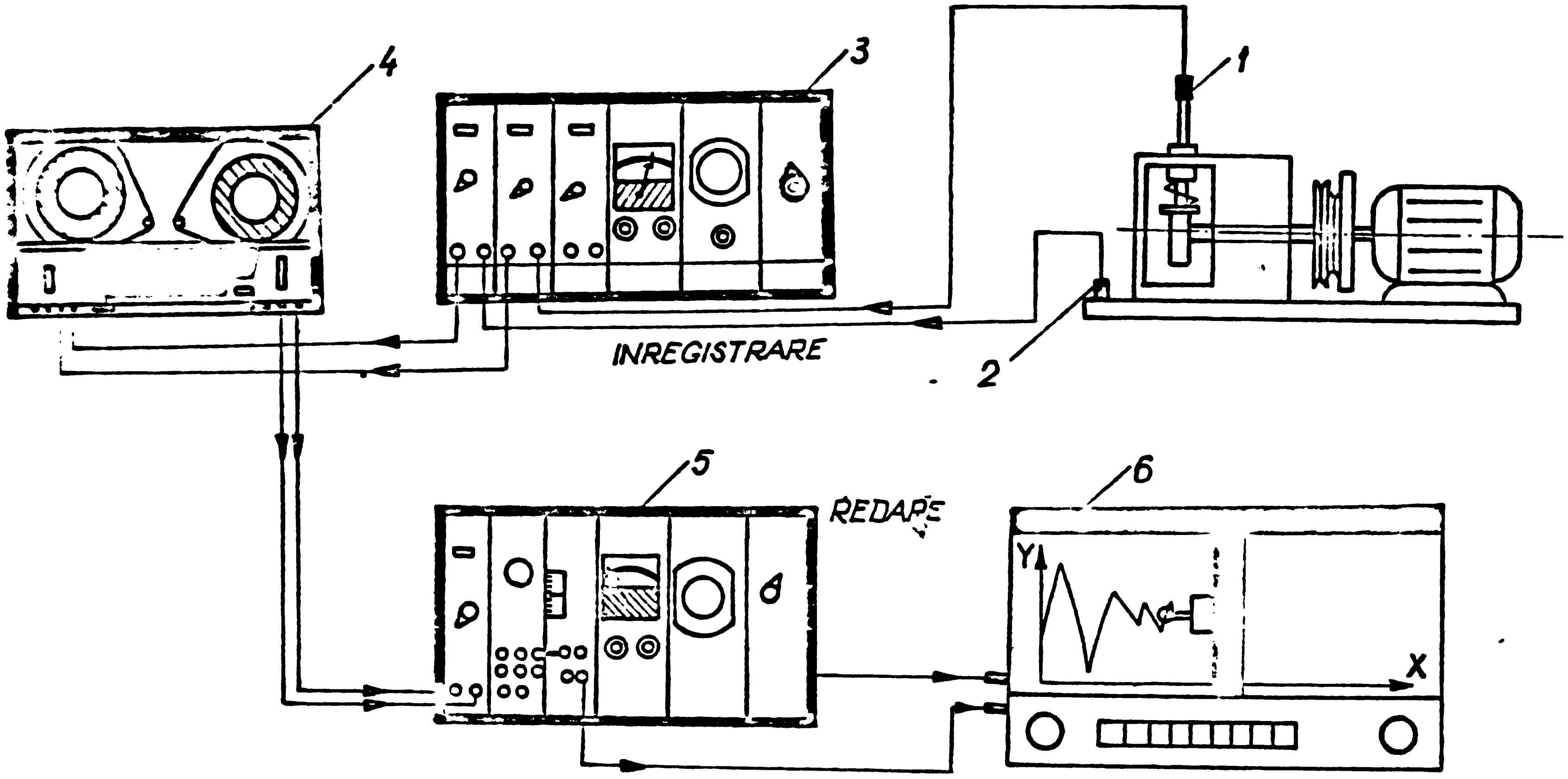


Fig. 6.5

1,2 - traductori piezoelectrici de accelerație; 3 - aparat de măsurat vibrații SM-231;4 - înregistrator magnetic 7003; 5 - aparat de măsurat vibrații cu filtru comutabil; 6 - înregistrator în coordonate.

n·830 rot/min		Scara inregistrării	Scara redării
Etalon		10	932,1 mv/mm
Înregistrare	1	320	0,032,2 mv/mm
	2	32	0,032,2 mv/mm
	3	320	0,032,2 mv/mm
	4	10	0,032,2 mv/mm

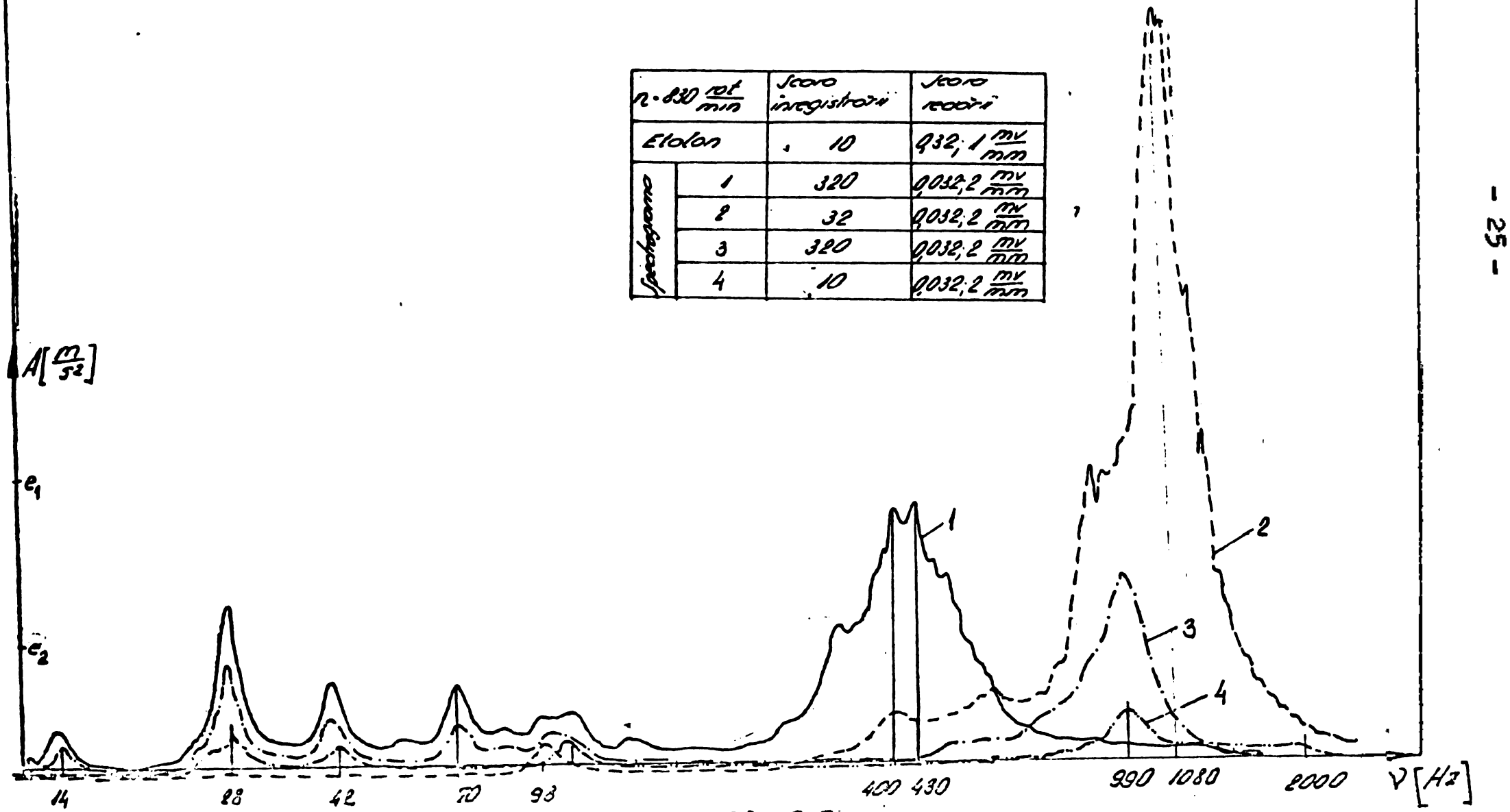


Fig.6.6

BUPT

$n = 950 \frac{obr}{min}$		Skala integratoru	Skala rejestr.
Etalon		10	$0{,}32;\ 1 \frac{mV}{mm}$
Zwierciadła	1	320	$0{,}032;2 \frac{mV}{mm}$
	2	32	$0{,}032;2 \frac{mV}{mm}$
	3	320	$0{,}032;2 \frac{mV}{mm}$
	4	32	$0{,}032;2 \frac{mV}{mm}$

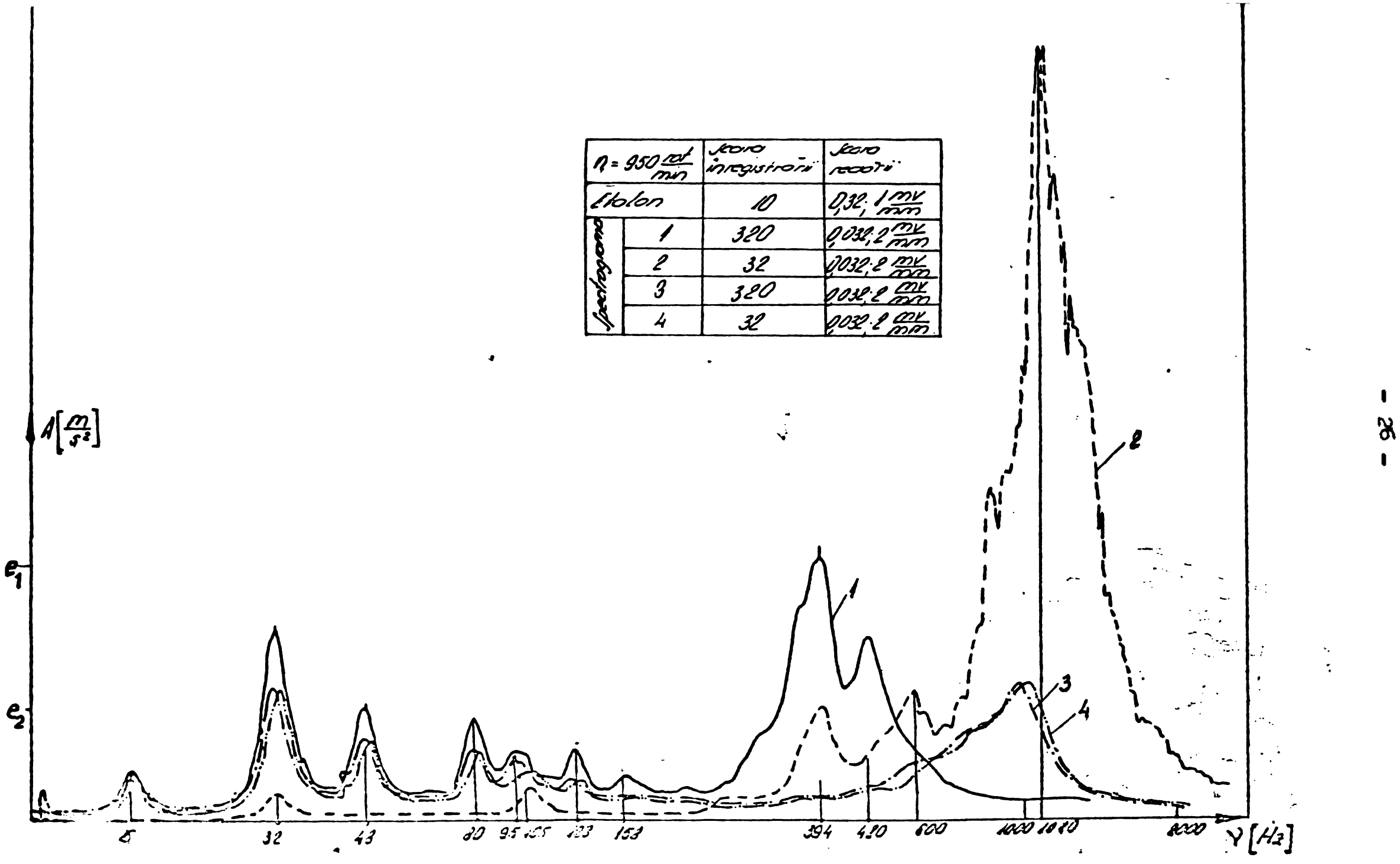


Fig.6.7

BUPT

$n \cdot 1080 \frac{rot}{min}$		Ilość impulsów	Ilość rodzaju
Etalon		10	$0{,}32; 1 \frac{cm}{mm}$
Przebieg	1	320	$0{,}032; 2 \frac{cm}{mm}$
	2	32	$0{,}032; 2 \frac{cm}{mm}$
	3	100	$0{,}032; 2 \frac{cm}{mm}$
	4	10	$0{,}032; 2 \frac{cm}{mm}$

