

ORION-EMG
"H Y G R O M A T I C"
MOISTURE METER
TYPE 2829

HYGROMATIC

MOISTURE METER

Type "ORION-EMG 2829"

Application

A constantly recurrent problem of primary industries engaged in the processing of cereals is the quick and dependable determination of the moisture contained in various grains. Different measuring methods have been practised for a considerable time, none of them being, however, comparable in simplicity with the electronic procedure which determines the relative humidity of the test substance by reducing the test to the measurement of a single electric quantity, notably of capacity /C/.

The HYGROMATIC Moisture Meter Type ORION-EMG 2829 is suitable for determining the humidity not only of cereals but of any other granular or pulverulent substance each time using a different measuring vessel /condenser/ suitable for the particular test.

The relative measuring methods are under constant improvement and the manufacturers make a point of furnishing a variety of measuring vessels with the relative calibration scales for continually supplementing the basic apparatus with accessories more and more extending its scope of application.

Description

The operation of the HYGROMATIC Moisture Meter is based upon the interdependence exist-

ing between the dielectric properties of a hygroscopic /humidity absorbing/ substance and the amount of moisture it contains. The dielectric strength varies nearly in proportion to the humidity of the material. The substance is made to act as the dielectric medium of condenser designed for the purpose and the corresponding capacity variations of the latter are measured in an electric circuit and determined by readings taken from the meter scale.

As to its electrical design, the HYGROMATIC Moisture Meter consists of the following principal parts:

1. Calibrated /standard/ condenser
2. Measuring condenser vessel
3. Oscillator
4. Vacuum-tube voltmeter
5. Indicating meter
6. Mains power supply unit

The test substance, acting as a dielectric medium, alters the capacity of the measuring condenser which, coupled in series to the calibrated /standard/ condenser, forms a voltage divider. Constant power for the divider which includes the two mentioned condensers, is supplied through one part /Vlb/ of a double triode by an electronically coupled oscillator working at a frequency of 2 Mc/s.

The stability of the oscillator in frequency and elimination of disturbing effects are ensured by safety temperature compensation and screening resp.

The oscillator voltage arising on the voltage divider is distributed in the ratio of the two condenser capacities. The second part

of the former double triode /V1a/ acts as a vacuum tube voltmeter which measures the rate of voltage drop on the measuring condenser.

Voltage and current for the various stages of the apparatus are obtained from the mains power supply unit which furnishes a stabilized anode voltage for the double triode. A mains transformer acting as saturated core transformer compensates the mains voltage fluctuations and warrants the constancy of the results.

The measuring process is greatly simplified by the circumstance that the basic scale of the instrument dial covers the entire measuring range without any changing. Thus, by a preliminary measurement, a tentative humidity range can be determined within which the precise measurement is subsequently to be taken. Marked on the basic scale are four sections, each corresponding to a spread band. By a switching-over to the particular range each section of the basic scale extends itself to the entire scale length. Marked on the band-spread scales are the most usual humidity percentages of the three principal sorts of grain. Separate calibrated scales corresponding to the extended ranges and indicating the humidity rates of wheat, rye and barley, can be fixed on to the basic instrument by a single movement.

A measuring condenser type 2829/2 with scales calibrated according to the extended ranges can be supplied on separate request for the test of maize, peas and sunflower seeds.

Operation

The apparatus works along the following principle, schematically shown in Fig.4:

One half V_{1b} of the double triode operates as an electronically coupled oscillator at a frequency of 2 Mc. The oscillator voltage is coupled through the standard condenser /C 3/ to the other half V_{1a} of the double triode which features a grid rectifier type vacuum tube voltmeter. The wire potentiometer /P 11/ serves for the electric zeroing of the indicator instrument /M/.

The values of the set of resistors and wire potentiometers /R8 - P1/, /R9 - P2/, /R10 - P3/, /R11 - P4/ and /R12 - P5/ have been so selected that the anode voltages in either half of the double triode admit of being equalized in correspondence to the particular measuring range.

