

THE SPRING RESEARCH AND MANUFACTURERS' ASSOCIATION

A SURVEY OF MOTORISED
AND SELFBRAKING SWIFTS

by

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A SURVEY OF MOTORISED
AND SELFBRAKING SWIFTS

SUMMARY

This survey has collected together information on motorised and selfbraking swifts capable of handling wires of up to 6 mm in diameter and coil weights of up to 500 kg.

The features of each type are described in the body of the survey and a table at the end enables a quick comparison to be made between the major features of each machine.

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March 1978

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1. INTRODUCTION

Experience and tests have shown that variation in spring dimension of as coiled springs is partly due to the varying back tension produced by free running swifts. This is particularly noticeable with fine wires or where heavy bundle weights are used.

In addition, with high wire feed rates, if the coiling is interrupted the inertia of the swift can unwind many metres of wire, hence leading to tangling problems.

This survey examines swifts of the motorised and selfbraking type currently available for wire diameter up to 6mm.

2. SWIFTS EXAMINED

Manufacturer

Dixi S.A.

Karl Hack

Model

Type: Integral with machine

Type: MBH1 - EL

MBH2 - EL

MBH3 - EL

MBH 2/A

MBH 3/A

MBH 6

<u>Manufacturer</u>	<u>Model</u>
Herckelbout-Pernin	Type: DAS 450
	DAS 600
	DAS 800
Okuno	Type: ARS 15H
	ARS 15
	ARS 30
	ARS 50
	ARS 80
Dr. Ramisch	Type: B + options
Schenker	Type: DHE 200
	DHE 600
	DKE 800
	DHE 1200
Showa	Type: SR - 20
	SR - 50
	SR - 100
	SR - 150
Simplex Rapid	Type: Z - 1
	Z - 2 Z-2/5 Z-2/SW
	Z - 5
	Z - 6
	Z - 7
	Z - 8
John H. Smith	Type: Mark 1
	Mark 2
Wafios	Type: AHM1
	AHM2

3. FEATURES EXAMINED

This survey considers the mechanical specifications of each swift, as well as physical dimension.

The properties considered are:-

1. Is the speed infinitely variable over its operating speed range?
2. Is the speed controlled electronically or mechanically? (i.e. Thyristor drive, adjustable pulley)
3. Does the speed of the swift automatically adjust to the wire demand, or is the speed set by an operator to an approximation with the swift doing the final adjustments?
4. Has the swift a mechanical or electrical brake fitted, or does the motor reverse its torque?
5. Does the swift use the coiling machine or the wire to sense the demand?
6. Does the swift hold the wire bundle in the vertical or horizontal plane?
7. Is the swift capable of handling spools and bobbins of wire?
8. Is the power to the coiling machine and swift cut off if wire demand is too great, too small or if tangling occurs?
9. Does the swift have a wire storage system to allow for intermittent operation of the coiling machine?
10. If soft starting/braking is incorporated, is it controlled by a slipping clutch or electronically by the motor?

The individual price of each machine has not been included because of the fluctuations that can occur particularly with the imported machines. As an approximate guide the swift have been put into the three price bands below. The larger more sophisticated machine being the most expensive and the smaller simpler type being in the cheaper range.

1. Electronic proportional control swifts: £1750 - £4100
2. Variable speed ON-OFF control swifts: £ 900 - £2000
3. Self braking swift: £ 180 - £ 400

At the end of this survey there is a table which compares the major features of all the swifts examined.

4. SPECIFICATIONS OF MACHINES

4.1 Dixi S.A.

U.K. Agents: None

42 Av. du Technicum,
CH - 2400 Le Loche,
Switzerland.

Although this manufacturer does not produce swifts separately from its spring making machines, their swifts are included for comparison. These lightweight swifts operate on the on-off principle, and the wire is used to make an electrical contact with limit switches so that there is always a small excess of wire to stop the wire pulling tight.

The swifts can handle round or semi-flat wire, of 0.03 - 1mm diameter for round and a minimum thickness of 0.01 mm and maximum width of 7mm for semi-flat wire.

4.2 Maschinenfabrik Karl Hack Kg,

U.K. Agents: None

D-7410 Reutlingen,
Bismarckstrasse 98,
West Germany.

MBH1-EL/MBH2-EL

These two swifts are similar, but the latter is of larger capacity. The former handles wire diameters of 0.1 - 1.2 mm and coil weights of 25kg, whilst the latter takes wire diameter 0.2 - 1.8 mm and coil weights of 50 kg. The motor is electronically controlled and has soft starting and braking for fine wires. The swift can be fitted with additional coil storage if large dwell times in wire feed are required. Both swifts have safety cut out in case of tangling.

MBH3-EL

This is a heavier swift handling wires from 1.5 to 3.5 mm and coil weights of 200 kg. The electronic speed control automatically adjusts to the required speed within the range.

MBH2A/MBH3A

These two swifts are again similar, except for the latter being larger in capacity. The MBH2A handles wire of up to 1.8mm and coil weight of 30kg and the MBH3A will take wires up to 3.5mm and coils up to 150kg.

These swifts automatically adjust to the traction speed by sensing the position of the wire. Additional storage can be fitted if required. Automatic cut outs are fitted in case tangling occurs.

MBH6

This is the heaviest swift in the range, handling coil weights up to 1000 kg and wire diameters of 2.5 - 6mm. The swift uses a hydraulic motor for its power and automatically adapts to the required feed rate. Additional storage can be fitted if required. The swifts can have tall wire plates for the high coil weights, or the more conventional reel.

4.3 Herckelbout-Pernin

Les Preyts	U.K.Agents, Kubach & Sambrook Ltd
05100 Briancon	Clock House
France	Cowfold
	Sussex

This manufacturer produces three motorised swifts the DAS 450 - DAS 600 and the DAS 800. Insufficient information was supplied to include a detailed report on these.

4.4 Okuno Machine Co.Ltd.,

U.K. Agent: None

No. S-10, 1 - chrome

Chihara-cho

Izumiotsu,

Osaka,

Japan.

Okuno Machine Co. Ltd, produce seven motorised swifts, all of

which operate on the on-off principle.

Type ARS - 15H

This the smallest in the range, taking coil weights of up to 15kg and wire diameters of 0.1 - 0.3 mm.

The power comes from a 30W D.C. motor and the on-off control from a lever arm sensing the position of a loop of the fed wire. The lever arm then acts on two limit micro switches. The swift operates with the wire coil in the vertical plane. Cut outs are fitted in case of tangling, the maximum speed is 50 rpm.

Type ARS - 15

This is a larger version of the above, taking coil weight of up to 60kg. and wire diameter of 0.1 - 1.5 mm. The swift holds the coil in the horizontal plane and uses a slightly different loop system for control. This has a maximum speed of 80 rpm and gives a wire feed of 150 m/min.

Type ARS - 30

This swift is similar to the ARS - 15 but of larger capacity and has the D.C. motor replaced by a fixed speed A.C. motor, giving the swift a speed of 50 rpm. and a maximum wire feed of 140 m/min. The swift works on the on-off principle and has cut outs in case of tangling. The swift takes coils of 200 kg and wire diameters of 1.0 - 3.0mm.

Type ARS - 50, ARS - 80

These two swifts are similar, except in physical size, handling wires of 2 - 5 mm, 3 - 8 mm diameter respectively, with the weight 500kg and 1000kg.

The maximum speed is fixed at 50 rpm and gives maximum feed rates of 140, 220 m/min. On-off control is accomplished by means of a lever arm sensing the position of a loop of wire as it pays out. Safety cut outs are included in case of tangling.

4.5 Dr. Ramisch GmbH & Co. U.K. Agents: Burton McCall Ltd.,
415 Krefeld Samuel Street,
Neuer Weg 24 -40 Leicester,
West Germany. LE1 1RU

Type B + Options

This is the smallest in the range and is in the upper size limit of the survey. The type 'B' comes in three coil weight sizes and eleven options.

These options include:-

- G Geared motor maintaining 16 rpm.
- GB Geared motor with built in adjustable brake.
- ESG D.C. motor automatic adjustment to wire demand by feeler and potentiometer (2 - 30 rpm.)
- J Interval control by feeler and limit switch.
- W Interval control by rocker and limit switch for rigid metals.
- E Proximity switch for control of sensitive metals.
- R Slip hub, adjustable for soft starting.
- D Double stand for continuous operation loading whilst paying out.
- H Lifting gibbet with safety tackle for loading swift
- N Head can be fitted 45° from the standard vertical position.
- Se Additional segment.

This swift can also be fitted with a wire accumulator system which allows for varying demand over a cycle without changing the back tension to the coiler. The swifts can be tailor-made to the requirements of the spring maker with regards to wire material, diameters and dimensions.

Controlled amounts of back tension, maximum and minimum run up and braking times can be built into the basic swift. The swifts are built to work with the coils in the vertical and horizontal plane, although some models can be tilted up to 45° or 90° .

4.6 Schenker Maschinen A.G.,
CH-5012 Schonenwerd, U.K. Agents: Colpro Engineering Ltd.,
Switzerland. Moons Moat Ind. Estate,
Padgetts Lane,
Redditch,
Worcs.
B98 ORA

Schenker Maschinen produce swifts handling wire sizes from
0.1 mm - 7 mm diameter.

DHE - 200

This is a lightweight electronically controlled swift. It
can take bobbins, spools or coils of wire up to 15kg in weight.
The speed of the swift is set by the operator to an approxima-
tion of the required speed and limit switches turn the swift
on and off when too little or too much wire is being payed out.
The motor speeds up as quickly as the inertia of the system
allows.

Braking is controlled by electronic elements that reverse the
motor torque so that it can be stopped almost instantaneously.

It has a 0-90 rpm speed range with greater than 90 rpm available
on request.

The motor unit and wire reel can be rotated from the horizontal
to vertical plane if required. It is fitted with safety cut
outs to stop both the coiling machine and swift if the wire
feed is interrupted due to tangling.

The swift is compact so that it may be fitted directly to the
machine. The direction of rotation is reversible as required.

DHE - 600

This swift can handle wire diameters from 0.1 mm up to 1 mm
and coil weights of 60kg.

This unit is again electronically controlled with the added
feature that the braking reaction can be varied for soft
operation if required. The maximum speed is 80 rpm but this

can be increased by the manufacturer.