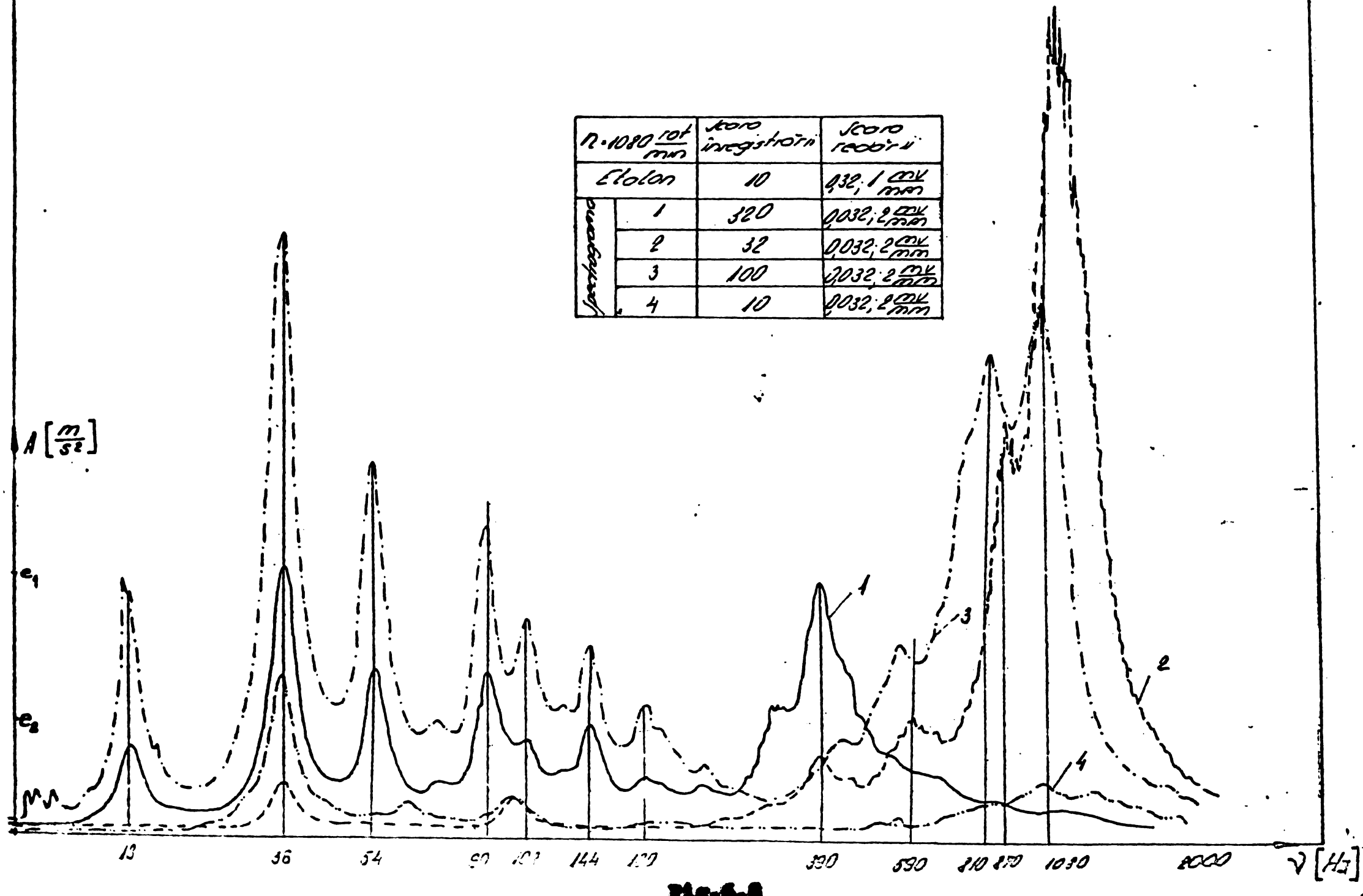


Fig.6.8

BUPT

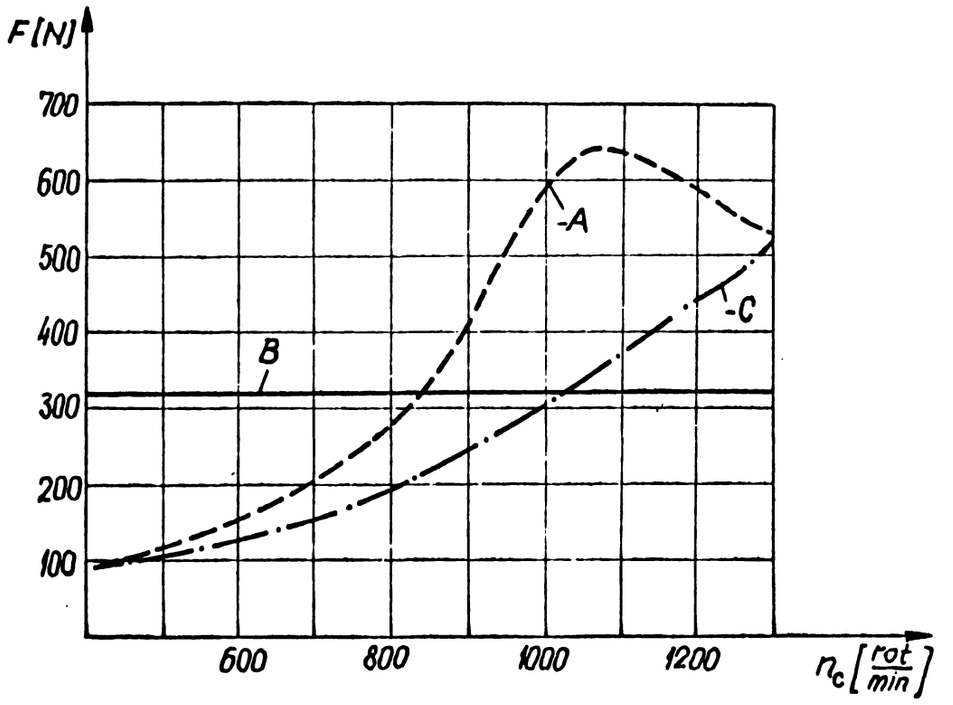


Fig. 6.9

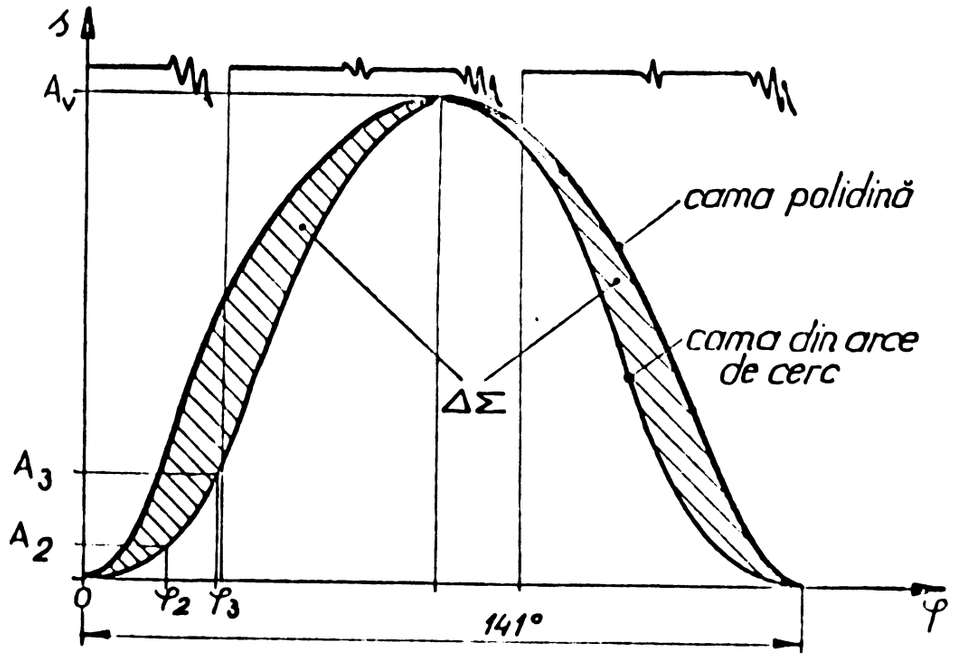


Fig. 6.11

BUPT

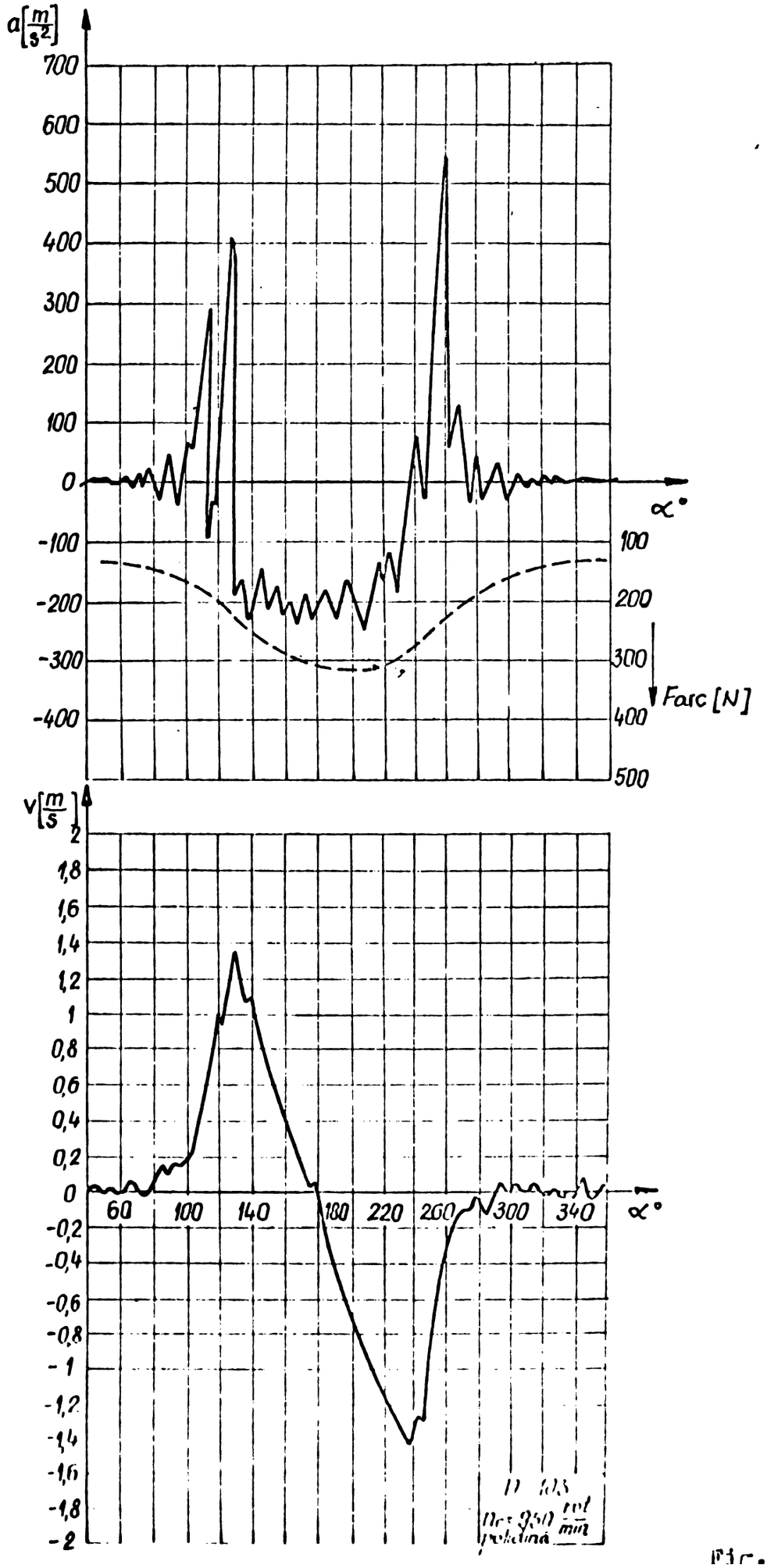
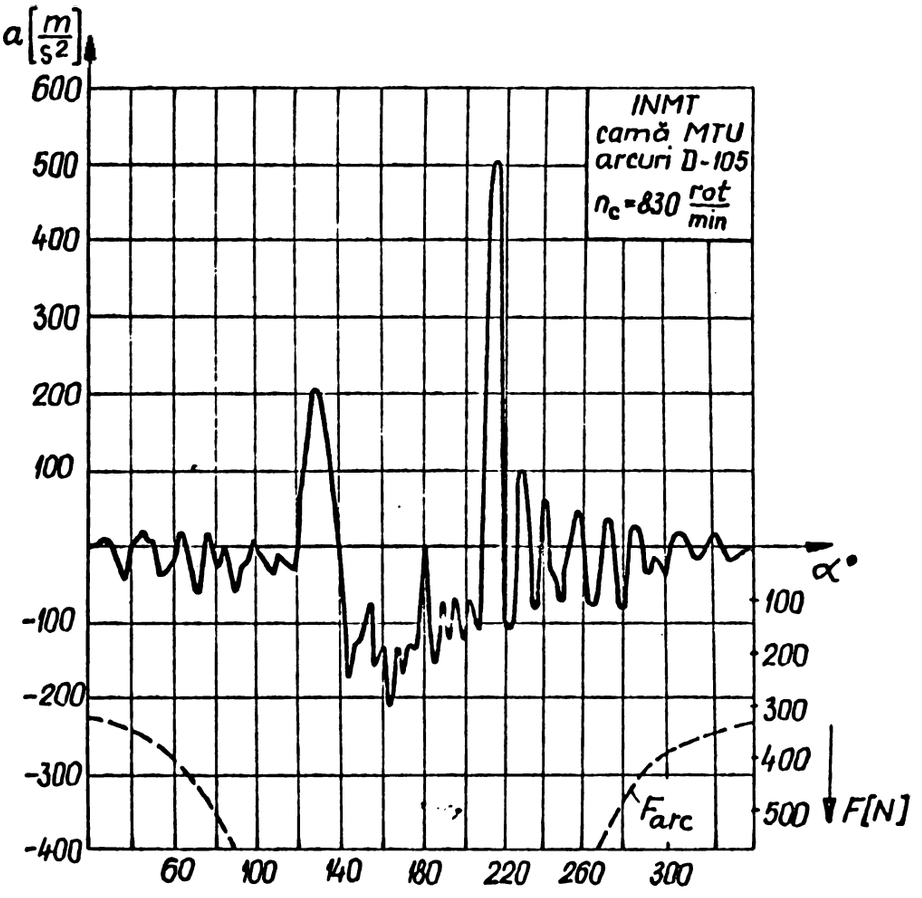
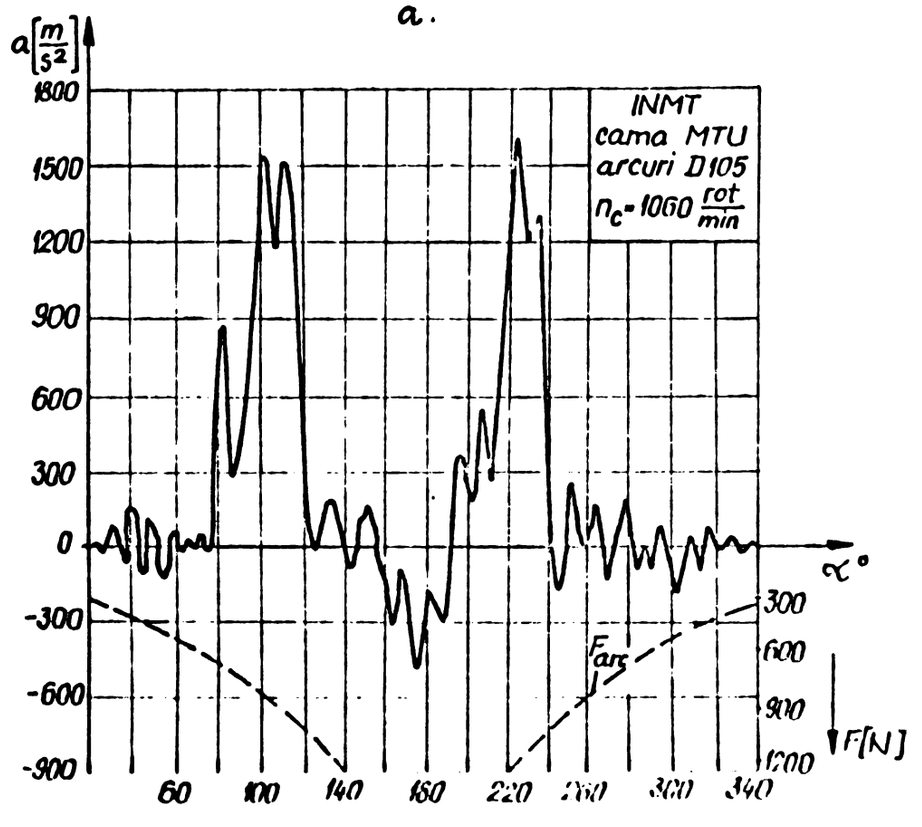

a [m/s²]
700
600
500
400
300
200
100
0
-100
-200
-300
-400
α°
100
200
300
400
500
Farc [N]
v [m/s]
2
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
-1
-1,2
-1,4
-1,6
-1,8
-2
60
100
140
180
220
260
300
340
α°

Fig. 6.10


a [m/s²]
600
500
400
300
200
100
-100
-200
-300
-400
60
100
140
180
220
260
300
α°
INMT
camă MTU
arcuri D-105
n_c=830 rot/min
F_arc
100
200
300
400
500
F[N]

a.


a [m/s²]
1800
1500
1200
900
600
300
0
-300
-600
-900
60
100
140
180
220
260
300
340
α°
INMT
cama MTU
arcuri D105
n_c=1060 rot/min
F_arc
300
600
900
1200
F[N]

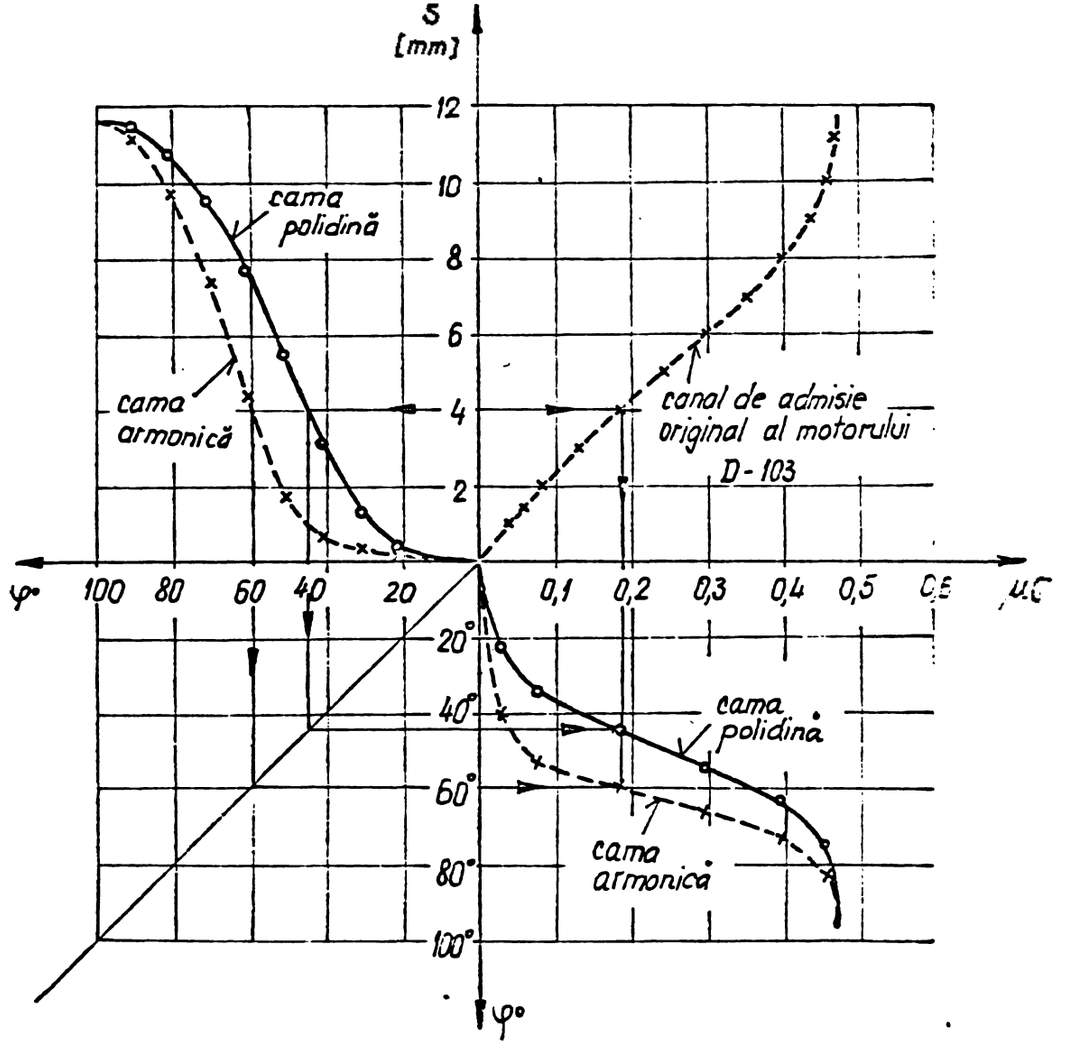
b.