This swift holds the wire in the horizontal plane but will handle spools and bobbins of wire. The swift is also fitted with a cut out which stops itself and the coiling machine if tangling occurs.

DKE - 800

This swift handles wire diameters of 0.3 - 2 mm in coils of 200kg. The power is from a 3-phase A.C. motor through a variable stepless gear box giving speeds of 4.5 - 22.5 rpm.

The swift operates with the wire coil in the horizontal plane. No braking system is fitted so the swift decelerates due to the friction in the drive system giving a soft operation.

The swift incorporates a safety cut out if the wire tangles or if the feed is interrupted.

DHE - 1200

This is the heaviest swift in the range, taking wire from 0.5 mm - 7 mm in diameter and coil weights of up to 250kg.

The speed is electronically controlled and infinitely variable over its 0 - 60 rpm speed range. This speed can be increased if required. Deceleration is controlled electronically and can be varied as required. This swift is also fitted with a safety cut out in case of tangling.

4.7 Showa Machine Works Ltd., U.K. Agents: None
1 - 27 Mitejima 4 - Chome Nishiyodugawaku,
Osaka,
555 Japan.

Types SR - 20, SR - 50, SR - 100, SR - 150

These four swifts are all similar in operations and handle successively larger loads, 0.4 mm, 1.2 mm, 2 mm, and 3 mm wire diameters and 15kg, 40kg, 80kg, and 120 kg coil weights respectively. The swifts use a D.C. motor and are

infinitely variable over their operating range (SR - 20, 5 - 50 rpm; SR - 50, SR - 100, SR - 150, 7 - 70 rpm) Control is by an on-off system via a tension arm sensing the wire.

The maximum wire feeds are 60, 120, 175, 175 m/min respectively. A timer is fitted (optional on the SR - 20) so that the swift and coiler will stop after a preset period. Cut outs are fitted to stop the swift and coiler if the wire supply ends or tangling occurs. The maximum speeds of the swift can be changed by the manufacturer if required.

4.8 Simplex Rapid, U.K. Agents: S.A.H. Machine Tools Ltd.,
20139 Milano, 78 Hawthorne Lane,
Via c. Bianconi 8. Coventry,
Italy CV4 9DB.

Simplex Rapid produce a total of six self braking and motorised swifts handling wires from 0.1 mm to 6 mm.

Type Z - 1

This is a light weight self braking swift handling wire diameters of 0.15 - 2.00 mm and coil weights of up to 80kg. The braking is accomplished by means of a mechanically operated disc brake when the wire demand is reduced.

Type Z - 2, Z - 2/5 and Z - 2/SW

These swifts handle wire diameters of 0.1 - 1.0 mm and coil weights of up to 25kg with 60kg capacity on request.

They are powered and electronically controlled with an infinitely variable speed of up to 100 rpm. The Z - 2/S and Z - 2/SW run at higher speeds of 180 and 200 rpm respectively.

The maximum and minimum speed are set by the operator and the swift uses a combination of limit switches and potentiometer to find the correct speed for the required demand.

A limit switch stops the swift if the wire demand is too great. An electrical contact is fitted to the coiling machine to stop

both the swift and coiling machine should tangling occur. These swifts have 'soft' braking and acceleration operations for fine wires.

The Z - 2 range can be fitted with a self-centring coil holder if required.

Type Z - 5

This is a non-motorised self-braking swift capable of handling wire of 1 mm - 6 mm, and coil weights of up to 350kg. The self-braking is accomplished by means of an electro-magnetically operated brake which can be adjusted for the feed speed and coil weight used. A simple band brake is also fitted and can be used to apply a constant back tension on the wire. The brake can be connected to the coiling machine's clutch or motor for control. A safety switch is also incorporated to cut the power if tangling occurs.

Type Z - 6, Z - 7, Z - 8

These swifts are a larger version of the Z - 2 range, handling coil weights of 200kg, 350kg and 500kg respectively. These use an electronically controlled motor with a combined proportional and on-off control. The wire feed duration can be changed using a built-in tuning system. There is an adjustable electric brake for soft operations. The Z - 6 can be supplied with 0.8 and 1 mm diameter wire plates with 0.8 and 1 mm diameter cast iron bases.

The swifts are fitted with cut outs if tangling occurs or if the swift is tilted at an angle.

4.9 John H. Smith (Engineers) Ltd.,

Birds Royd Lane,

Brighouse,

Yorkshire.

HD6 1LY

Mark 1

The power driven swift handles nominal wire diameters of up to 3 mm and coil weights of up to 1000kg.

The speed is varied by a 4:1 variable drive to give the required feed rate of up to 75 m/min which can be increased or decreased as the customer requires. The swift is also fitted with an adjustable electro-mechanically operated brake.

The meter is controlled by a swinging arm operating a limit switch to give an on-off system.

Safety cut outs are also included in case tangling occurs, to switch off the swift and feed machine.

Mark 2

This swift is similar to the Mark 1 except that it can take wires of up to 6 mm diameter and has a slightly different and stronger control arm.

4.10	<u>Wafios Maschinenfabrik,</u> Reutlingen, West Germany.	U.K. Agents: Wafios (GB) Ltd., No. 3 Factory, Clydebank Ind,Est., Clydebank, Dunbartonshire,
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AHMI

This is a light and fast motorised swift having a maximum speed of 200 rpm. The swift will carry coil weights of up to 50kg with wire diameter of 0.1 - 1.5 mm. The swift is powered by an electronically controlled motor which is set to the required speed by the operator. The wire feed is controlled by sensors detecting the position of the first wire loop. If the payout is too low the swift speeds up to the higher operator-set speed, and if it is too high the swift slows to the second and slower set speed. The coiling machine and swift are stopped automatically if tangling or other obstruction occurs.

AHM2

This is a larger version of the AHM1 swift, handling coil weights of up to 120kg and diameters of 0.5 - 2.5 mm.

The maximum speed is reduced to 90 rpm but the maximum feed rate is the same at 110 m/min.

The coil holder is low in height, which helps manual loading of the coils of wire.

5. Comparison Chart

Make & Model	Wire Size min & max (mm)	Coil Wt. (kg)	Powered	Method of Control	Max Speed (rpm)	Max Wire Feed (m/min)	Method of Braking	Safety Cut-outs	Wire Accumulator
Dixi as fitted to Machines	0.03 - 1 round section		Yes	On-off			Friction of system	Yes	No
Karl Hack MBH1 - EL	0.1 - 1.2	25	Yes	Electronic Motor proportional control	50	60 m/min with 0.4m dia coil	Friction of drive system	Yes	Optional
MBH2 - EL	0.2 - 1.8	50	Yes		32	60 m/min with 0.6m dia coil		Yes	Optional
MBH3 - EL	1.5 - 3.5	200	Yes		23	60 m/min with 0.85m dia coil		Yes	Yes
MBH2A	1.8	300	Yes		32	40 m/min with 0.4m dia coil		Yes	Yes
MBH3A	3.5	150	Yes		20	50 m/min with 0.85 dia coil		Yes	Yes
MBH6	2.5 - 6.0	1000	Yes		20	60 m/min with 1m dia coil		Yes	Yes

Comparison Chart cont.

Make & Model	Wire Size min & max (mm)	Coil Wt. (Kg)	Powered	Method of Control	Max Speed (rpm)	Max Wire Feed (m/min)	Method of Braking	Safety Cut- outs	Wire Accumulator
Herckelboubt- Pernin									
DAS 450		8	Yes						
DAS 600			Yes						
DAS 800		80	Yes		60	130 m/min with 0.7m dia coil		Yes	No
Okuno									
ARS - 15H	0.1 - 0.3	15	Yes	{Electronic} {Motor {on-off {control	50			Yes	{Small {Capacity
ARS - 150	0.1 - 1.5	60	Yes		80	150 m/min with 0.6m dia coil		Yes	
ARS - 30	1 - 3	200	Yes	{A.C. Motor {on-off {control	50	140 m/min with 0.9m dia coil	{Friction {of drive {system	Yes	Yes
ARS - 50	2 - 5	500	Yes		50	140 m/min with 0.9m dia coil		Yes	Yes
ARS - 80	3 - 8	1000	Yes		50	220 m/min with 1.4m dia coil		Yes	Yes

Comparison Chart cont.

Make & Model	Wire Size min & max (mm)	Coil Wt. (Kg)	Powered	Method of Control	Max Speed (rpm)	Max Wire Feed (m/min)	Method of Braking	Safety Cut-outs	Wire Accumulator
Dr Ramisch GmbH & Co Type B + Options	as required	500	Yes	A.C. or D.C on-off or proportional control	30	75 m/min with 0.8m dia coil	Electric brake variable	Yes	Optional
Schenker									
DHE - 200	0.1 - 0.5	15	Yes	{Electronic} {motor} {using on-} {off control}	0-90	40 m/min with 0.13m dia coil	{Electronic} {variable}	Yes	No
DHE - 600	0.1 - 1	60	Yes	{Electronic} {motor} {using on-} {off control}	0-80	100 m/min with 0.4m dia coil	{Electronic} {variable}	Yes	No
DKE - 800	0.3 - 2	200	Yes	A.C. Motor using on-off control	4.5 - 21.5	40 m/min with 0.6m dia coil	Friction of Drive system	Yes	No
DHE - 1200	0.5 - 7	250	Yes	Electronic motor using on-off control	0-60	225 m/min with 1.2 mm dia coil	Electronic variable	Yes	No
Showa									
SR - 20	- 0.4	15	Yes	{Electronic} {Motor using} {on-off} {control}	5-50	60 m/min with 0.38m dia coil	{Friction} {of drive} {system}	Yes	No
SR - 50	- 1.2	40	Yes	{Electronic} {Motor using} {on-off} {control}	7+70	120 m/min with 0.55m dia coil	{Friction} {of drive} {system}	Yes	No

Comparison Chart cont.

Make & Model	Wire Size min & Max (mm)	Coil Wt. (Kg)	Powered	Method of Control	Max Speed (rpm)	Max Wire Feed (m/min)	Method of Braking	Safety Cut- outs	Wire Accumulator
Showa									
SR - 100	- 2	80	Yes	{Electronic } motor using on- off control}	7-70	175 m/min with 0.8m dia coil	{Friction } drive system }	Yes	No
SR - 150	- 3	120	Yes	{Electronic } motor using on- off control}	7-70	175 m/min with 0.8m dia coil	{Friction } drive system }	Yes	No
Simplex Rapid									
Z - 1	0.15 - 2	80	No	{Electronic } motor using on-off + proportional control }	0-100	180 m/min with 0.6m dia coil	Mechanical disc brake	Optional	No
Z - 2	0.1 - 1	25	Yes	{Electronic } motor using on-off + proportional control }	0-180	340 m/min with 0.6m dia coil	{Friction } of drive system }	Yes	No
Z - 2/S	0.1 - 1	25	Yes	{Electronic } motor using on-off + proportional control }	0-200	360 m/min with 0.6m dia coil	{Friction } of drive system }	Yes	No
Z -2/SW	0.1 - 1	25	Yes	{Electronic } motor using on-off + proportional control }	0-200	360 m/min with 0.6m dia coil	{Friction } of drive system }	Yes	No
Z - 5	1 - 6	350	No	{Electronic } motor using on-off + proportional control }	0-70	200 m/min with 1m dia coil	Electric Brake	Yes	No
Z - 6		200	Yes	{Electronic } motor using on-off + proportional control }	0-70	200 m/min with 1m dia coil	{Friction } of drive system }	Yes	No
Z - 7		350	Yes	{Electronic } motor using on-off + proportional control }	0-50	190 m/min with 1.2m dia coil	{Electric } variable }	Yes	No
Z - 8		500	Yes	{Electronic } motor using on-off + proportional control }	0-40	150 m/min with 1.2m dia coil	{Electric } variable }	Yes	No

Comparison Chart cont.

Make & Model	Wire Size min & max (mm)	Coil Wt. (Kg)	Powered	Method of Control	Max Speed (rpm)	Max Wire Feed (m/min)	Method of Braking	Safety Cut- outs	Wire Accumulator
John H. Smith									
Mark 1	- 3	1000	Yes	{A.C. Motor } {using on- } {off control }		75 m/min	{Electric- } {Mechanical } {Brake }	Yes	No
Mark 2	- 6	1000	Yes			75 m/min		Yes	No
Wafios									
AHM1	0.1 - 1.5	50	Yes	{Electronic } {motor } {using on- } {off control }	0-200	125 m/min with 0.4m dia coil		Yes	No
AHM2	0.5 - 2.5	120	Yes		0-90	110 m/min with 0.8m dia coil		Yes	No

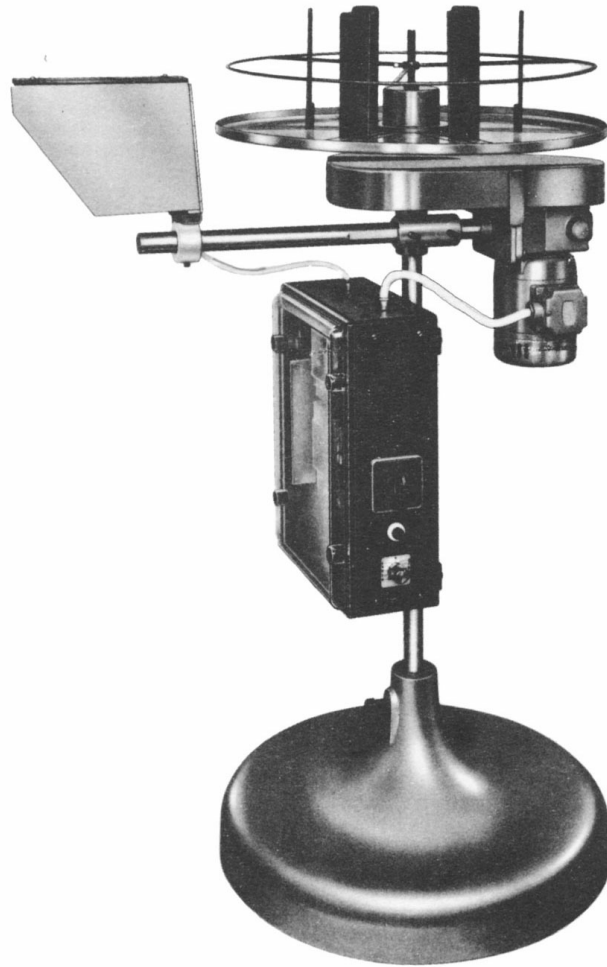
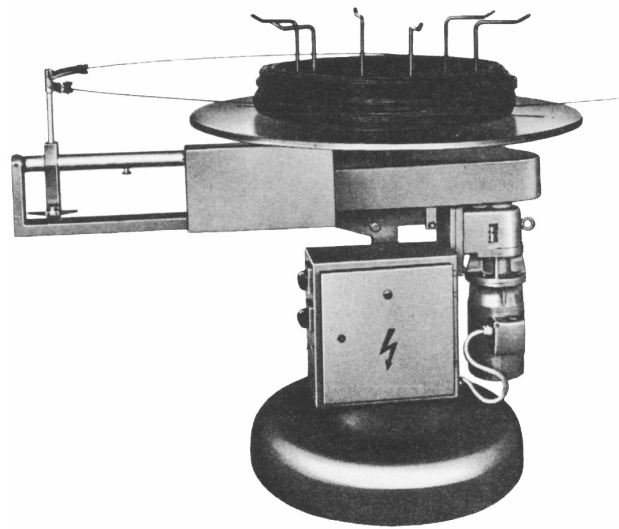