Fig. 6.12

Tabelul 6.5 a

Poz.	S [mm]	μG [-]
1	1	0,04
2	2	0,075
3	3	0,13
4	4	0,19
5	5	0,25
6	6	0,30
7	7	0,35
8	8	0,40
9	9	0,44
10	10	0,46
11	11	0,47
12	11,6	0,475

Canal de admisie original al motorului D-103



BIBLIOTECA CENTRALĂ
BUPT

Tabel 6.6b

nr.	S [mm]	$\mu\sigma$ [-]
1	1	0,07
2	2	0,135
3	3	0,210
4	4	0,30
5	5	0,37
6	6	0,41
7	7	0,44
8	8	0,47
9	9	0,485
10	10	0,495
11	11	0,51
12	11,5	0,515

model de canal de admisie îmbunătățit pentru D-103

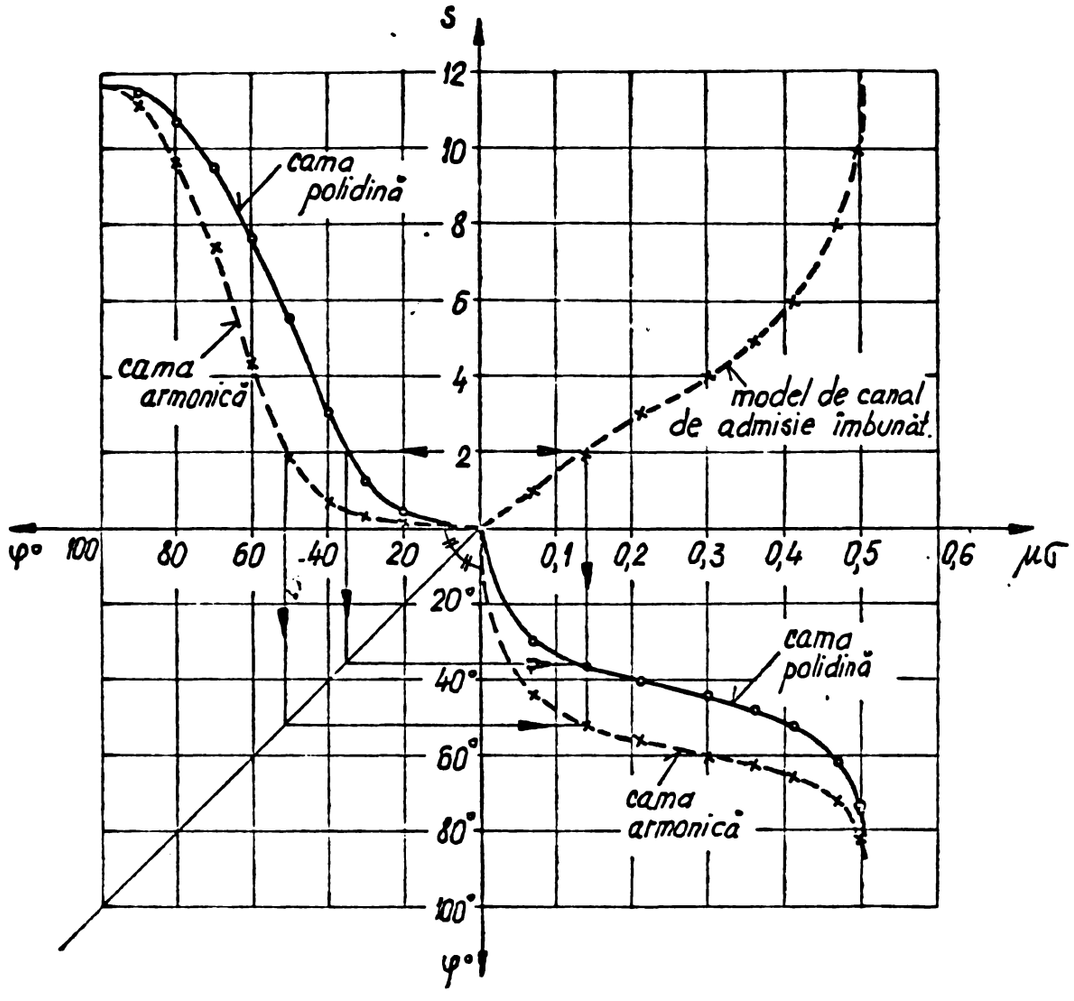


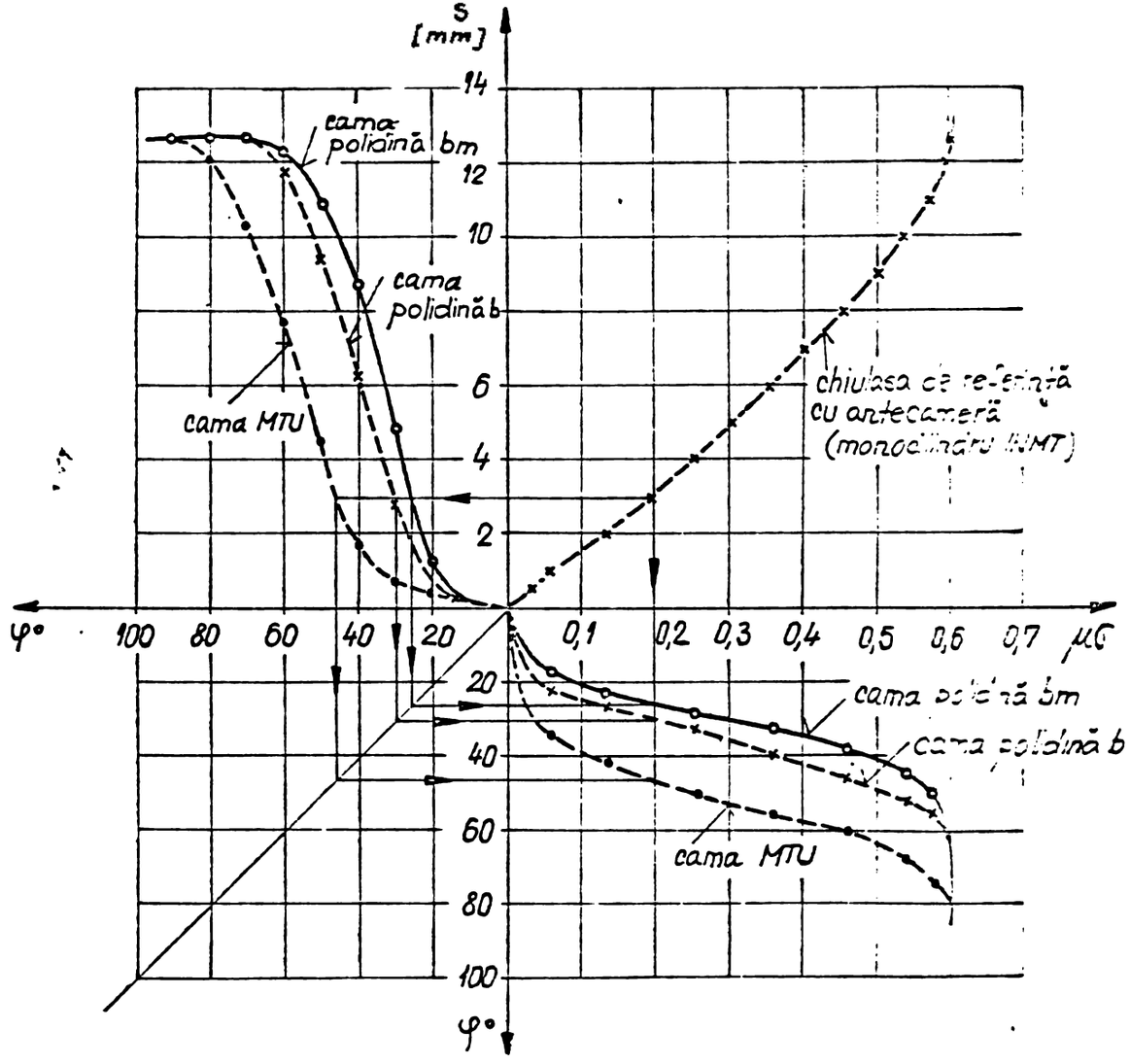
Fig. 6.13b

BUPT

Tabelul 6.8 a

Poz.	S [mm]	μG [-]
1	1	0,058
2	2	0,135
3	3	0,196
4	4	0,251
5	5	0,304
6	6	0,359
7	7	0,408
8	8	0,457
9	9	0,503
10	10	0,539
11	11	0,573
12	12	0,596
13	12,5	0,603

chiulasă de referință cu antecameră – motor INMT-165/155



BUPT

Tabelul 6.8 b

Poz.	S [mm]	$\mu\sigma$ [-]
1	1	0,055
2	2	0,092
3	3	0,119
4	4	0,161
5	5	0,210
6	6	0,260
7	7	0,310
8	8	0,357
9	9	0,403
10	10	0,440
11	11	0,475
12	12	0,497
13	12,5	0,506

chiulasa de referință cu injecție directă - motor INMT-155/155

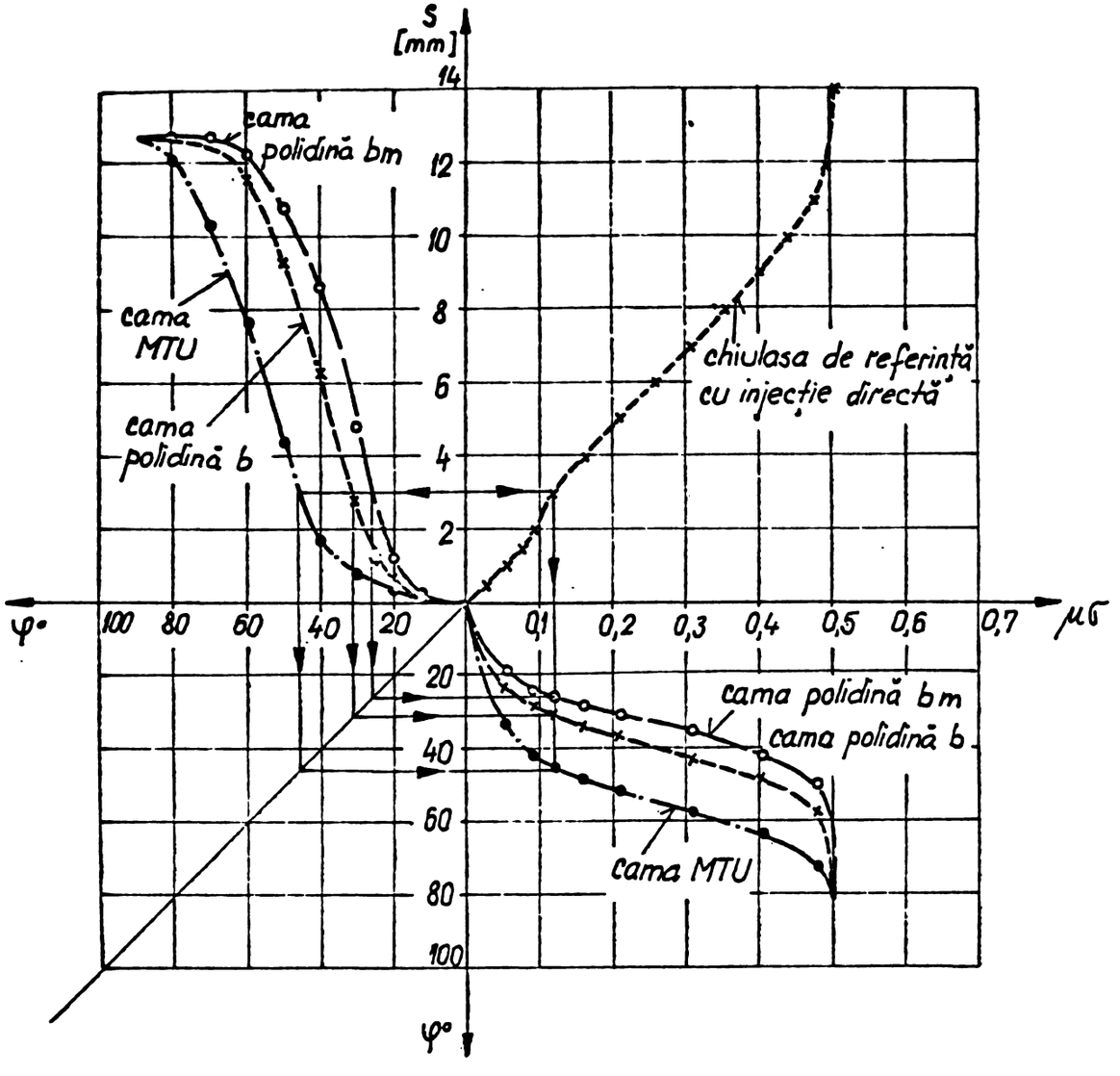


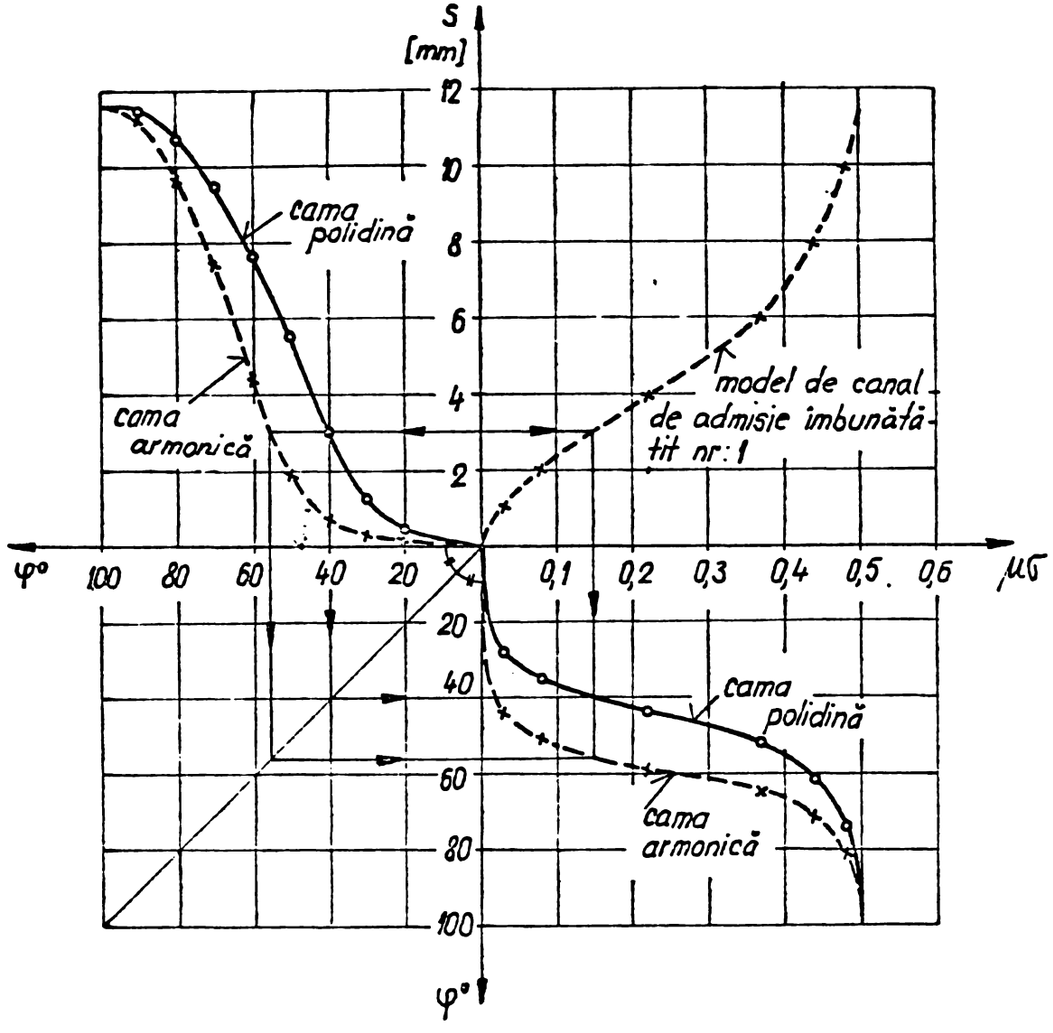
Fig.6.14 b

BUPT

Tabelul 6.6.c

Poz	S [mm]	$\mu\sigma$ [-]
1	1	0,03
2	2	0,08
3	3	0,15
4	4	0,23
5	5	0,31
6	6	0,37
7	7	0,41
8	8	0,44
9	9	0,465
10	10	0,48
11	11	0,495
12	11,5	0,5