fig 6.1/6.2 Karl Hack MBH1-EL/MBH2-EL



6.3 Karl Hack MBH 3-EL

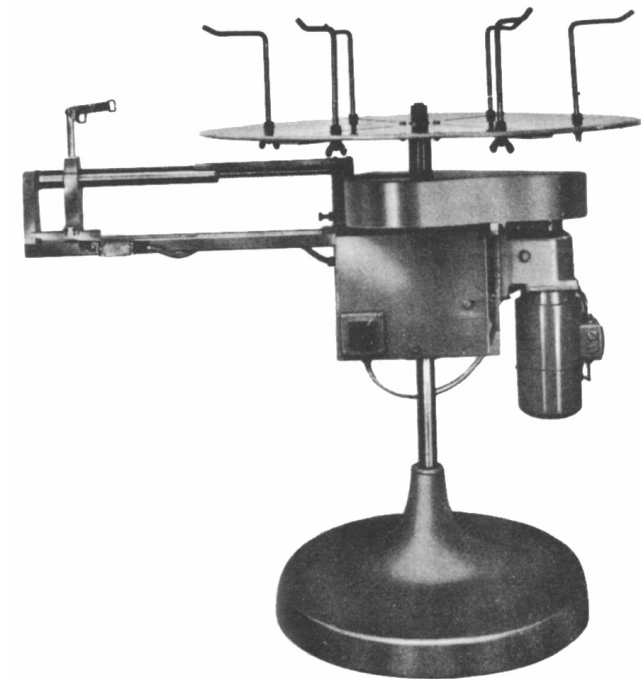


fig 6.4/6.5 Karl Hack MBH 2/A MBH 3/A

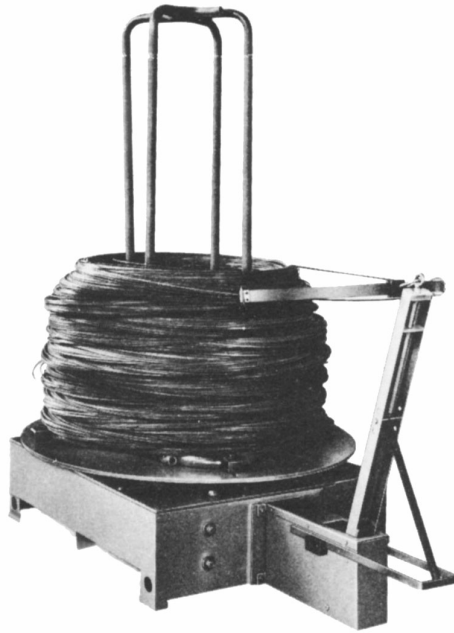


fig 6.6 Karl Hack MBH 6

ARS-15

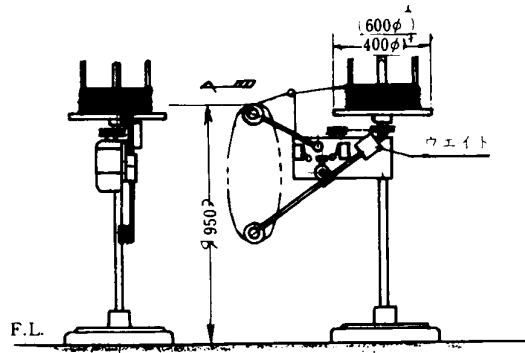


fig 6.7 Okuno ARS 15

ARS-15H

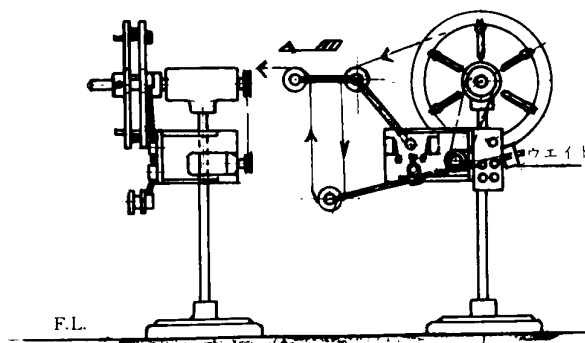


fig 6.8 Okuno ARS 15H

ARS-30

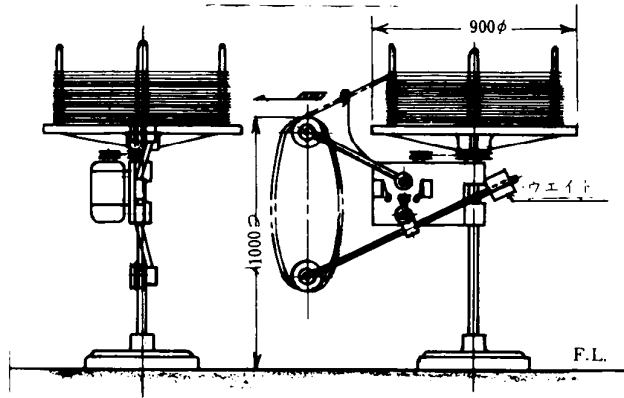


fig 6.09 Okuno ARS - 30

ARS-50

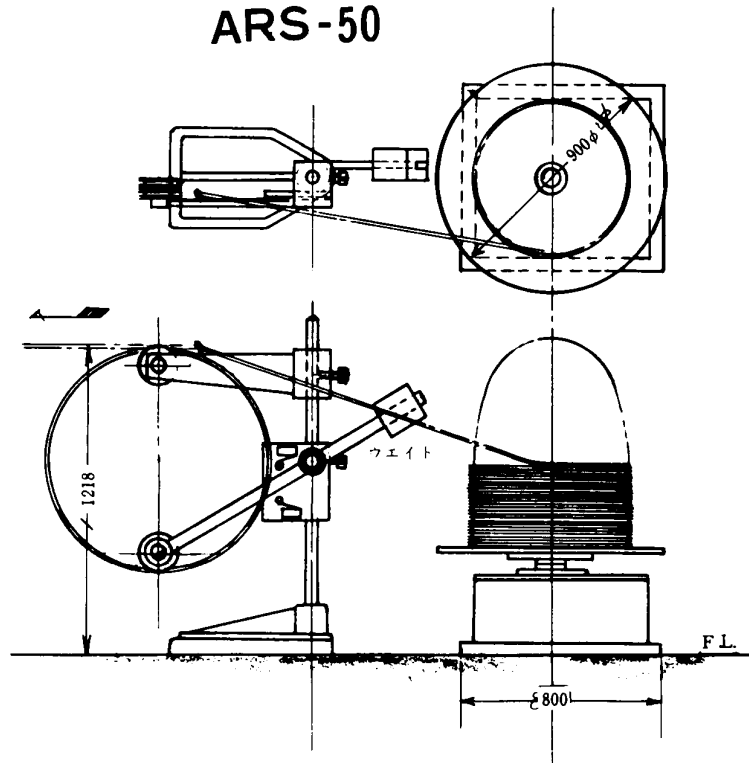


fig 6.10 Okuno ARS - 50

ARS-80

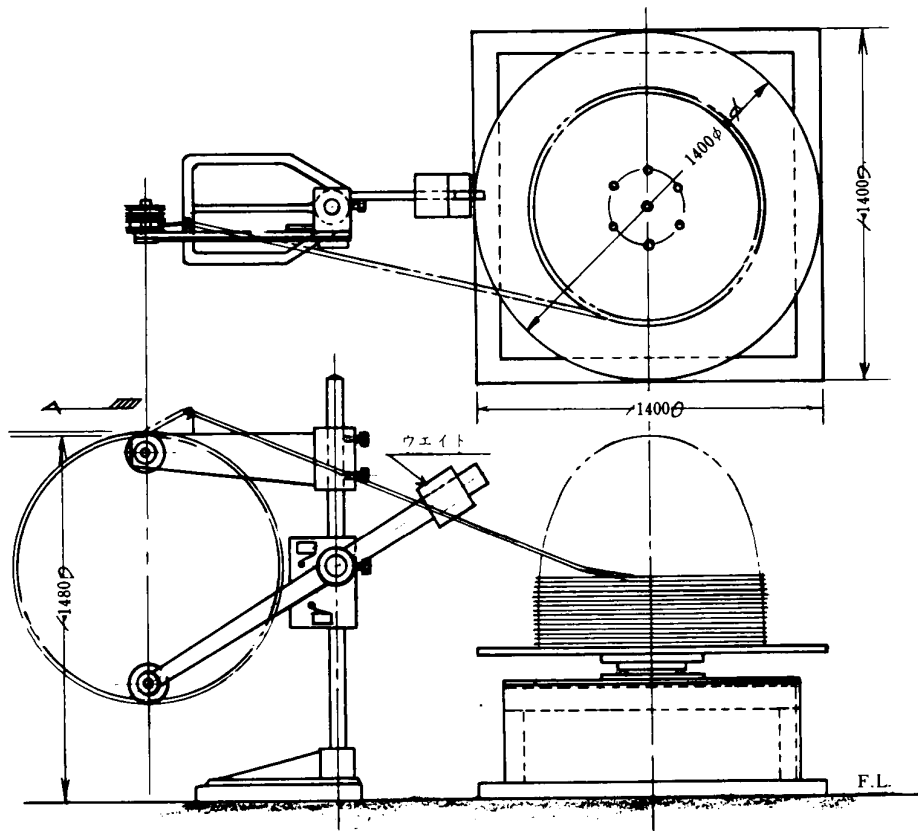


fig 6.11 Okuno ARS - 80

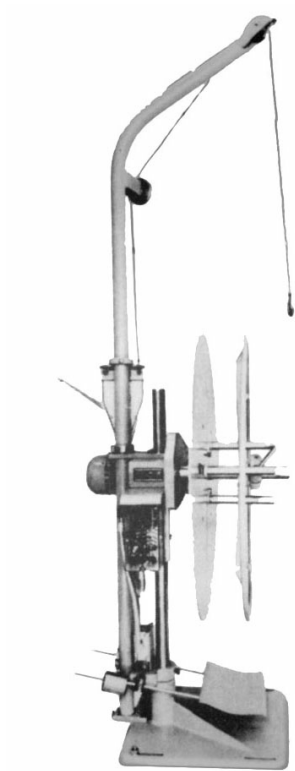


fig 6.12 Dr Ramisch BI5 OGNR+ H



fig 6.13 Dr Ramisch BI5 ZGEN

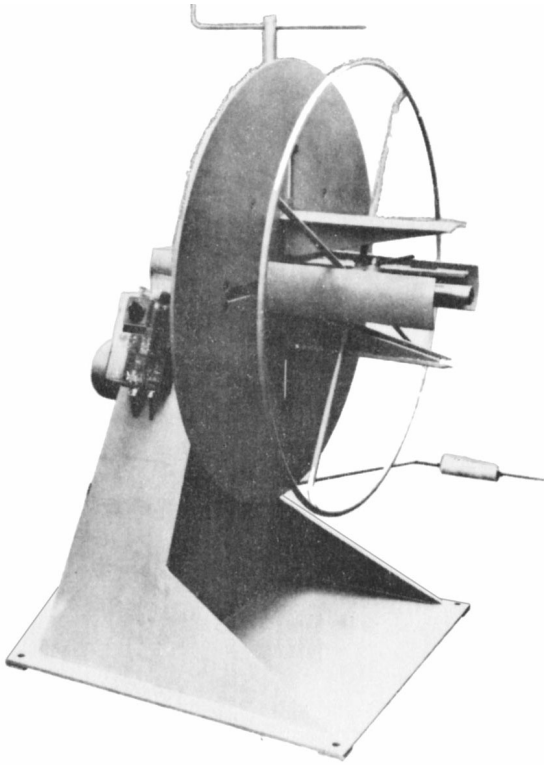


fig 6.14 Dr Ramisch B50 ZGJR

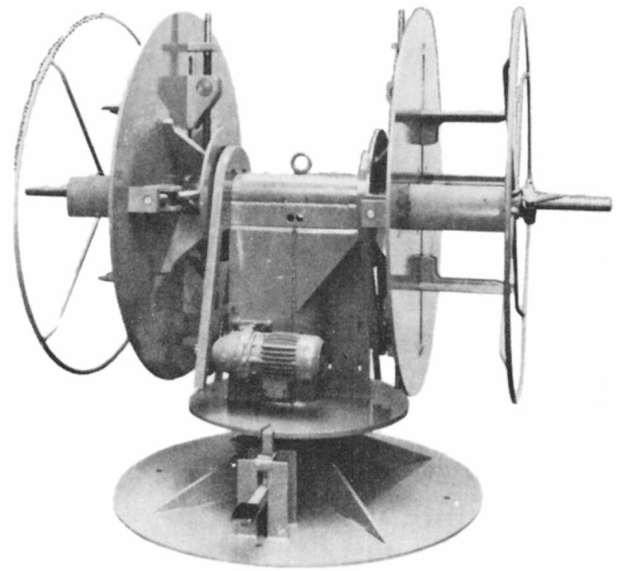


fig 6.15 Dr Ramisch B 50 ZDGJR

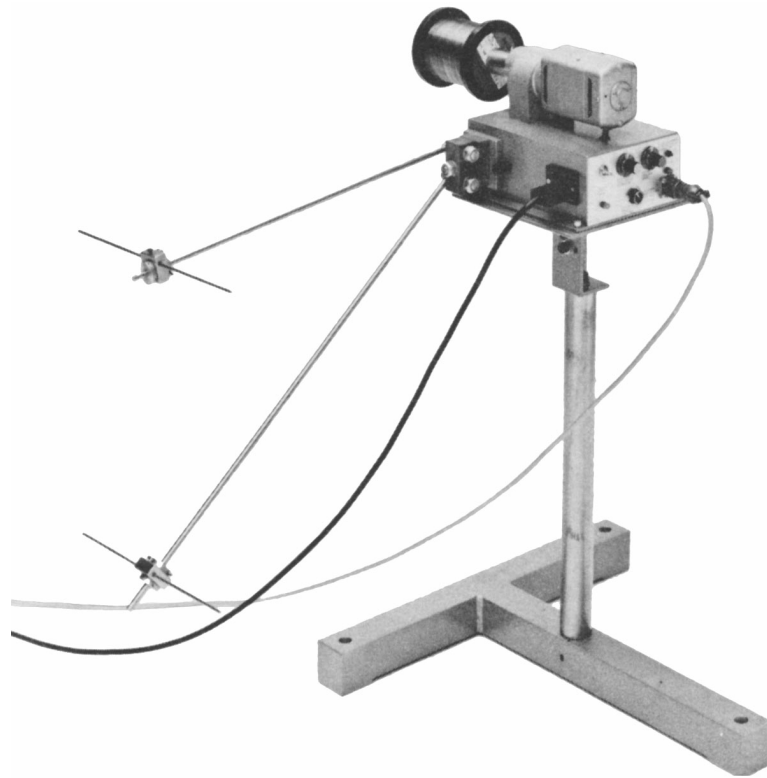


fig 6.16 Schenker DHE 200

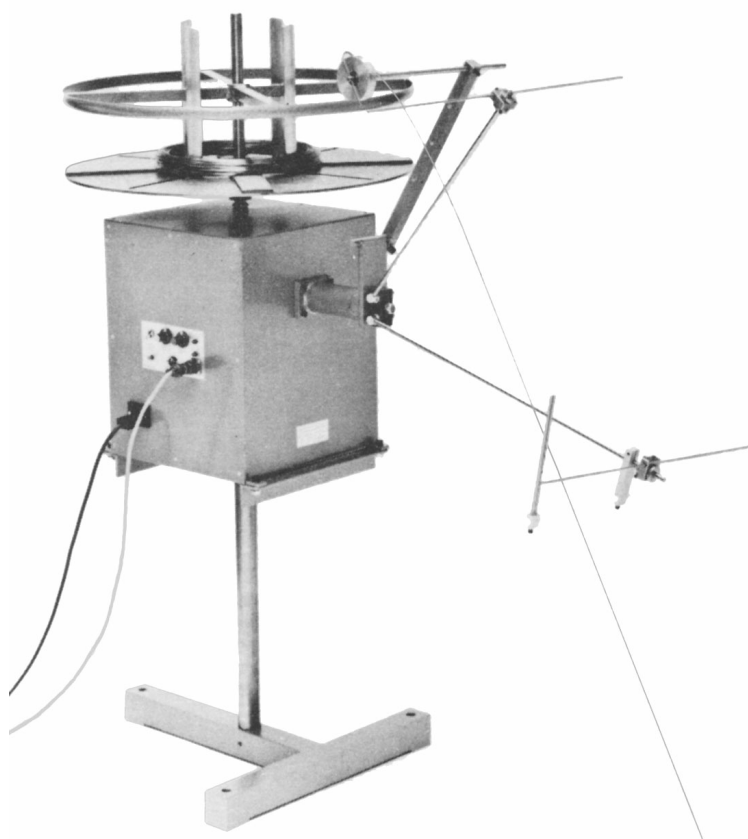


fig 6.17 Schenker DHE 600

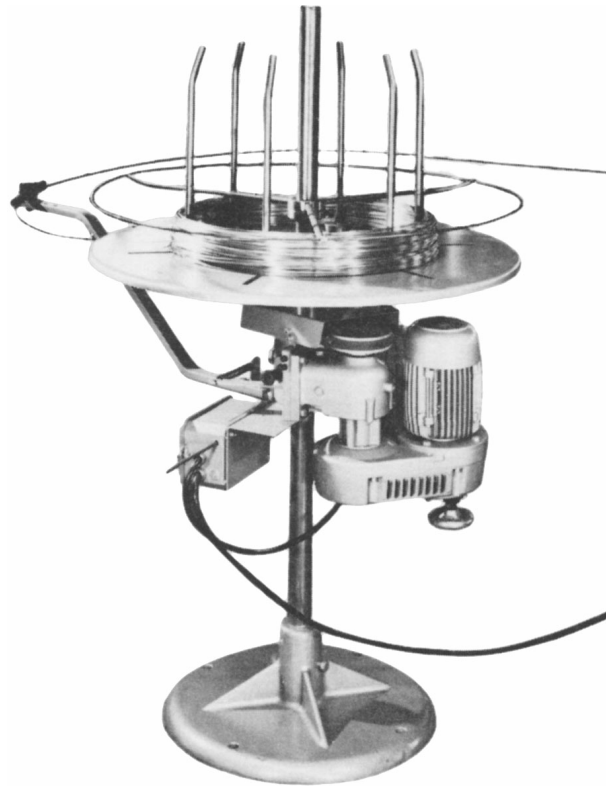


fig 6.18 Schenker DKE 800

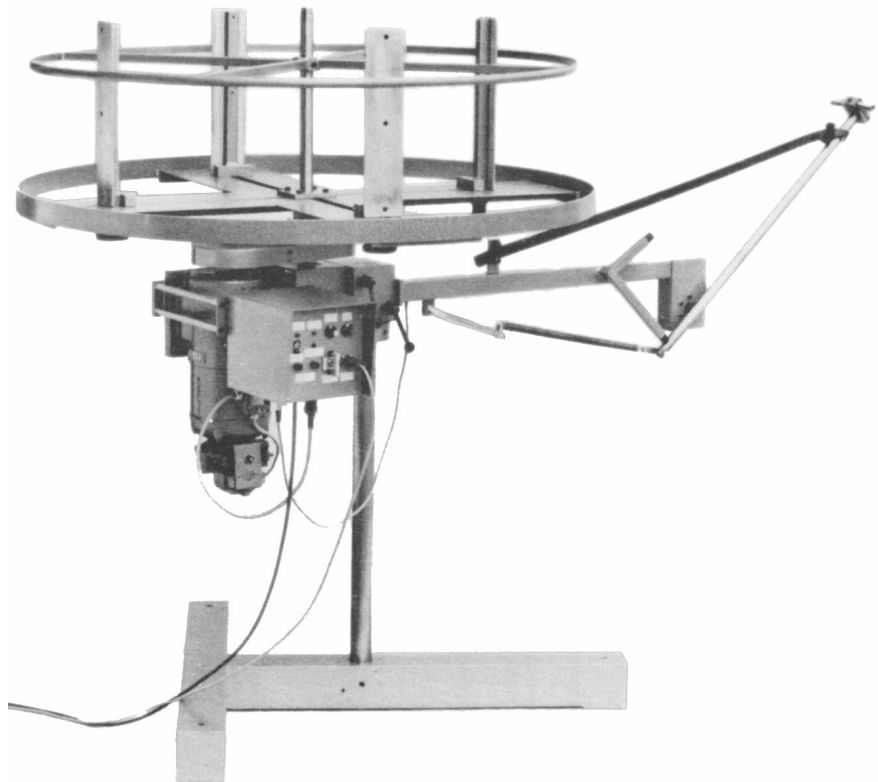
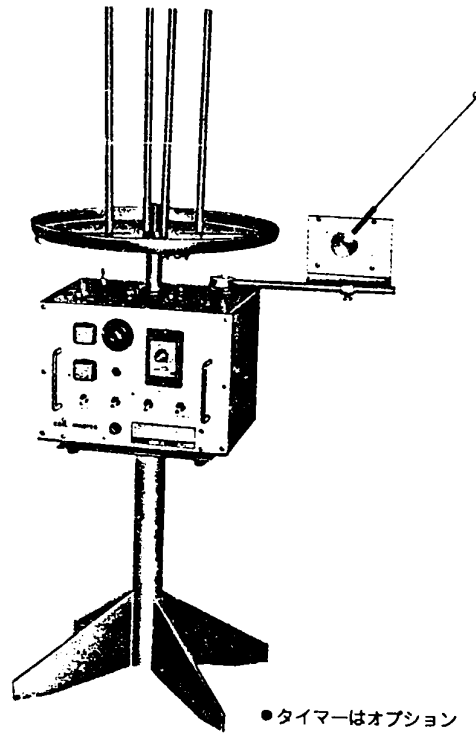


fig 6.19 Schenker DHE 1200



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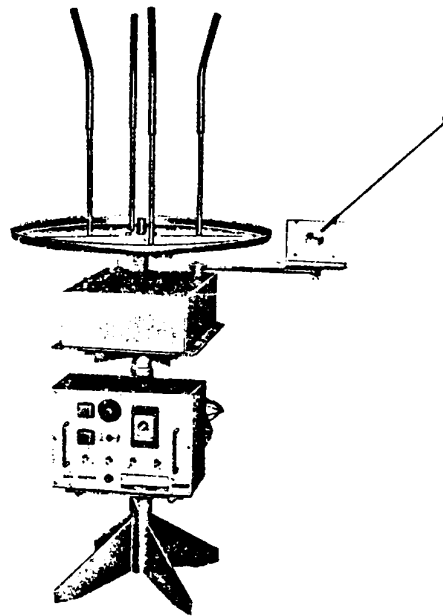