Model de canal de admisie îmbunătățit nr.1 pentru D-103



BUPT

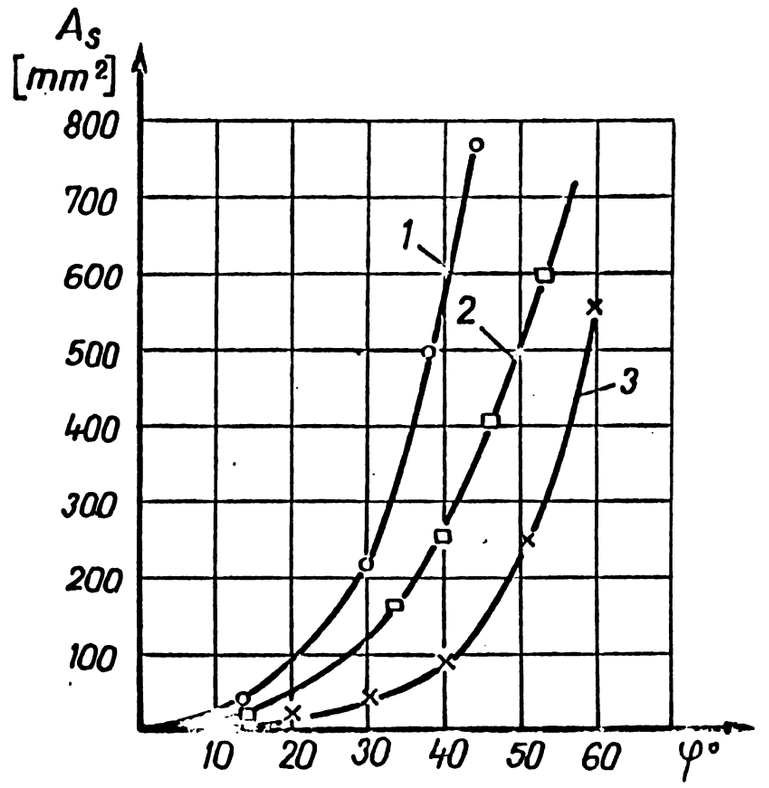


Fig. 6.15

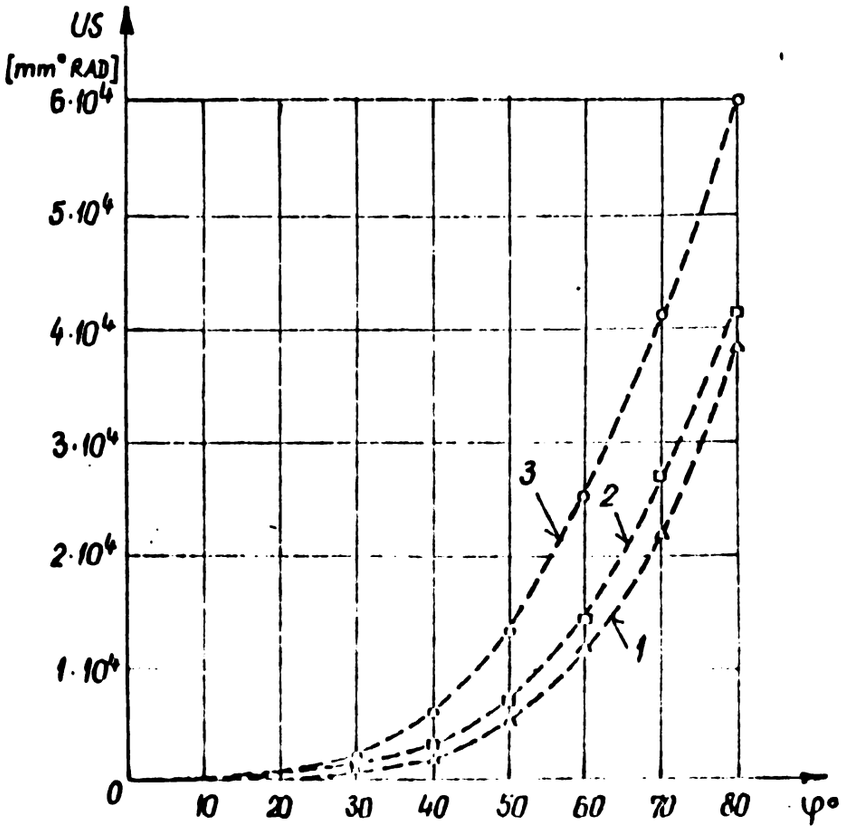
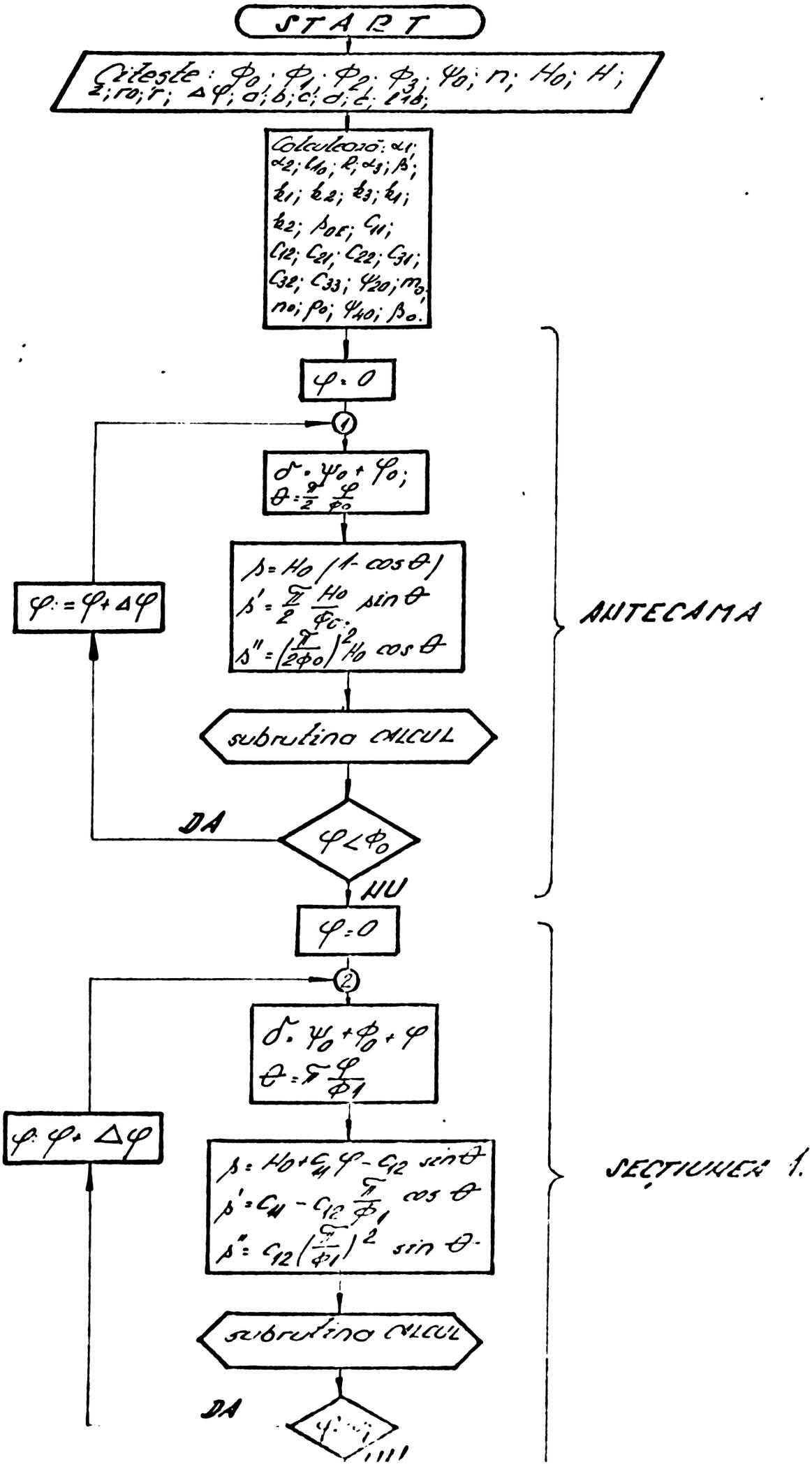


Fig. 6.16

BUPT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Citeste: Φ_0; Φ_1; Φ_2; Φ_3; Ψ_0; n; H_0; H; z; r_0; r; $\Delta\varphi$; a; b; c; d; L; l_{1b};
Calculeaza: α_1; α_2; l_{1a}; R; α_3; β'; k_1; k_2; k_3; k_4; k_2; p_{0E}; c_{11}; c_{12}; c_{21}; c_{22}; c_{31}; c_{32}; c_{33}; ψ_{20}; m_0; n_0; p_0; ψ_{40}; β_0.
$\varphi = 0$
1
$\sigma = \psi_0 + \varphi_0$;
$\theta = \frac{\pi}{2}\frac{\varphi}{\Phi_0}$
$s = H_0 / 1 - \cos\theta /$
$s' = \frac{\pi}{2}\frac{H_0}{\Phi_0}\sin\theta$
$s'' = \left(\frac{\pi}{2\Phi_0}\right)^2 H_0 \cos\theta$
subrutina CALCUL
$\varphi < \Phi_0$
DA
$\varphi := \varphi + \Delta\varphi$
NU
ANTECAMA
$\varphi = 0$
2
$\sigma = \psi_0 + \Phi_0 + \varphi$
$\theta = \pi\frac{\varphi}{\Phi_1}$
$s = H_0 + c_{11}\varphi - c_{12}\sin\theta$
$s' = c_{11} - c_{12}\frac{\pi}{\Phi_1}\cos\theta$
$s'' = c_{12}\left(\frac{\pi}{\Phi_1}\right)^2 \sin\theta$
subrutina CALCUL
$\varphi = \Phi_1$
DA
$\varphi := \varphi + \Delta\varphi$
SECTIUNEA 1.