fig 6.20 Showa SR 20 /SR 50

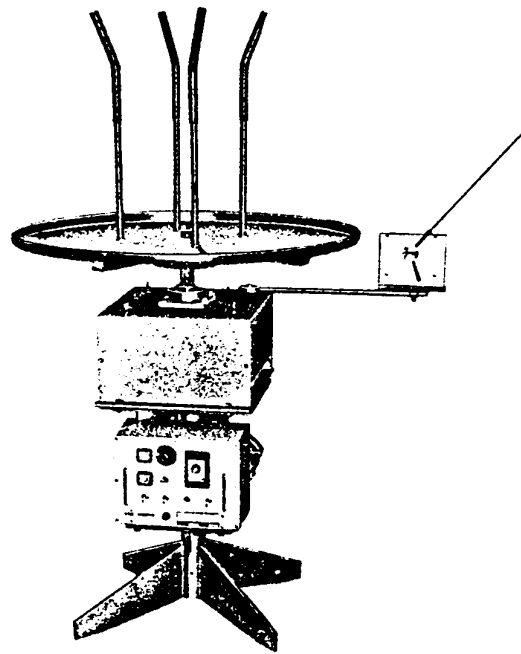


fig 6.21 Showa SR 100/ SR 150



Fig. 6.22
Simplex Rapid Z-1

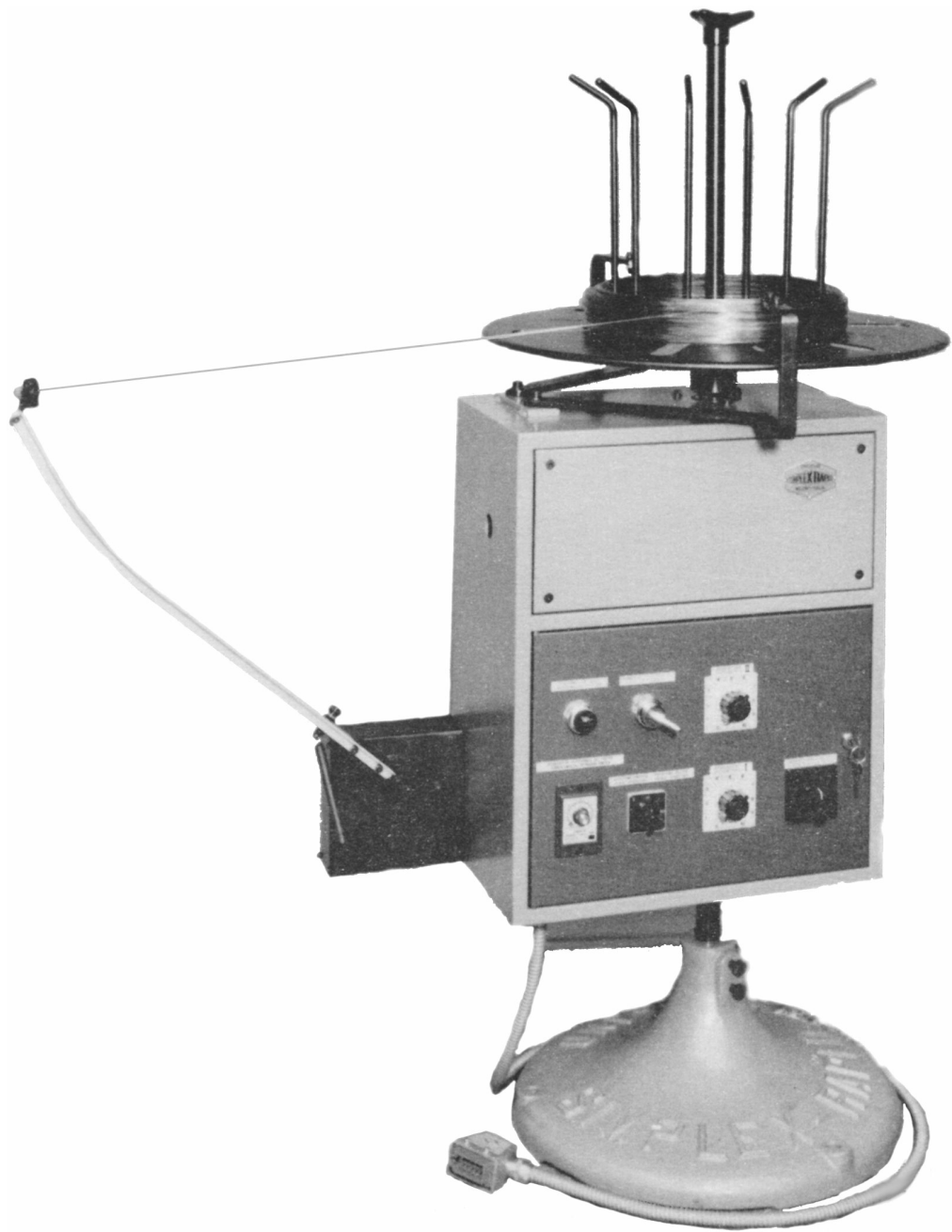


fig 6.23 Simplex Rapid Z - 2S

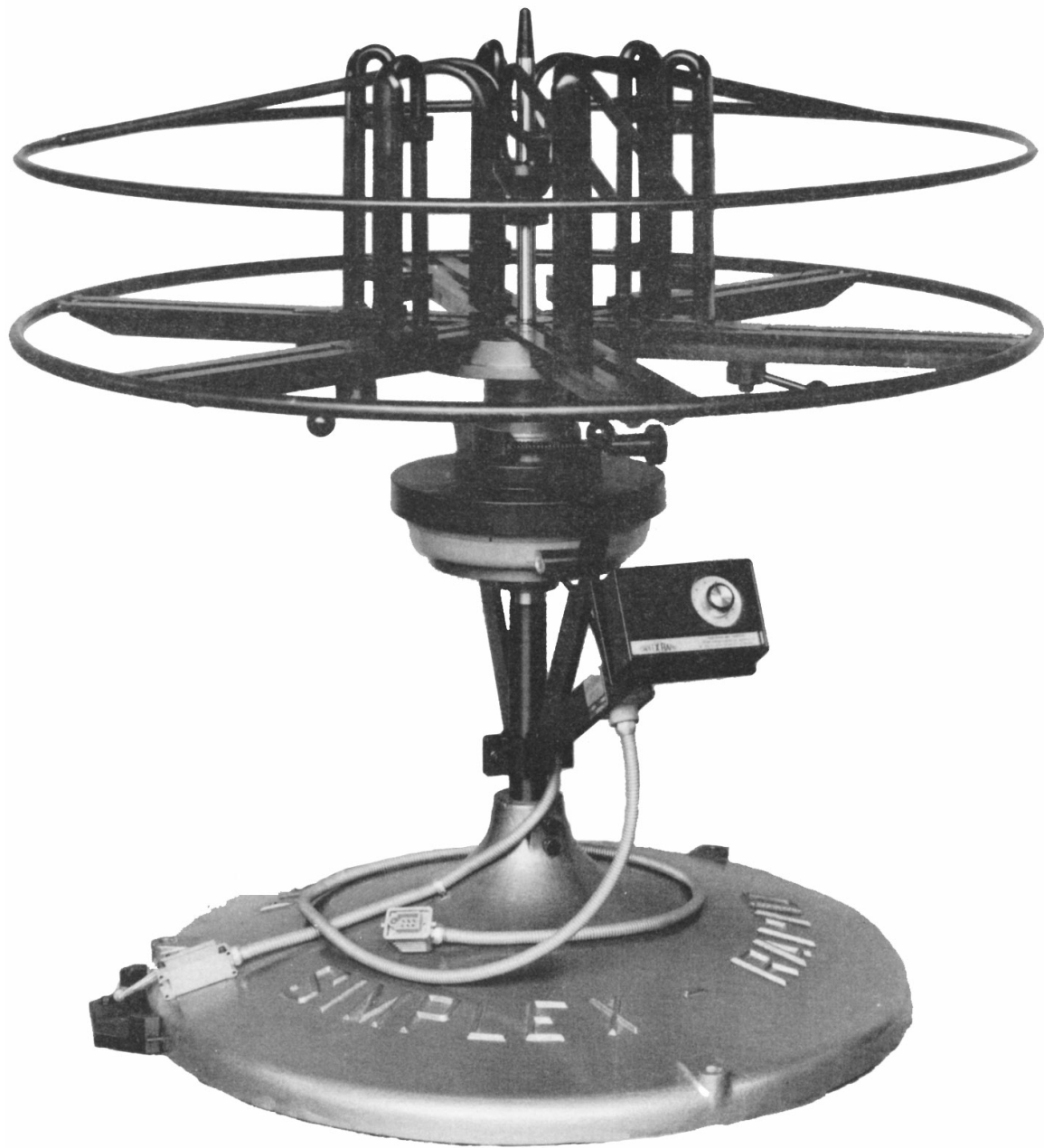


fig 6.24 Simplex Rapid Z - 5

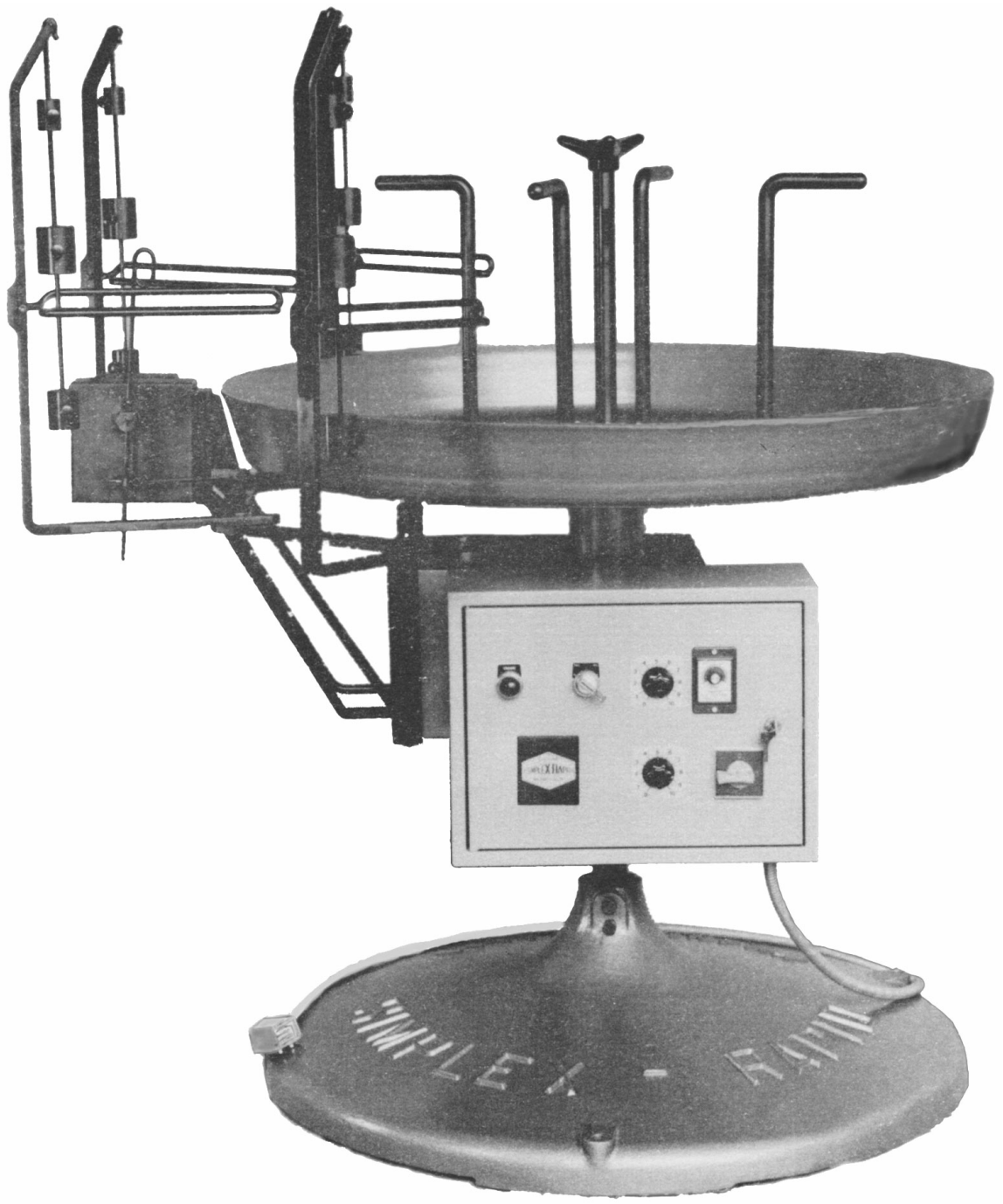


fig 6.25 Simplex Rapid Z - 6

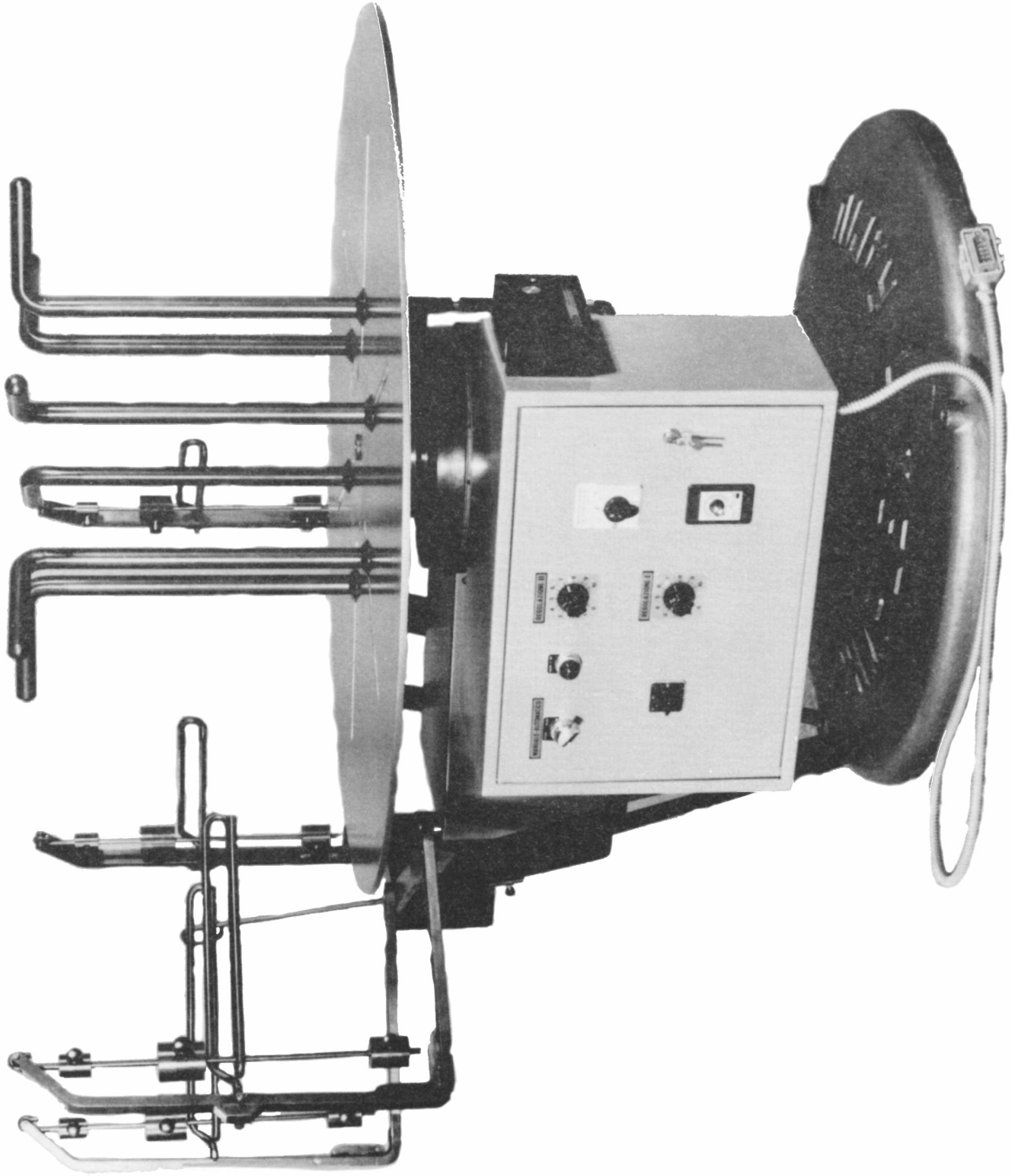


fig 6.26 Simplex Rapid Z - 7

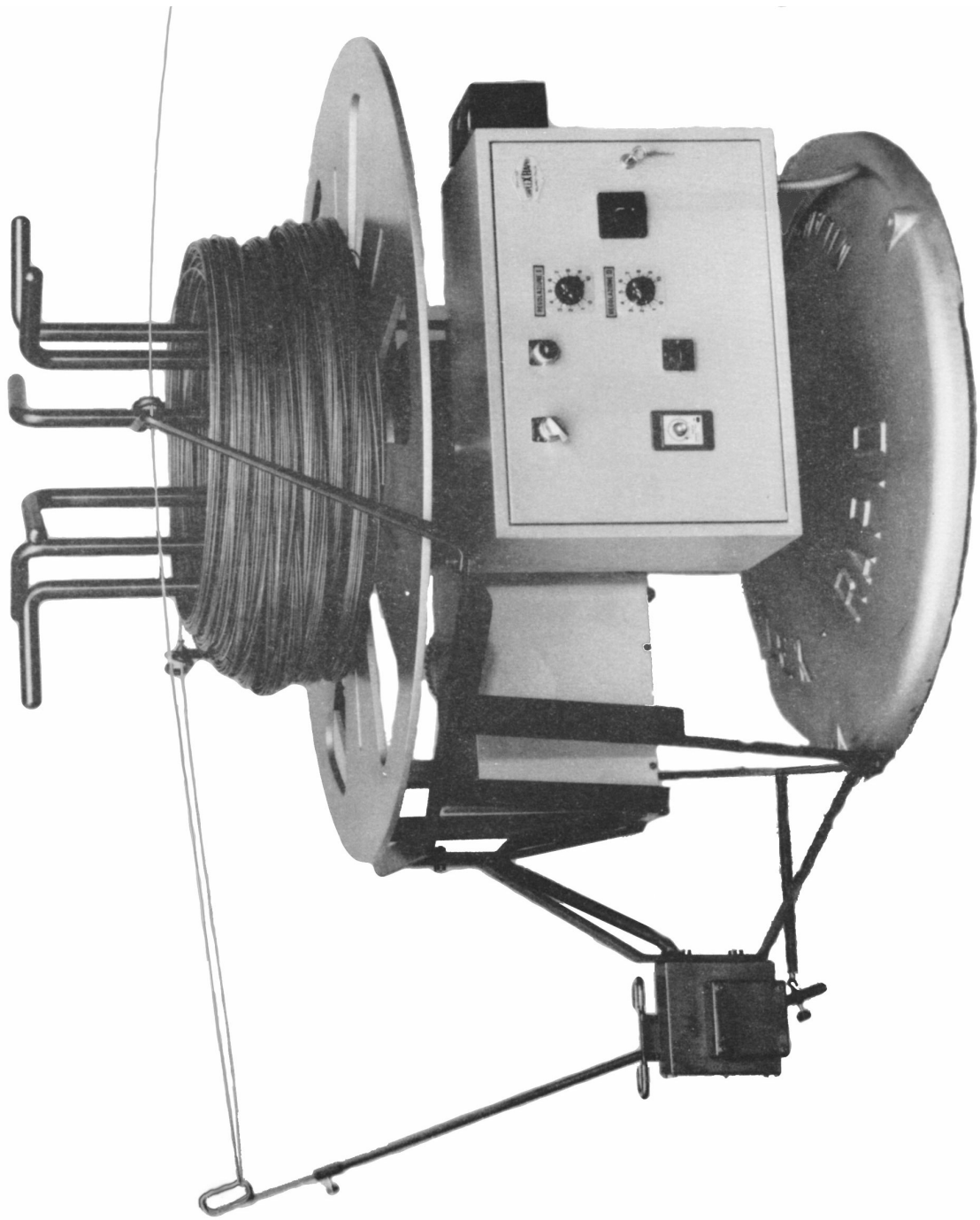


fig 6.27 Simplex Rapid Z - 8