BUPT

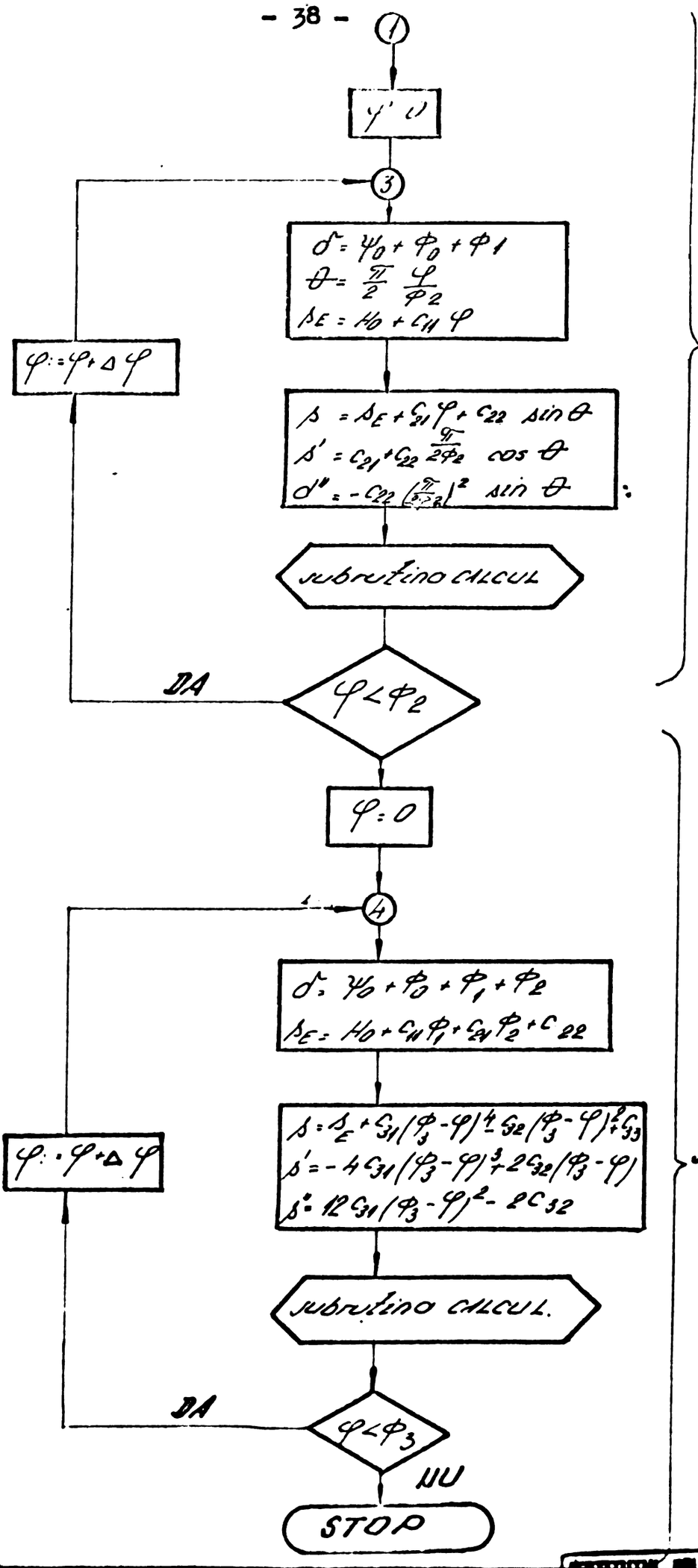

Fig. 6.17

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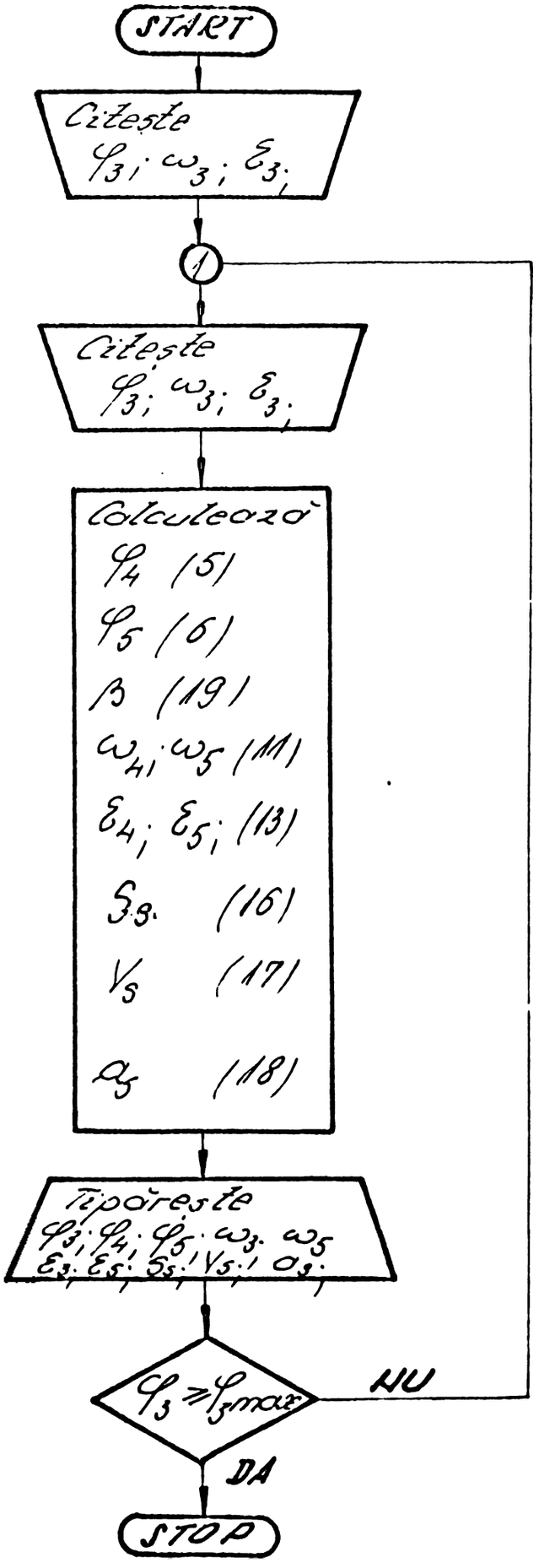
BUPT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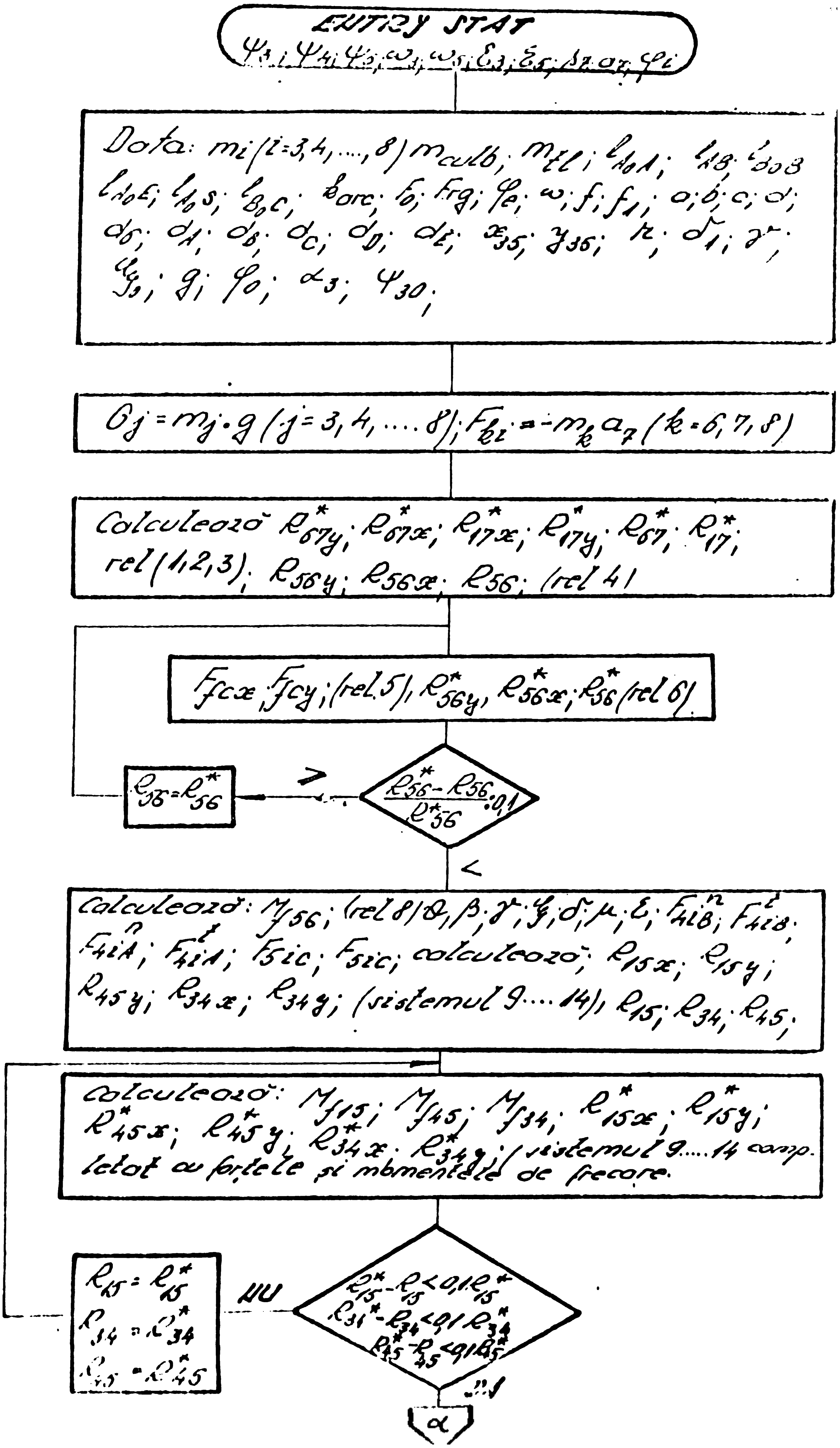
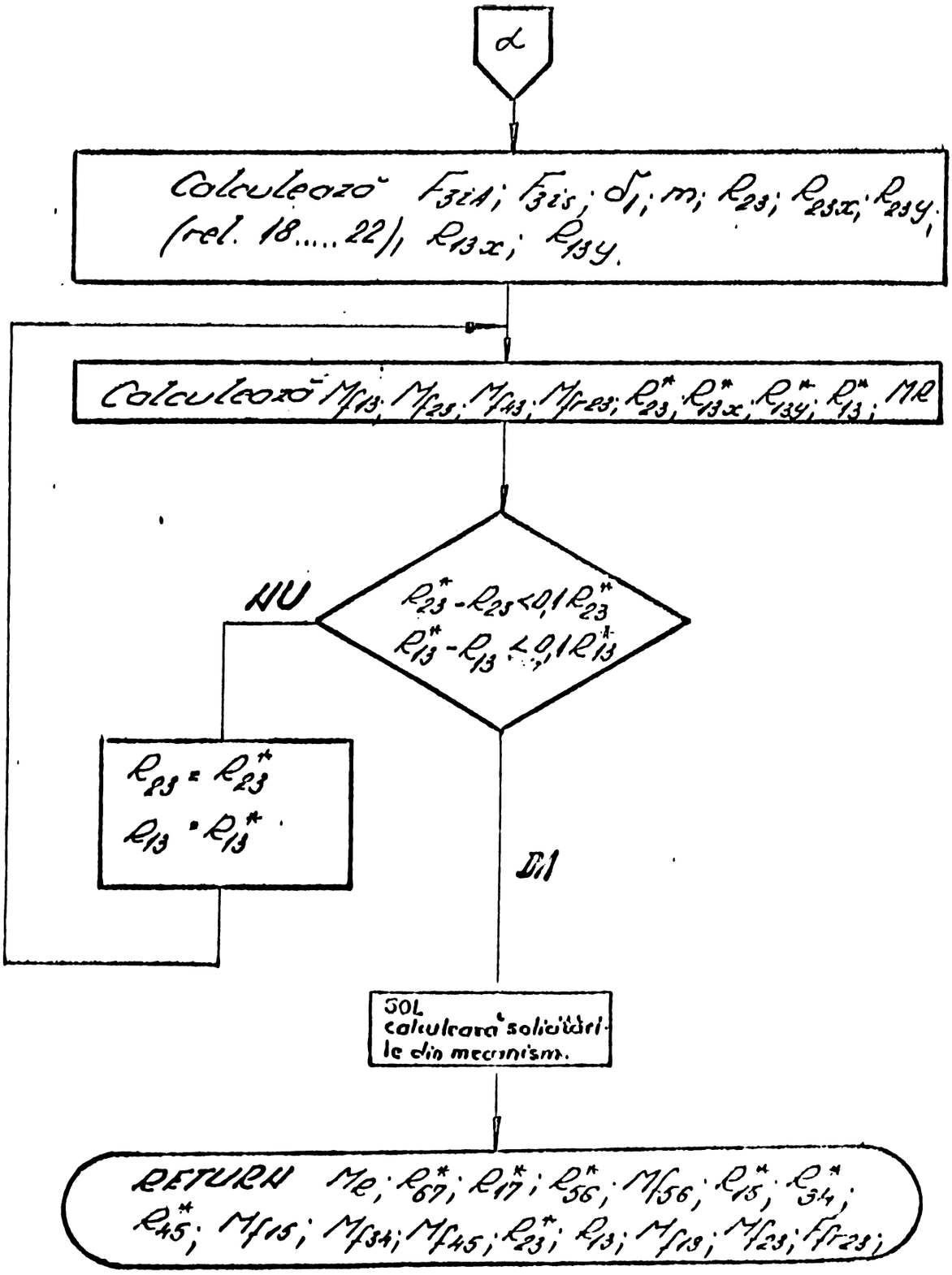
Citeste
φ_3; ω_3; ε_3;
1
Citeste
φ_3; ω_3; ε_3;
Calculează
φ_4 (5)
φ_5 (6)
β (19)
ω_4; ω_5 (11)
ε_4; ε_5; (13)
S_3 (16)
V_5 (17)
σ_3 (18)
Tipăreste
φ_3; φ_4; φ_5; ω_3; ω_5
ε_3; ε_5; S_3; V_5; σ_3;
$\varphi_3 = \varphi_{3max}$
NU
DA
STOP

Fig. 6.18

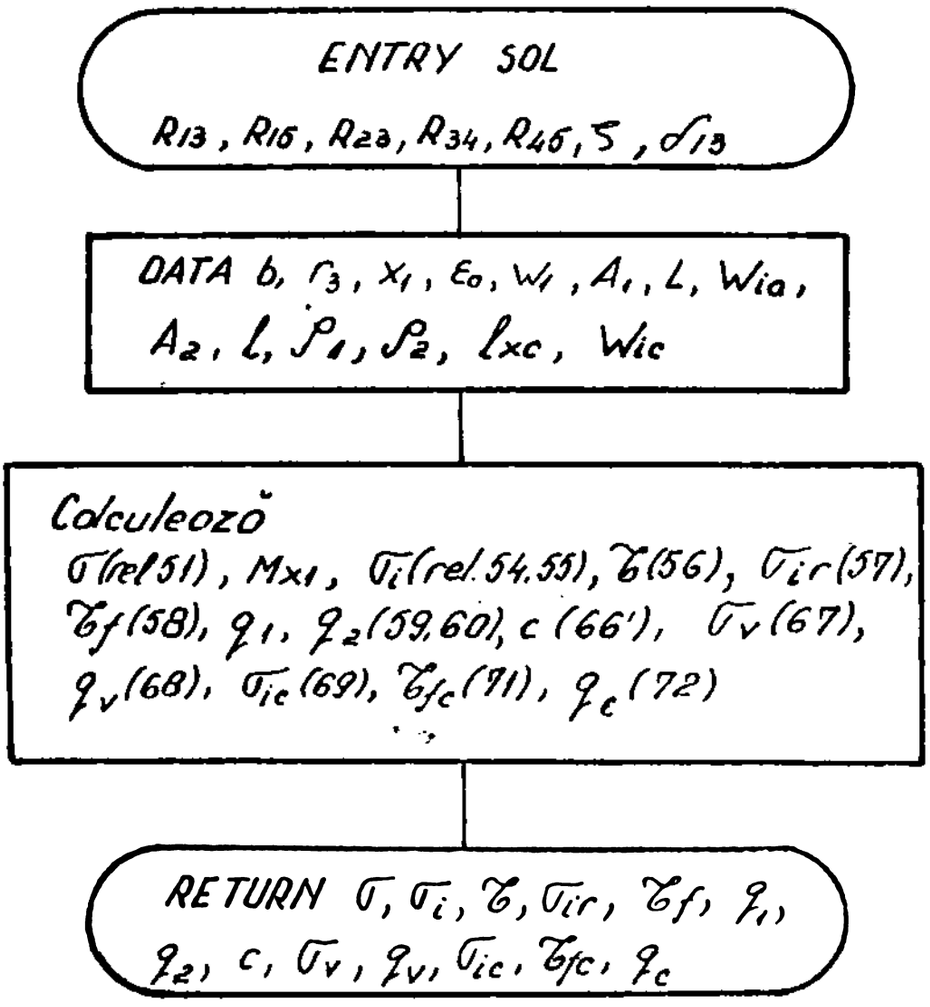
BUPT


ENTRY STAT
ψ3; ψ4; ψ5; ω4; ω5; ε3; ε5; s7; a7; φi
Data: mi (i=3,4,...,8) malb; mtl; l101; l4B; l303
l10E; l1S; l8C; borc; f0; Frg; φe; ω; f; f1; a; b; c; d;
dS; dA; dB; dC; dD; dE; x35; y35; h; δ1; γ;
ψ3; g; φ0; α3; ψ30;
Gj = mj·g (j=3,4,....8); Fkt = -mk a7 (k=6,7,8)
Calculează R*67y; R*67x; R*17x; R*17y; R*67; R*17;
rel (1,2,3); R56y; R56x; R56; (rel 4)
Ffcx; Ffcy; (rel.5), R*56y, R*56x; R*56 (rel 6)
R56 = R*56
>
R*56 - R56 / R*56 : 0,1
<
Calculează: Mf56; (rel 8) θ, β, γ, ψ, δ, μ, ε; Fn41B; Ft41B;
Fn41A; Ft41A; F51C; F51C; calculează; R15x; R15y;
R45y; R34x; R34y; (sistemul 9.... 14), R15; R34; R45;
calculează: Mf15; Mf45; Mf34; R*15x; R*15y;
R*45x; R*45y; R*34x; R*34y; (sistemul 9.....14 completat cu forțele și momentele de frecare.
R15 = R*15
R34 = R*34
R45 = R*45
NU
R*15 - R15 < 0,1 R*15
R*34 - R34 < 0,1 R*34
R*45 - R45 < 0,1 R*45
DA
α

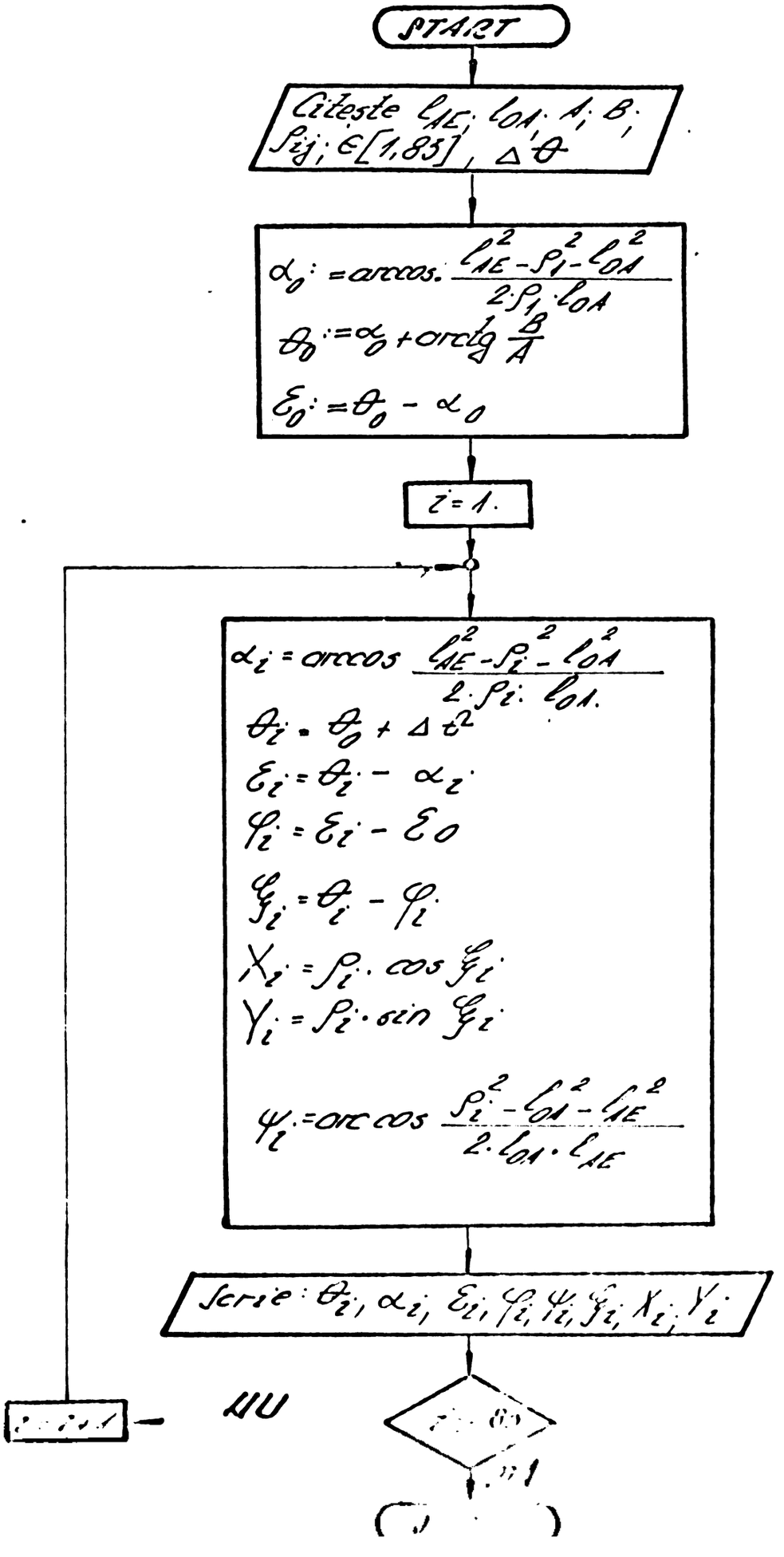
BUPT


α
Calculează F_{32A}; F_{32S}; δ_1; m; R_{23}; R_{23x}; R_{23y}; (rel. 18.....22)/ R_{13x}; R_{13y}.
Calculează M_{f13}; M_{f23}; M_{f43}; M_{fr23}; R_{23}^*; R_{13x}^*; R_{134}^*; R_{13}^*; MR
NU
$R_{23}^* - R_{23} < 0,1 R_{23}^*$
$R_{13}^* - R_{13} < 0,1 R_{13}^*$
$R_{23} = R_{23}^*$
$R_{13} = R_{13}^*$
DA
SOL calculează solicitările din mecanism.
RETURN M_e; R_{67}^*; R_{17}^*; R_{56}^*; M_{f56}; R_{15}^*; R_{34}^*; R_{45}^*; M_{f15}; M_{f34}; M_{f45}; R_{23}^*; R_{13}; M_{f13}; M_{f23}; f_{fr23};