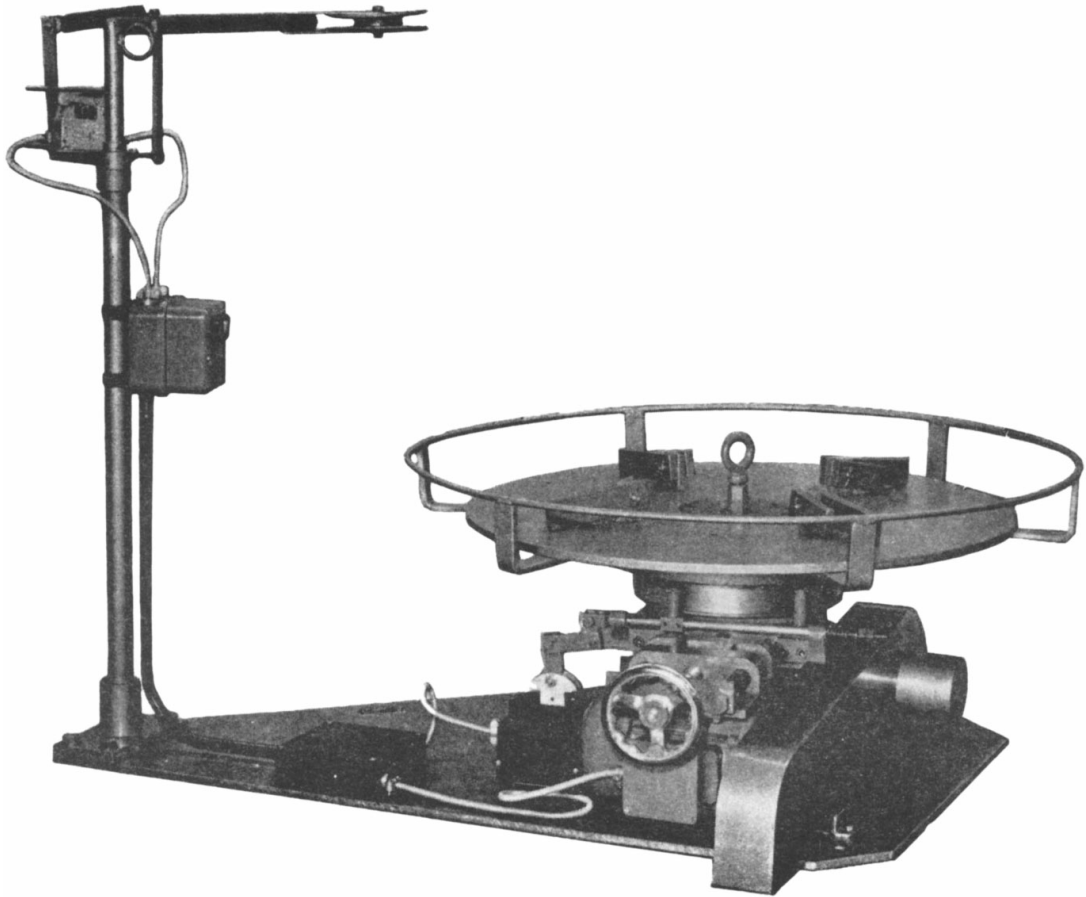


fig 6.28 John H Smith MK1

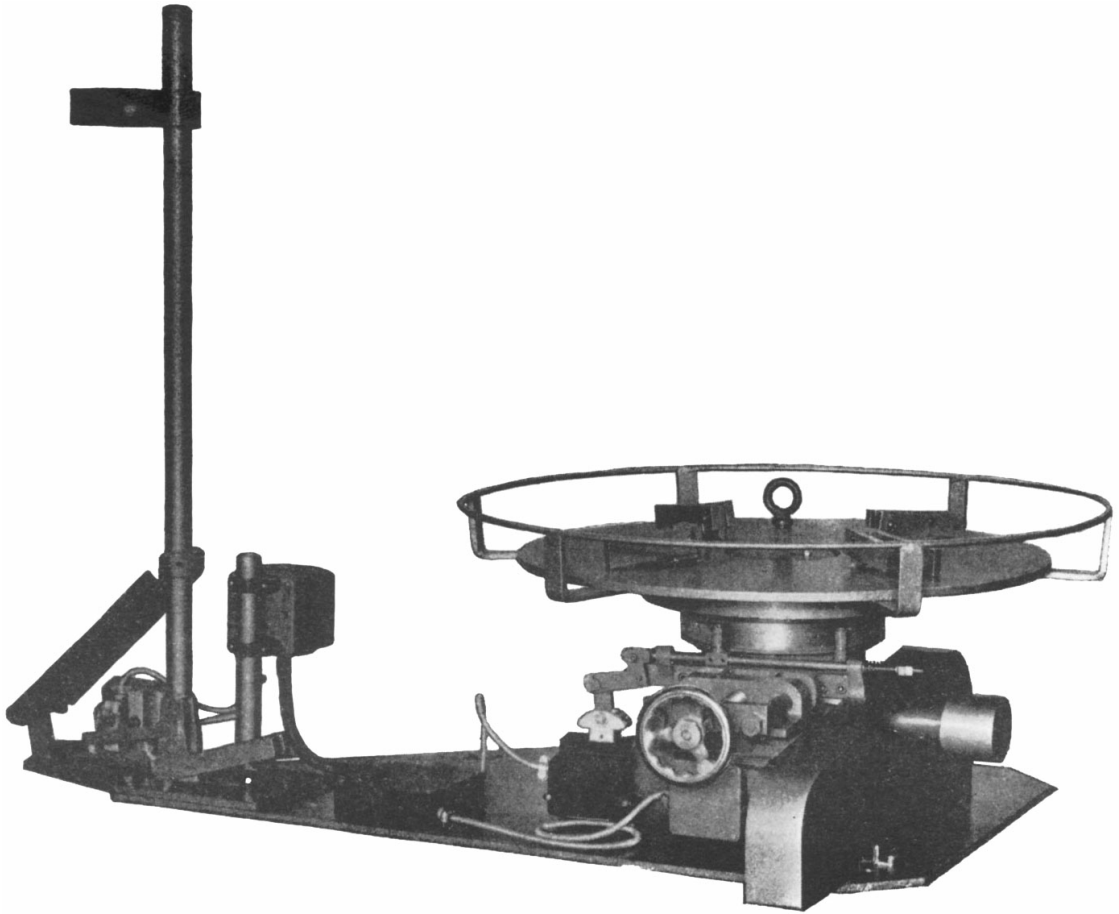


fig 6.29 John H Smith MK2

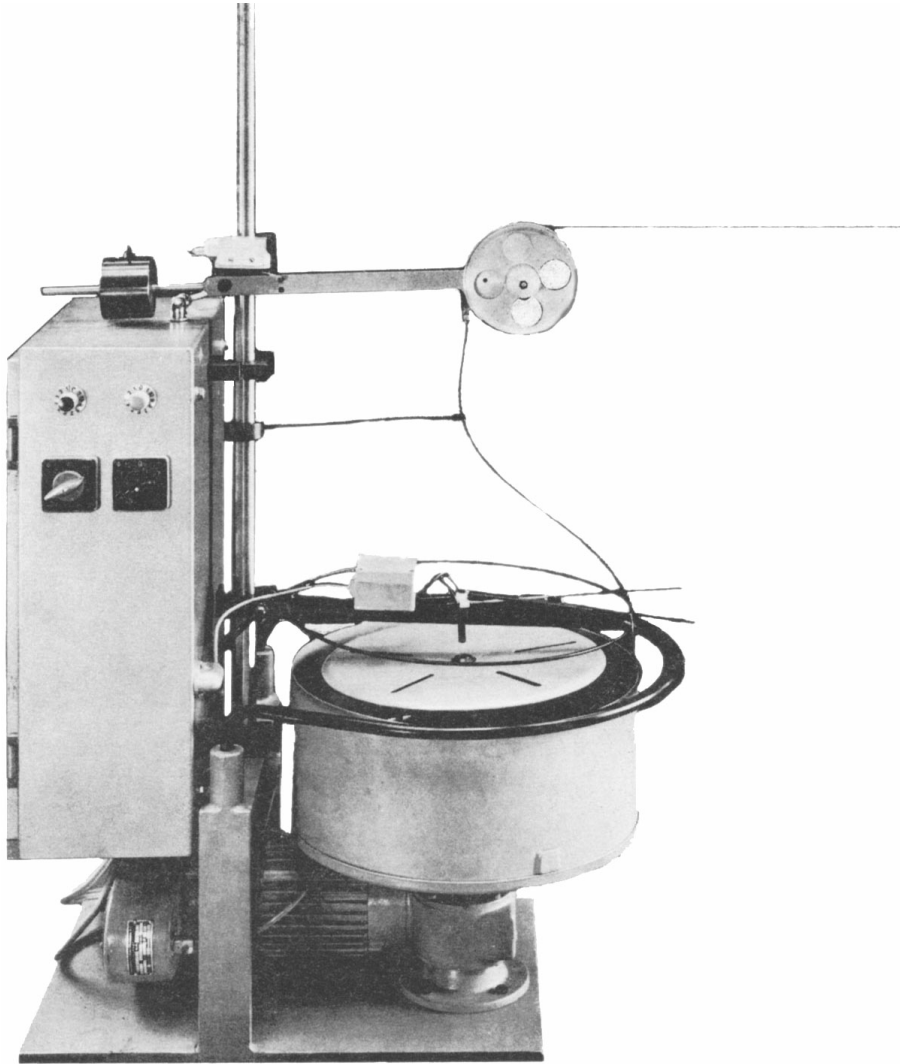


fig 6.30 Wafios AHM 1

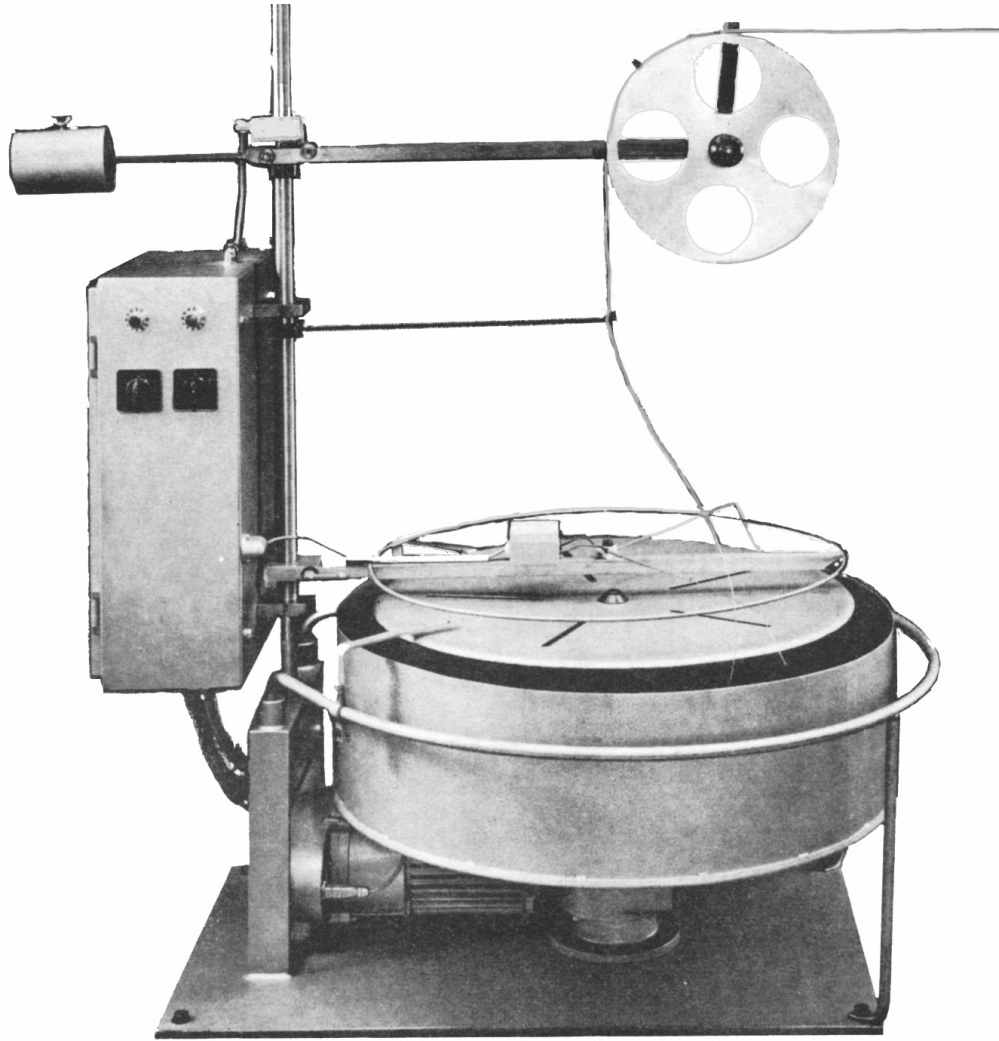


fig 6.31 Wafios AHM 2