BUPT


ENTRY SOL
R13 , R16 , R23 , R34 , R45 , S , δ13
DATA b, r3 , x1 , ε0 , W1 , A1 , L, Wia ,
A2 , l, ρ1 , ρ2 , lxc , Wic
Calculeozõ
σ(rel51) , Mx1 , σi(rel.54.55), τ(56), σir(57),
τf(58), q1 , q2(59.60), c (66'), σv(67),
qv(68), σic(69), τfc(71), qc(72)
RETURN σ, σi , τ, σir , τf , q1 ,
q2 , c , σv , qv , σic , τfc , qc

BUPT


START
Citeste l_{AE}; l_{OA}; A; B;
ρ_{ij}; $\in [1,85]$, $\Delta\theta$
$\alpha_0 := \arccos \frac{l_{AE}^2 - \rho_1^2 - l_{OA}^2}{2 \cdot \rho_1 \cdot l_{OA}}$
$\theta_0 := \alpha_0 + \operatorname{arctg} \frac{B}{A}$
$\varepsilon_0 := \theta_0 - \alpha_0$
$i = 1$.
$\alpha_i = \arccos \frac{l_{AE}^2 - \rho_i^2 - l_{OA}^2}{2 \cdot \rho_i \cdot l_{OA}}$
$\theta_i = \theta_0 + \Delta\theta^2$
$\varepsilon_i = \theta_i - \alpha_i$
$\varphi_i = \varepsilon_i - \varepsilon_0$
$\zeta_i = \theta_i - \varphi_i$
$X_i = \rho_i \cdot \cos \zeta_i$
$Y_i = \rho_i \cdot \sin \zeta_i$
$\psi_i = \arccos \frac{\rho_i^2 - l_{OA}^2 - l_{AE}^2}{2 \cdot l_{OA} \cdot l_{AE}}$
Scrie: θ_i, α_i, ε_i, φ_i, ψ_i, ζ_i, X_i, Y_i
NU

BUPT

A N E X A

BUPT

A N E X A

```
JOB DISTRIB.AN:PO..,PR:HARIN/
COMPILE FORTRAN [A*.MAP
*IARTOP
                                              DISTRIB     .7/.4/73   12.25.27

* OUTAME FILE *0=10%
      REAL K1,K2,K3,KM1,KM2,KM3,LAB,LBC,LCD,   ..LED,LDV,LB,LAE,MC,NC,
     -M1,N1,O2,M3,N3,MI,NI
      F(X)=PI/180.*X
      COMMON RM,P,PSI2I,LAC,LAD,LAB,LCD,LBC,...,GAMA,BETA4,LDV,OMEGA,PI,
     -ALFA,PSIO,LAO,ALFA3
  111 READ(105,11,END=43)FIM0G,FIM1G,FIM2G,FIM3G,PSI0G,TUR,M..,N..,Z,RO,
     -R,PG,A,B,C,D,E,LAB,LBC,LCD,LAD,LDV,LBE,LAE,GAMAG,FIM4G
   11 FORMAT(8F10.3)
      DO 300 N22=1,4
      WRITE(108,12)Z,TUR,FIM0G,FIM1G,FIM2G,FIM3G,PSI0G,GAMAG,PG,RO,..
     -R0,R,A,B,C,D,E,LAB,LBC,LCD,LAD,LDV,LBE,LAE
   12 FORMAT(T53,'DATE INITIALE'/T52,13('*')//T5,'Z',T13,'TUR',T23,
     -'FIM0G',T33,'FIM1G',T43,'FIM2G',T53,'FIM3G',T63,'PSI0G',T73,
     -'GAMAG',T84,'RAS',T94,'R0',T104,'R',T114,'PG'/T4,'(-)',T14,
     -'(ROT/MIN)',T29,7(3X,'(GRD)',6X),T97,'(MM)',3X,'(MM)'/T2,F7.4,T10,
     -11(' ',F8.3,' ')//T5,'R',T14,'A',T23,'B',T32,'C',T41,'D',T50,'E',
     -T58,'LAB',T67,'LBC',T76,'LCD',T85,'LAD',T94,'LDV',T103,'LBE',
     -T112,'LAE'/T3,13('(MM)',5X)/T6,13(F7.3,2X))
      PI=3.1415927
      FIM0=F(FIM0G)
      FIM1=F(FIM1G)
      FIM2=F(FIM2G)
      FIM3=F(FIM3G)
      P=F(PG)
      GAMA=F(GAMAG)
      PSI0=F(PSI0G)
      OMEGA=(PI*TUR)/30.
      ALFA1=ATAN(D/C)
      ALFA2=ATAN(A/B)
      LAC=SQRT(A**2+B**2)
      RM=R0+R
      COSALFA3=(LAD**2+LAE**2-RM**2)/2./LAD/LAE
      TANALFA3=SQRT(1.-(COSALFA3)**2)/COSALFA3
      ALFA3=ATAN(TANALFA3)
      COSALFA=(LAD**2+RM**2-LAE**2)/2./LAD/RM
      TANALFA=SQRT(1.-COSALFA**2)/COSALFA
      ALFA=ATAN(TANALFA)
      COSBETA=(LAE**2+LAB**2-LBE**2)/2./LAE/LAB
      TANBETA=SQRT(1.-(COSBETA)**2)/COSBETA
      BETA=ATAN(TANBETA)
      K1=8.*Z*(FIM2/PI)**2
      K2=(5.+Z)/6.*FIM3**2
      K3=(4.+2.*Z)/3.*FIM3
      KM1=K1+K2+K3*FIM2
      KM2=K3+4.*Z*FIM2/PI
      SOEP=KM0*PI/2./FIM0

                                              DISTRIB     07/04/73   12.25.29

      C11=(KM1*SOEP+KM2*HM)/(2.*KM1*KM2*FIM1)
      C12=(C11-SOEP)*FIM1/PI
      C32=(2*C11-SOEP)/KM2
      C21=C32*K3
      C31=C32*(1.-Z)/6./FIM3**2
      C22=C32*K1
      C23=C32*K2
      PSI2I=PI-(ALFA1+ALFA2+ALFA3+BETA)
      MI=LAC-LAB*COS(PSI2I)
      NI=-LAB*SIN(PSI2I)
      OI=(MI**2+NI**2-LBC**2+LCD**2)/2./LCD
      RADIC=MI**2+NI**2-OI**2
      SINPSI4I=(-NI*OI-MI*SQRT(MI**2+NI**2-OI**2))/(MI**2+NI**2)
      TANPSI4I=SINPSI4I/SQRT(1.-(SINPSI4I)**2)*(-1.)
      PSI4I=ATAN(TANPSI4I)
      BETA4=(ATAN(C/D)-PSI4I)-GAMA
      SOP=0
      CRON=0
      CN=0
      WRITE(108,13)
   13 FORMAT(T47,'R E Z U L T A T E'/T46,21('*'),/T4,'FI',...,
     -'FI',T22,'SS',T32,'S',T41,'CRON',T50,'X...',...,'Y...',...,
     -'YO',T97,'V',          T116,'S',
     -'(GRD)',T22,'(MM)',    T...('(MM)',5X),('(-)',5X)4('(...)',...,
     -'(...)',T103,   '(M/SP)'/)
      WRITE(108,14)
   14 FORMAT(T52,'A N T E C A M A'/T52,15('*'))
      NPO=FIM..G/DG+1
      DO 21 I=1,NPO
      IF(NPO-1)45,46,46
```

BUPT

```
46  FIOG=FIMOG-(I-1)*PG
47  FIO=F(FIOG)
    ARGOG=FIOG+PSIOG
    ARGO=F(ARGOG)
    ARGO=PI*FIOG/2./FIMOG
    PSIOG=PSIOG
    IF(KOD.EQ.1)PSIOG=PSIOG+2*FIM0G+2*FIM1G+2*FIM2G+2*FIM3G+FIM4G
    PSIO=F(PSIOG)
    SO=HMO*(1.+COS(ARGO))
    IF(I.EQ.1) GO TO 17
    DCRON=.5*(SUM+SO)*P/OMEGA
    CRO=CRO+DCRON
    CRO1=(I-1)*P*SO/OMEGA
    CRON=CRO/CRO1
17  SUM=SO
```

DISTRIB 01/04/78 12.25.29

```
    SOP=HMO*PI/2/FIMO*SIN(ARGO)
    SOS=HMO*(PI/2/FIMO)**2*COS(ARGO)
    CALL CALCUL(SO,SOP,SOS,ARGO,I*FIO,PSIO,KOD,N22,CRON)
20  CONTINUE
    IF(KOD.EQ.1) GO TO 48
    WRITE(108,100)
100 FORMAT(T59,'*'/T57,'*     *')
48  WRITE(108,15)
15  FORMAT(T53,'S E C T I U N E A 1'/T53,19('*')/)
    NP1=FIM1G/PG+1
    DO 22 J=1,NP1
    IF(KOD-1)41,42,42
41  FI1G=(J-1)*PG
    GO TO 43
42  FI1G=FIM1G-(J-1)*PG
43  FI1=F(FI1G)
    ARG1=PI*FI1G/FIM1G
    ARG1G=PSIOG+FIMOG+FI1G
    ARG1=F(ARG1G)
    PSIOG=PSIOG+FIMOG
    IF(KOD.EQ.1)PSIOG=PSIOG+FIMOG+2*FIM1G+2*FIM2G+2*FIM3G+FIM4G
    PSIO=F(PSIOG)
    S1=HMO+(C11*FIM1-C12*PI)*(FI1/FIM1)+2*C12*PI*(FI1/FIM1)**3-C12*PI*
   *(FI1/FIM1)**4
    IF(J.EQ.1) GO TO 191
    DCRON=.5*(SUM+S1)*P/OMEGA
    CRO=CRO+DCRON
    CRO1=(NPO+J-1)*P*S1/OMEGA
    CRON=CRO/CRO1
191 SUM=S1
    S1P=(1./FIM1)*(C11*FIM1-C12*PI+6*C12*PI*(FI1/FIM1)**2-4*C12*PI*(
   *FI1/FIM1)**3)
    S1S=12*C12*PI/FIM1**2*(FI1/FIM1-(FI1/FIM1)**2)
    CALL CALCUL(S1,S1P,S1S,ARG1,J*FI1,PSIO,KOD,N22,CRON)
22  CONTINUE
    WRITE(108,100)
    IF(KOD.EQ.1) GO TO 44
30  WRITE(108,16)
16  FORMAT(T53,'S E C T I U N E A 2'/T53,19('*')/)
    NP2=FIM2G/PG+1
    DO 23 K=1,NP2
    IF(KOD-1)37,38,38
37  FI2G=(K-1)*PG
    GO TO 39
38  FI2G=FIM2G-(K-1)*PG
39  FI2=F(FI2G)
    S1F=HMO+C11*FIM1
```

DISTRIB 01/04/78 12.25.29

```
    ARG2=PI*FI2G/2./FIM2G
    ARG2G=PSIOG+FIMOG+FIM1G+FI2G
    ARG2=F(ARG2G)
    PSIOG=PSIOG+FIMOG+FIM1G
    IF(KOD.EQ.1)PSIOG=PSIOG+FIMOG+FIM1G+2*FIM2G+2*FIM3G+FIM4G
    PSIO=F(PSIOG)
    S2=S1F+C21*FI2+C22*SIN(ARG2)
    IF(K.EQ.1) GO TO 231
    DCRON=.5*(SUM+S2)*P/OMEGA
    CRO=CRO+DCRON
    CRO1=(NPO+NP1+K-1)*P*S2/OMEGA
    CRON=CRO/CRO1
231 SUM=S2
    S2P=C21+C22*PI/2./FIM2*COS(ARG2)
    S2S=-C22*(PI/2./FIM2)**2*SIN(ARG2)
```

```
      WRITE(108,100)
      IF(KOD.EQ.1) GO TO 40
   32 WRITE(108,17)
   17 FORMAT(T50,'S E C T I U N E A 3'/T50,19('*')/)
      NP3=FIM3G/PG+1
      DO 24 L=1,NP3
      IF(KOD-1)33,34,34
   33 FI3G=(L-1)*PG
      GO TO 35
   34 FI3G=FIM3G-(L-1)*PG
   35 FI3=F(FI3G)
      PSICG=PSIOG+FIM0G+FIM1G+FIM2G
      IF(KOD.EQ.1)PSICG=PSIOG+FIM0G+FIM1G+FIM2G+2*FIM3G+FIM4G
      PSIC=F(PSICG)
      S2F=HM0+C11*FIM1+C21*FIM2+C22
      S3=S2F+C31*(FIM3-FI3)**4-C32*(FIM3-FI3)**2+C33
      IF(L.EQ.1) GO TO 391
      DCRON=.5*(SUM+S3)*P/OMEGA
      CRO=CRO+DCRON
      CRO1=(NP0+NP1+NP2+L-1)*P*S3/OMEGA
      CRON=CRO/CRO1
  391 SUM=S3
      S3P=-4*C31*(FIM3-FI3)**3+2*C32*(FIM3-FI3)
      S3S=12*C31*(FIM3-FI3)**2-2*C32
      ARC3G=PSIOG+FIM0G+FIM1G+FIM2G+FI3G
      ARC3=F(ARC3G)
      CALL CALCUL(S3,S3P,S3S,ARC3,L,FI3,PSIC,KOD,N22,CRON)
   24 CONTINUE
      WRITE(108,100)
      IF(KOD.EQ.1) GO TO 50
```

DISTRIB   07/04/78   14.25.29

```
      WRITE(108,25)
   25 FORMAT(T50,'S E C T I U N E A 4'/T50,19('*')/)
      NP4=FIM4G/PG+1.
      DO 26 L1=1,NP4
      FI4G=(L1-1)*PG
      FI4=F(FI4G)
      PSICG=PSIOG+FIM0G+FIM1G+FIM2G+FIM3G
      PSIC=F(PSICG)
      S4=HM0+HM
      IF(L1.EQ.1) GO TO 491
      DCRON=.5*(SUM+S4)*P/OMEGA
      CRO=CRO+DCRON
      CRO1=(NP0+NP1+NP2+NP3+L1-1)*P*S4/OMEGA
      CRON=CRO/CRO1
  491 SUM=S4
      S4P=0.
      S4S=0.
      ARC4G=PSIOG+FIM0G+FIM1G+FIM2G+FIM3G+FI4G
      ARC4=F(ARC4G)
      CALL CALCUL(S4,S4P,S4S,ARC4,L1,FI4,PSIC,KOD,N22,CRON)
   26 CONTINUE
      WRITE(108,100)
      KOD=1
      GO TO 32
   40 WRITE(108,28)
   28 FORMAT(T2,119('*'),5(/))
  300 CONTINUE
      GO TO 111
   13 STOP
      END
```

DISTRIB   07/04/78   14.25.29

ETIQ	ADR.	ETIQ	ADR.	ETIQ	ADR.	ETIQ	ADR.
12	0000	15	1306	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	4070	36	1352	[illegible]	[illegible]	[illegible]	[illegible]
41	[illegible]	42	1366	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0F3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
300	4958	391	1725	[illegible]	[illegible]		

SYMBOLE	TYPE	CLAS	ADRESSE	LONG
[illegible]	[illegible]	[illegible]	[illegible]	2

SYMBOLE	TYPE	CLAS	ADRESSE	LONG
[illegible]	0	3	0400	4

DISTRIB 01/04/78 12.20.16

```
      SUBROUTINE CALCUL(S,SP,SS,ARC,I,FI,PSIC,KOD,M22,CRON)
      REAL M,LAD,LAB,N,LCD,LBC,LDV,LAE,LAO
      COMMON RM,R,PSI2I,LAE,LAD,LAB,LCD,LBC,C,D,GAMA,BETAI,LDV,OMEGA,PI,
     -ALFA,PSIO,LAO,ALFA3
      EPS=PSIC+FI-ALFA
      IF(KOD.EQ.1)EPS=PSIC-FI-ALFA
      XA=LAO*COS(EPS)
      YA=LAO*SIN(EPS)
      XE=XA-LAE*COS(ALFA3-EPS+S/LAE)
      YE=YA+LAE*SIN(ALFA3-EPS+S/LAE)
      XEP=-LAO*SIN(EPS)+LAE*SIN(ALFA3-EPS+S/LAE)*(-1+SP/LAE)
      YEP=LAO*COS(EPS)+LAE*COS(ALFA3-EPS+S/LAE)*(-1+SP/LAE)
      XC=XE-(R*YEP)/SQRT(XEP**2+YEP**2)
      YC=YE+(R*XEP)/SQRT(XEP**2+YEP**2)
      PSI2=PSI2I-S/LAE
      M=LAD-LAB*COS(PSI2)
      N=LAB*SIN(PSI2)
      D=(L**2+M**2+LCD**2-LBC**2)/2./LCD
      SINPSI4=(-N*D-M*SQRT(M**2+N**2-D**2))/(M**2+N**2)
      TANPSI4=SINPSI4/SQRT(1.-(SINPSI4)**2)*(-1.)
      PSI4=ATAN(TANPSI4)
      BETA=(ATAN(C/D)-PSI4)-GAMA
      SV=LDV*(SIN(BETAI)-SIN(BETA))
      IF(S.EQ.0.) GO TO 21
      RTR=SV/S
      V=SP*OMEGA/1000.
      VS=RTR*V
      A=SS*OMEGA**2/1000.
      AS=RTR*A
21    CALL GRADE(FI,NFI,MFI)
      WRITE(100,2)I,NFI,MFI,SV,S,CRON,XE,YE,XC,YC,V,A
    2 FORMAT(T2,I3,T8,I2,T14,I2,T22,(F7.3,2X),T36,6(F7.3,2X),T83,2(F10.
     -3,10X))
      IF(M22.NE.1) GO TO 200
  200 CONTINUE
      RETURN
      END
```

DISTRIB 01/04/78 12.20.16

```
      SUBROUTINE GRADE(GAMA,NG,NM)
      G=GAMA*180./3.14159
      NG=GAMA*180./3.14159
      NM=(G-FLOAT(NG))*60
      RETURN
      END
```

DISTRIB 01/04/78 12.20.20

BUPT

```
JOB CININ,AN:P800,PN:MARINA,COND(126,LT)
COMPILE FORTRAN DBG
      REAL L1,L2,L3,L4,L5,V(2),A(2,2),B(2),D(2,2),C(2),E(2),[illegible]
    2 CONTINUE
      READ(105,100,END=7)L1,L2,L3,L4,L5,02,DF2G,F2,TIP,NPOZT,[illegible]
     -LBOC,LAS
      READ(105,100) TUR
      M=NPOZT
      PI=3.1415927
      F2G=52.8166666
      01=PI*TUR/30.
      PRINT 202,L1,L2,L3,L4,LBOC,LAF,NPOZT,TIP
      PRINT 201
      DO 1 N=1,NPOZT
      READ(105,300) S,SP,SS
      F2=F2G*PI/180.-S/LAF
      FCG=F2*180./PI
      02=SP*01/LAF
      E2=SS*(01**2)/LAS
      CALL UNGHI(L1,L2,L3,L4,F2,F3,F4,TIP)
      IF(N.EQ.1) F4I=[illegible]
      B1I=ATAN(CF/[illegible])-F4I-[illegible]/180.+FI
      B1=ATAN(CF/[illegible]-F4-[illegible]*PI/180.+PI
      SSUP=LBOC*(SIN(B1I)-[illegible](B1))
      F3G=F3*180./PI
      F4G=F4*180./PI
      CF2=COS(F2)
      SF2=SIN(F2)
      CF3=COS(F3)
      SF3=SIN(F3)
      CF4=COS(F4)
      SF4=SIN(F4)
      XB=L2*CF2+L3*CF3
      YB=L2*SF2+L3*SF3
      XC=COS(F3+AL)*L5+XB
      YC=SIN(F3+AL)*L5+YB
      K=L3*L4*SF3*CF4-L3*L4*CF3*SF4
      A(1,1)=-L4*CF4/K
      A(2,1)=-L3*CF3/K
      A(1,2)=-L4*SF4/K
      A(2,2)=-L3*SF3/K
      B(1)=L2*02*SF2
      B(2)=-L2*02*CF2
      CALL SMAVEC(A,B,V,2,2)
      03=V(1)
      04=V(2)
      VSUP=-LBOC*04*COS(B1)/1000.
      ASUP=LBOC*04**2*SIN(B1)-LBOC*E4*COS(B1)
      ASUP=ASUP/1000.
                                            CININ      12/06/76   [illegible]

      SPR=SP*01/1000.
      SSR=SS*01**2/1000.
      IF(S.EQ.0)GO TO 3
      FT0=SSUP/S
    3 CONTINUE
      IF(SPR.EQ.0)GO TO 4
      FT1=VSUP/SPR
    4 CONTINUE
      IF(SSR.EQ.0)GO TO 5
      FT2=ASUP/SSR
    5 CONTINUE
      C(1)=L2*E2*SF2+L2*02**2*CF2+L3*03**2*CF3-L4*04**2*CF4
      C(2)=-L2*E2*CF2+L2*02**2*SF2+L3*03**2*SF3-L4*04**2*SF4
      CALL SMAVEC(A,C,E,2,2)
      E3=E(1)
      E4=E(2)
      WRITE(108,200) FCG,F3G,F4G,03,E3,04,E4,S,SSUP,FT0,SPR,VSUP,FT1,S[illegible]
     -,ASUP,FT2
      CALL TAB(F2G,SSUP,S,FT1,FT2,VSUP,SPR,ASUP,SSR,N,0,M)
    1 CONTINUE
      CALL TAB(F2G,SSUP,S,FT1,FT2,VSUP,SPR,ASUP,SSR,N,1,M)
      GO TO 2
    7 STOP
  100 FORMAT(8F10.5/F10.5,I10,5F10.5)
  200 FORMAT(2X,Z(G14.7,3X)/9(G14.7)//)
  201 FORMAT(1H1,T51,'R E Z U L T A T E'/T51,17('*')//T8,3HF2G,T25,[illegible]
     -,T42,3HF4G,T59,2HO3,T76,2HE3,T93,2HO4,T110,2HE4//T7,2[illegible]
     -P,T34,3HFT0,T48,2HVR,T62,4HVSUP,T76,3HFT1,T90,2HSR,T1[illegible]
     -B,3HFT3///)
  202 FORMAT(1H1,T48,'D A T E   I N I T I A L E'/ T48,24('*')//T2[illegible]
     -NTA INTRE ARTICULATII',F10.5/T20,'LUNGIMEA [illegible]
     -UNGIMEA IMPINGATORULUI',F10.5/T20,'BRATUL [illegible]
     -F10.5/T20,'BRATUL LUNG AL CULBUTORULUI',F10.5/T20,[illegible]
     -CHETULUI',F10.5/T20,'NUMARUL DE POZITII',I5/T20,'CONFIG[illegible]
     -NISMULUI',F10.5,4(/))
  300 FORMAT(3(F12.7,2X))
      END
                                            CININ      12/06/76   [illegible]
```

BUPT

```
      SUBROUTINE SMAVEC(A,X,M,N)
      DIMENSION A(M,M),X(M),Z(M)
      DO 5 I=1,N
    5 Z(I)=0
      DO 6 I=1,N
      DO 6 J=1,N
    6 Z(I)=A(I,J)*X(J)+Z(I)
      RETURN
      END
```

CININ 12/06/76 08.21.20

```
      SUBROUTINE TAB(F2G,F3G,F4G,XB,YB,03,04,E3,F4,N,K,M)
      DIMENSION Y(3,121),Z(3,121),W(2,121)
      IF(K.NE.0) GO TO 1
      Y(1,N)=F3G
      Y(2,N)=03
      Y(3,N)=E3
      Z(1,N)=F4G
      Z(2,N)=04
      Z(3,N)=E4
      W(1,N)=XB
      W(2,N)=YB
      RETURN
    1 CONTINUE
      PRINT 200
      CALL GRAPH(Y,3,M)
      PRINT 201
      PRINT 200
      CALL GRAPH(Z,3,M)
      PRINT 202
      PRINT 200
      CALL GRAPH(W,2,M)
      PRINT 203
      RETURN
  200 FORMAT(1H1)
  201 FORMAT(1H+,T22,'CURSA SUPAPEI',T42,'VITEZA SUPAPEI',T62,'ACCELE'
     -SUPAPEI',3(/))
  202 FORMAT(1H+,T22,'DEPLAS. C. ROLEI',T42,'VIT. C. ROLEI',T62,'ACCE
     -C. ROLEI',3(/))
  203 FORMAT(1H+,T22,'RAP. TRANSM. VIT.',T42,'RAP. TRANSM. ACC.',3(/)
      END
```

CININ 12/06/76 08.21.20

ECTEES AU COURS DE LA COMPILATION :

VARIABLES NON REFERENCEES :
F2G

CININ 12/06/76 08.21.28

```
      SUBROUTINE UNGHI(L1,L2,L3,L4,F2,F3,F4,TIP)
      REAL L1,L2,L3,L4
      PI=3.14159265389397
      IF(L1.EQ.L2*COS(F2)) GO TO 1
      BETA=ATAN2(L2*SIN(F2),(L1-L2*COS(F2)))
    2 CONTINUE
      COSM=(L3**2+L4**2-L2**2-L1**2)/2./L3/L4+L2*L1*COS(F2)/L3/L4
      SINM=SQRT(1.-COSM**2)
      IF(L3.EQ.L4*COSM) GO TO 3
      GAMMA=ATAN2(L4*SINM,(L3-L4*COSM))*TIP
    4 CONTINUE
      F3=GAMMA-BETA
      IF(L4.EQ.L3*COSM) GO TO 5
      SIGMA=ATAN2(L3*SINM,(L4-L3*COSM))*TIP
    6 CONTINUE
      F4=PI-BETA-SIGMA
      RETURN
    5 SIGMA=PI/2.*SIGN(1.,SIGMA)
      GO TO 6
    1 BETA=PI/2.*SIGN(1.,BETA)
      GO TO 2
    3 GAMMA=PI/2.*SIGN(1.,GAMMA)
      GO TO 4
      END
```

CININ 12/06/76 08.21.36

BUPT

```
JOB STATSAV,AN:P800,PN:MARINA
COMPILE FORTRAN DBG
```

```
      IMPLICIT REAL*8(A-H,O-Z)
    1 READ(105,100,END=7)PSI3,PSI4,PSI5,VR,AR,OS,ES,S7,A7,FI
      CALL STAT(PSI3,PSI4,PSI5,VR,OS,AR,ES,S7,A7,X,Y,A,B,FI)
      GO TO 1
    7 STOP
  100 FORMAT(10F8.5)
      END
```

```
                                        STATSAV     25/07/77  14.14.46

      SUBROUTINE STAT(PSI3,PSI4,PSI5,OM3,OM5,EPS3,EPS5,SMIC7,AMIC7,XI,YI
     -,AT,BI,FI)
      IMPLICIT REAL*8(A-H,O-Z)
      DOUBLE PRECISION M3,M4,M5,M6,M7,M8,MC,MCUL,MTL,LAB,LAE,LAS,LBC,LDC
     -,LDS,LDV,LAD,LAD
      DIMENSION ATAB(4,4),BTAB(4),BRES(4),ARES(4,5)
      DATA INDICE/1/,PI/3.1415926/,GRAV/9.806/
      IF(INDICE.NE.1)GO TO 6
      READ(105,100)M3,M4,M6,M7,M8,MC,MCUL,MTL,LAB,LAE,LAS,LBC,LDC,LDS,
     -LDV,CMIC,F0,FVG,FTF,PFV,OM,FMIC,FMIC1,H,A,B,C,D,DA,DA,DB,DC,DD,DE,
     -XS5,YS5,RMIC,DELTA1,GAM                                          ,C
     *S7,FIZ,ALFA,PSI30,LAD,LAD,DB
  100 FORMAT(8F14.7)
      G3=M3*GRAV
      G4=M4*GRAV
      G5=M5*GRAV
      G6=M6*GRAV
      G7=M7*GRAV
      G8=M8*GRAV
      TFM=SQRT(1.+FMIC**2)
      BETA1=ATAN2(C,D)
      THE1=ATAN2(YS5,XS5)
      CSI1=ATAN2(D,C)
```

BUPT

```
      INDICE=0
      PRINT 203
      PRINT 201,M3,M4,M6,M7,M8,MC,MCUL,MTL,LAB,LAE,LAS,LBC,LDC,LDS,LDV,
     -CMIC,F0,FVG,FIE,PFV,OM,FMIC,FMIC1,H,A,B,C,D,DA,DB,DC,DF,DG,
     -YSS,AMIC,DELTA1,GAM
      PRINT 202
    6 CONTINUE
      PSI3=PSI3*PI/180
      PSI4=PSI4*PI/180
      PSI5=PSI5*PI/180
      OM3=OM3/LAE
      EPS3=EPS3/LAE
      SMIC7=SMIC7/1000.
      FF=FI*PI/180.
      FRA=CMIC*SMIC7+F0
      FRG=0.
      IF(FF.LT.FIE)F8G=FVG*(1.-FF/FIE)
      FAI=-M6*AMIC7
      F7I=-M7*AMIC7
      FRI=-MR*AMIC7
      FR=FRA+F8G-F8I
      R7R=FR-GR
      R67Y=R7R /(1.-FMIC**2)
      R17X=FMIC*R67Y
```

STATSAV 25/07/77 14.14.46

```
      R56Y=R67Y-G6-F6I
      R56X=FMIC*R67Y
      Z56X=R56X
      Z56Y=R56Y
   22 CONTINUE
      R56Y=Z56Y
      R56X=Z56X
      Z56Y=R67Y-G6-F6I+FMIC1*R56X
      Z56X=FMIC*R67Y-FMIC1*R56Y
      IF(ABS(R56X-Z56X)/Z56X.GT.0.1)GO TO 22
      IF(ABS(R56Y-Z56Y)/Z56Y.GT.0.1)GO TO 22
      R56Y=Z56Y
      R56X=Z56X
      R56=AMAR(R56X,R56Y)
      AN=(FMIC1*R56*D6/2.-FMIC*H*R67Y)
     */R67Y
      AM=AN/FMIC
      AMF56=FMIC1*R56*D6/2.
      R17=R17X*TFM
      R67=R67Y*TFM
      BETA=BETA1-PSI5+PI
      IF(INDICE.EQ.1)BETA0=BETA .
      THETA=THE1-BETA
      CSI=CSI1+PSI4-PI
      DELTA=CSI1+PSI3
      AMIU=PI-PSI5+PSI4
      EPSI=PI+PSI3-PSI4
      F4ICN=M4/2.*OM5**2*LDC
      F4ICT=-M4/2.*EPS5*LDC
      F4IBN=M4/2.*OM3**2*LAB
      F4IBT=-M4/2.*EPS3*LAB
      F5IV=-MCUL*LDV*EPS5
      F5IS=-MC*OM5**2*LDS
      A1=R56X-F5IV*SIN(BETA-GAM)-F5IS*COS(THETA)+R56X
      B1=R56Y+F5IV*COS(BETA-GAM)+F5IS*SIN(THETA)-G5+R56Y
      B1=R56Y-F5IV*COS(BETA-GAM)+F5IS*SIN(THETA)-G5+R56Y
                ZFR=2.
      IF(BETA.LT.BETA0)ZFR=-ZFR
      C1=R56Y*COS(BETA)*2.0*LDV-R56X*SIN(BETA)*ZFR*LDV-F5IV*LDV+G5*F55/
     -COS(BETA)-AMF56+R56Y*COS(BETA-GAM)*LDV-R56Y*SIN(BETA-GAM)*LDV
      D1=+F4ICN*COS(BETA)+F4ICT*SIN(BETA)-F4IBN*SIN(DELTA)+F4IBT*COS(DE
     -TA)
      E1=F4ICN*SIN(BETA)-F4ICT*COS(BETA)-F4IBN*COS(DELTA)-F4IBT*SIN(DEL
     -A)+G4
      F1=F4ICN*SIN(AMIU)-F4ICT*COS(AMIU)+F4IBN*SIN(EPSI)-F4IBT*COS(EPSI
      BTAB(1)=C1+LDC*SIN(BETA)*A1+LDC*COS(BETA)*B1
      BTAB(2)=D1+A1
```

STATSAV 25/07/77 14.14.46

```
      BTAB(3)=E1-R1
      BTAB(4)=F1+COS(CSI)*A1+SIN(CSI)*B1
      DO 1 J=1,4
      DO 1 JK=1,4
    1 ATAB(J,JK)=0
      ATAB(1,1)=+LDC*SIN(BETA)
      ATAB(1,2)=+LDC*COS(BETA)
```

BUPT

```
      ATAB(2,3)=+1.
      ATAB(3,2)=-1.
      ATAB(3,4)=+1.
      ATABT=COS(CSI)
      ATAB(4,1)=ATABT
      ATAB(4,3)=-ATABT
      ATABT=SIN(CSI)
      ATAB(4,2)=ATABT
      ATAB(4,4)=+ATABT
      DO 2 J=1,4
      BRES(J)=BTAB(J)
      ARES(J,5)=BRES(J)
      DO 2 JK=1,4
    2 ARES(J,JK)=ATAB(J,JK)
      CALL INVMAT(4,ARES,BRES,1,D-20,1,5)
      IF(KOD.NE.0)PRINT 200,KOD
   21 R15X=BRES(1)
      R15Y=BRES(2)
      R34X=BRES(3)
      R34Y=BRES(4)
      R45X=A1-R15X
      R45Y=B1-R15Y
      R45Y=-R45Y
      R15=AMAR(R15X,R15Y)
      R34=AMAR(R34X,R34Y)
      R45=AMAR(R45X,R45Y)
      AMF15=FMIC1*DD/2.*R15
      AMF34=FMIC1*DB/2.*R34
      AMF45=FMIC1*DC/2.*R45
      DO 3 J=1,4
      BRES(J)=BTAB(J)
      DO 3 JK=1,4
    3 ARES(J,JK)=ATAB(J,JK)
      BRES(1)=BRES(1)+AMF15+AMF45
      F1F=F1-AMF45-AMF34
      BRES(4)=BRES(4)+F1F-F1
      DO 4 J=1,4
    4 ARES(J,5)=BRES(J)
      CALL INVMAT(4,ARES,BRES,1,D-20,1,5)
```

STATSAV 25/07/77 14.14.46

```
      IF(KOD.NE.0)PRINT 200,KOD
      IF(DABS((BRES(1)-R15X)/R15X).GT.0.1)GO TO 21
      IF(DABS((BRES(2)-R15Y)/R15Y).GT.0.1)GO TO 21
      IF(DABS((BRES(3)-R34X)/R34X).GT.0.1)GO TO 21
      IF(DABS((BRES(4)-R34Y)/R34Y).GT.0.1)GO TO 21
      R15X=BRES(1)
      R15Y=BRES(2)
      R34X=BRES(3)
      R34Y=BRES(4)
      R45X=A1-R15X
      R45Y=B1-R15Y
      R15=AMAR(R15X,R15Y)
      R34=AMAR(R34X,R34Y)
      R45=AMAR(R45X,R45Y)
      AMF34=FMIC1*DB/2.*R34
      FT1B=-MTL*LAB*EPS3
      FT1S=M3*OM3**2*LAS
      DEL3I=PSI30-PSI3
      BETA=FIZ-ALFA
      GAMA=CSIZ+FIZ-ALFA
      GAMA=CSIZ-BETA
      AT1=BETA+FI
      AT2=GAMA+FI+DEL3I
      AT2=GAMA-FI+DEL3I
      FT1S=SIN(AT1)
      FT1C=COS(AT1)
      FT2S=SIN(AT2)
      FT2C=COS(AT2)
      T03=1.+OM3/OM-2.
      XEP=-LAO*FT1S+LAE*FT2S*T03
      YEP=LAO*FT1C+LAE*FT2C*T03
      XES=-LAO*FT1C+LAE*FT2C*T03**2+LAE*FT2S*EPS3/OM**2
      YES=-LAO*FT1S-LAE*FT2S*T03**2+LAE*FT2C*EPS3/OM**2
      ANUM=     (XEP**2+YEP**2)**1.5/(XEP*YES-YEP*XES)/RMIC
      DX=XEP*(1.-ANUM)
      DY=YEP*(1.+ANUM)
      AMI=-DX/DY
      FIMI=ATAN(AMI)
       FIMI=ATAN2(B,A)+ATAN(AMI)-AT1-PI
      R23=LAB/LAE*(R34Y*SIN(DELTA)+R34X*COS(DELTA)+FI3B)/COS(PSI3+ATAN2(
     -B,A)+FIMI)
      R23=(LAB*(R34Y*SIN(DELTA)-R34X*COS(DELTA)-F3IB)+G3*LAS*SIN(DELTA1
     1+DELTA))/LAE*COS(ALFA+DELTA-ATAN(AMI))
      R23=R23
```

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```
      R23Y=R23*SIN(FIMI)
      R13X=R23X-R34X-F3IS*SIN(DELTA1+DELTA)-F3IB*COS(DELTA)
                                          ST4TSAV     25/07/77  14.14.46

      R13Y=R23Y-R34Y-F3IS*SIN(DELTA1+DELTA)-F3IB*SIN(DELTA)
      R13=AMAR(R13X,R13Y)
      AMF13=FMIC1*DA/2.*R13
      AMF23=FMIC1*DF/2.*R23
      AMFR23=FMIC1*RMIC*R23
      AMF23=DABS(AMF23)
      AMFR23=DABS(AMFR23)
      R23=LAB*(R34Y*SIN(DELTA)+R34X*COS(DELTA)+FI3B-AMF34+AMF13-AMF23+
     -AMFR23)/(LAB*COS(DRI3+ATAN2(B,A)+FIMI)
      R23=(LAB*(R34Y*SIN(DELTA)-R34X*COS(DELTA)-F3IB)+G3*LAB*SIN(DELTA1
     1+DELTA)-AMF34+AMF13-AMF23+AMFR23)/LAE*COS(ALFA+DELTA-ATAN(AMI))
      IF(DABS((R23-R23I)/R23I).GT.0.1)GO TO 5
      R23X=R23*COS(FIMI)
      R23Y=R23*SIN(FIMI)
      R13X=R23Y-R34X-F3IS*SIN(DELTA1+DELTA)-F3IB*COS(DELTA)
      R13Y=R23Y-R34Y-F3IS*COS(DELTA1+DELTA)-F3IB*SIN(DELTA)
      R13=AMAR(R13X,R13Y)
      R23=DARS(R23)
      PRINT 205
205   FORMAT(1H0)
      PRINT 201,EI,PSI3,PSI4,PSI5,OM3,OM5,EPS3,EPS5,SMIC7,AMIC7,XI,YI,AI
     -,RI,F8,R78,R17,R67,R56X,R56Y,R56,      THETA,CSI,DELTA,AMIU,EPSI,
     -R15X,R15Y,R15,R34Y,R34Y,R34,R45X,R45Y,R45,AMF15,AMF34,AMF45,R23X,
     *BETA,
     -R23Y,R23,R13X,R13Y,R13,AMF13,AMF23,AMFR23
      RETURN
200   FORMAT(5(/),T20,6HRESOL:,I2)
201   FORMAT(T5,8G15.7)
202   FORMAT(10(/),T10,2HEI,T25,4HPSI3,T40,4HPSI4,T55,4HPSI5,T70,3HOM3,
     -T85,3HOM5,T100,4HEPS3,T115,4HEPS5//T10,2HS7,T25,2HA7,T43,2HXI,T55,
     -2HYI,T70,2HAI,T85,2HBI,T100,2HF8,T115,3HR78//T10,3HR17,T25,3HR67,
     -T40,4HR56X,T55,4HR56Y,T70,3HR56,T85,5HTHETA,T100,3HCSI,T115,5HDELT
     -A//T10,3HMIU,T25,7HEPSILON,T40,4HR15X,T55,4HR15Y,T70,3HR15,T85,4HR
     -34Y,T100,4HR34Y,T115,3HR34//T10,4HR45Y,T25,4HR45Y,T40,3HR45,T55,
     -5HAMF15,T70,5HAMF34,T85,5HAMF45,T100,4HR23X//T10,4HR23Y,T25,3HR23,
     -T40,4HR13X,T55,4HR13Y,T70,3HR13,T85,5HAMF13,T100,5HAMF23,T115,6HAM
     -FR23//T5,120(1H*),5(/))
203   FORMAT(10(/),T10,2HM3,T25,2HM4,T40,2HM6,T55,2HM7,T70,2HM8,T85,2HMC
     -,T100,4HMCUL,T115,3HMTL,//T10,3HLAB,T25,3HLAE,T40,3HLAS,T55,3HLAC,
     -T70,3HLDC,T85,3HLDS,T100,3HLDV,T115,4HCMIC//T10,2HF0,T25,3HFVG,T40
     -,3HFIE,T55,3HDFV,T70,2HOM,T85,4HFMIC,T100,5HFMIC1,T115,1HM//T10,
     -1HA,T25,1HB,T40,1HC,T55,1HD,T70,2HD6,T85,2HDA,T100,2HDB,T115,2HDC/
     -/T10,2HDD,T25,2HDF,T40,3HXS5,T55,3HYS5,T70,4HRMIC,T85,6HDELTA1,T10
     -0,3HGAM/3(/))
      END
                                          STATSAV     25/07/77  14.15.21

      DOUBLE PRECISION FUNCTION AMAR(A,B)
      IMPLICIT REAL*8(A-H,O-Z)
      AMAR=SQRT(A**2+B**2)
      RETURN
      END
                                          STATSAV     25/07/77  14.15.26

      SUBROUTINE INVMAT(N,A,X,EPS,INDIC,NRC)
C
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION IROW(12),JCOL(12),JORD(12),Y(12),A(N,NRC),X(N)
      MAX=N
      IF(INDIC.GE.0)MAX=N+1
C       **  IS N LARGER THEN 12 **
      IF(N.LE.12)GO TO 5
      WRITE(108,200)
      STMUL=0.
      RETURN
C       ** BEGIN ELIMINATION PROCEDURE **
    5 DETER=1.
      DO 18 K=1,N
      KM1=K-1
C       ** SEARCH FOR THE PIVOT ELEMENT **
      PIVOT=0.
      DO 11 I=1,N
      DO 11 J=1,N
C       ** SCAN IROW AND JCOL ARRAYS FOR INVALID PIVOT SUBSCRIPTS **
      IF(K-59.1)60 TO 9
```

BUPT

```
      DO 8 JSCAN=1,KM1
      IF(I.EQ.IROW(ISCAN))GO TO 11
      IF(J.EQ.JCOL(JSCAN))GO TO 11
    8 CONTINUE
    9 IF(ABS(A(I,J)).LE.ABS(PIVOT))GO TO 11
      PIVOT=A(I,J)
      IROW(K)=I
      JCOL(K)=J
   11 CONTINUE
C      **INSURE THAT SELECTED PIVO IS LARGER THAN EPS **
      IF(ABS(PIVOT).GT.EPS)GO TO 13
      STMUL=0.
      RETURN
C      ** UPDATE THE DETERMINANT VALUE **
   13 IROWK=IROW(K)
      JCOLK=JCOL(K)
      DETER=DETER*PIVOT
C      ** NORMALIZE PIVOT ROW ELEMENTS **
      DO 14 J=1,MAX
   14 A(IROWK,J)=A(IROWK,J)/PIVOT
C      **CARRY OUT ELIMINATION AND DEVELOP INVERSE **
      A(IROWK,JCOLK)=1./PIVOT
      DO 18 I=1,N
      AIJCK=A(I,JCOLK)
      IF(I.EQ.IROWK)GO TO 18
```

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```
      A(I,JCOLK)=-AIJCK/PIVOT
      DO 17 J=1,MAX
   17 IF(J.NE.JCOLK)A(I,J)=A(I,J)-AIJCK*A(IROWK,J)
   18 CONTINUE
C      ** ORDER SOLUTION VALUES(IF ANY) AND CARTE JORD ARRAY **
      DO 20 I=1,N
      IROWI=IROW(I)
      JCOLI=JCOL(I)
      JORD(IROWI)=JCOLI
   20 IF(INDIC.GE.0)X(JCOLI)=A(IROWI,MAX)
C      ** ADJUST SIGN OF DETERMINANT **
      INTCH=0
      NM1=N-1
      DO 22 I=1,NM1
      IP1=I+1
      DO 22 J=IP1,N
      IF(JORD(J).GE.JORD(I))GO TO 22
      JTEMP=JORD(J)
      JORD(J)=JORD(I)
      JORD(I)=JTEMP
      INTCH=INTCH+1
   22 CONTINUE
      IF(INTCH/2*2.NE.INTCH)DETER=-DETER
C      ** FIST BY ROWS  **
   26 DO 28 J=1,N
      DO 27 I=1,N
      IROWI=IROW(I)
      JCOLI=JCOL(I)
   27 Y(JCOLI)=A(IROWI,J)
      DO 28 I=1,N
   28 A(I,J)=Y(I)
C      ** THEN BY COLUMNS **
      DO 30 I=1,N
      DO 29 J=1,N
      IROWJ=IROW(J)
      JCOLJ=JCOL(J)
   29 Y(IROWJ)=A(I,JCOLJ)
      DO 30 J=1,N
   30 A(I,J)=Y(J)
C      ** RETURN FOR INDIC NEGATIVE OR ZERO **
      STMUL=DETER
      RETURN
C      ** FORMAT FOR OUTAUT STATEMENT **
  200 FORMAT(10HON TOO BIG)
      END
```

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TEES AU COURS DE LA COMPILATION :

AVERTISSEMENT : ETIQUETTE '26' DEFINIE,NON REFERENCEE.

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```
      DOUBLE PRECISION FUNCTION
     *ATAN(X)
      IMPLICIT REAL*8(A-H,O-Z)
      ATAN=DATAN(X)
      RETURN
      END
```

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```
      DOUBLE PRECISION FUNCTION
     *ATAN2(X,Y)
      IMPLICIT REAL*8(A-H,O-Z)
      ATAN2=DATAN2(X,Y)
      RETURN
      END
```

STATSAV 25/07/77 14.15:48

```
      DOUBLE PRECISION FUNCTION
     *ARS(X)
      IMPLICIT REAL*8(A-H,O-Z)
      ARS=DABS(X)
      RETURN
      END
```

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```
      DOUBLE PRECISION FUNCTION
     *SIN(X)
      IMPLICIT REAL*8(A-H,O-Z)
      SIN=DSIN(X)
      RETURN
      END
```

STATSAV 25/07/77 14.15:58

```
      DOUBLE PRECISION FUNCTION
     *COS(X)
      IMPLICIT REAL*8(A-H,O-Z)
      COS=DCOS(X)
      RETURN
      END
```

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```
      DOUBLE PRECISION FUNCTION
     *SQRT(X)
      IMPLICIT REAL*8(A-H,O-Z)
      SQRT=DSQRT(X)
      RETURN
      END
```

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MODULE	FXMDATA	TYPE	P	LONGUEUR	01ER (00488)
MODULE	STAT	TYPE	P	LONGUEUR	2610 (09744)
MODULE	AMAR	TYPE	P	LONGUEUR	0080 (00128)
MODULE	INVMAT	TYPE	P	LONGUEUR	0B28 (02856)
MODULE	ATAN	TYPE	P	LONGUEUR	0048 (00072)
MODULE	ATAN2	TYPE	P	LONGUEUR	0050 (00080)
MODULE	ARS	TYPE	P	LONGUEUR	0048 (00072)
MODULE	SIN	TYPE	P	LONGUEUR	0048 (00072)

BUPT

: [illegible]ST,AN:P801,PN:MARINA,COND(126,LT)
COMPILE FORTRAN DBG,MAP

```
      DOUBLE PRECISION RO(83),LAE,LOA,ALFA0,TETA0,B,A,TETAI,EPSI,ALFAI,F
     -I,PSI,ZITA,XI,YI,ACOS,EPSI0
      READ(105,11)   LAE,LOA,A,B
   11 FORMAT(4D16.7)
      DATA RO/65.1484,65.1586,65.1840,65.2246,65.2907,65.3770,65.4939,
     -65.6183,65.7453,65.8723,65.9993,66.1314,66.3244,66.5962,66.9544,
     -67.4039,67.9475,68.5800,69.3013,70.1014,70.9701,71.8972,72.9649,
     -73.8530,74.8411,75.8088,76.7334,77.6046,78.4047,79.1261,79.7585,
     -80.3021,80.7516,81.1009,81.3816,81.5746,81.6965,81.7626,81.7990,
     -81.7905,81.7905,81.7890,81.7626,81.6965,81.5746,81.3816,81.1009,
     -80.7516,80.3021,79.7585,79.1260,78.4047,77.6046,76.7334,75.8088,
     -74.8411,73.8530,72.8649,71.8972,70.9701,70.1014,69.3013,68.5800,
     -67.9475,67.4039,66.9544,66.5962,66.3244,66.1314,66.0695,65.9400,
     -65.8799,65.8190,65.7581,65.6971,65.6361,65.5142,65.3923,65.2703,
     -65.2145,65.1738,65.1561,65.1484/
      WRITE(108,22)
   22 FORMAT('1',T2,'NR SCT',T10,'TETAI',T25,'ALFAI',T40,'EPSI',T55,'F
     -II',T70,'PSIT',T85,'ZITA',T100'XI',T115'YI'///)
      ALFA0=ACOS((-LAE**2+RO(1)**2+LOA**2)/2.D0/RO(1)/LOA)
      TETA0=ALFA0+DATAN2(B,A)
      EPSI0=TETA0-ALFA0
      DO 1 I=1,83
      ALFAI=ACOS((-LAE**2+RO(I)**2+LOA**2)/2.D0/RO(I)/LOA)
      TETAI=TETA0+(I-1)*2.D0*3.14159265358980D0/180.D0
      EPSI=TETAI-ALFAI
      FI=EPSI-EPSI0
      ZITA=TETAI-FI
      XI=RO(I)*DCOS(ZITA)
      YI=RO(I)*DSIN(ZITA)
      PSI=ACOS((-RO(I)**2+LOA**2+LAE**2)/2D0/LOA/LAE)
      FI3=1.520562-PSI
      K=I-1
      WRITE(108,33)K,TETAI,ALFAI,EPSI,FI,FI3,ZITA,XI,YI
   33 FORMAT(T5,I2,T10,G14.7,T25,G14.7,T40,G14.7,T55,G14.7,T70,G14.
     -7,T85,G14.7,T100,G14.7,T115,G14.7)
    1 CONTINUE
      STOP
      END


      DOUBLE PRECISION FUNCTION ACOS(X)
      DOUBLE PRECISION X
      ACOS=DATAN(DSQRT(1.D0-X**2)/X)
      RETURN
      END
```

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