Considering the very wide measuring range of the apparatus, a single scale would hardly offer adequate readings. Therefore, in compliance with the several measuring ranges, a set of resistors and potentiometers /R1-P6/ and /R2 - P7, P8, P9, P10/ has been provided which, mounted on common shafts with the sets mentioned above and operating as series resistors, regulate the sensitivity of the indicator instrument /M/, determining the magnitude of the final deviation in the several ranges. Zero adjustment in the various measuring ranges is executed by the corresponding values of the set of resistors and potentiometers /R8 - P1/, /R9 - P2/, /R10 - P3/, /R11 - P4/ and /R12 - P5/. The measuring range

of the HYGROMATIC Moisture Meter is divided into five ranges. The lowest reading accuracy is 0,1 % relative humidity in ranges 3, 4 and 5. The measuring condenser C_k containing the test substance is coupled to points 2 and 3 of the apparatus and forms, in conjunction with the standard condenser C_3 , a voltage divider. The part V_{1a} of the double triode operating as vacuum tube voltmeter measures the voltage drop on the measuring condenser; variations in the anode current of the tube can be ascertained by a reading taken from the indicating meter M which is calibrated in percentages of water content.

Measuring condenser type	Test substance	Volume	Initial capacity
2829/1	Wheat, rye, barley	300 g	7,5 pF
2829/2	Maize, peas, sun-flower seeds	400 g	7,5 pF

The capacitors C_1 and C_2 which are connected in series with the measuring condenser C_k serve partly for extending or restricting the scale and partly for safeguarding the indicator instrument against damage by an occasional short-circuit of the measuring condenser C_k .

The capacitors C_6 and C_7 are used for grounding the two anodes of the double triode in respect of high frequency. An incorporated saturated core transformer T_1 and a separate stabilizer tube V_2 provide the apparatus the required constancy. The oscillator is temperature compensated. Mains voltage fluctuations of $\pm 10\%$ leave the apparatus practically unaffected.

SETTING INTO OPERATION

Fig.2. shows the front panel with control knobs and indicator instrument, Fig.3. the mechanical layout, Fig.4. the detailed electric connection diagram, and Fig.5. the measuring condenser.

The apparatus which is factory-adjusted to 220 V can be switched over to 110 V by means of a change-over switch arranged below a small plate at the rear of the case. The device works with alternating current only.

Before switching on the apparatus set the instrument pointer to zero by means of the zero adjusting knob. After adjusting and checking the mains voltage insert the connecting cord into the plug socket and bring the switch /S 2/ on the front plate in to the "ON" position. The pilot lamp lights up to indicate that the apparatus is ready to use. Bring the switch /S 3/ to the "METER ON" position. After a few minutes the instrument pointer deflects. Now set the instrument electrically to zero, using the potentiometer /P 11/ on the front panel. The side wall terminals of the measuring condenser remain unconnected. During this procedure the switch /S 1/ is in position 1 or 2. If it is set to position 3, 4 or 5, the instrument pointer will deflect to the left. Zeroing is preferably performed in range 2, which is more sensitive than range 1.

Let the switched-on apparatus heat up for about 30 minutes. If the zero point moves away in the meantime, readjust it with the potentiometer "ADJ" /P 11/.

Hereafter the apparatus assumes its final temperature to which the specified measuring accuracy rates are given. In ranges 1 and 2, the instrument abides at zero without the measuring condenser being connected. After finishing the above operations place the measuring condenser /vessel/ in the connecting terminals /terminals 2 and 3/ on the side of the apparatus. Now the instrument pointer will deflect, showing a greater deflection in range 2 than in range 1. Range 1 serves only for a rough estimation of the unknown humidity percentage which can be determined precisely after a change-over to the corresponding measuring range. Before measurement set the switch /S 1/ to position 1, and the apparatus is instantly ready for service.

MEASUREMENT /with condenser type 2828/1/
Cereals /wheat, rye, barley/

Set the switch /S 1/ to position 1 or 2. Withdraw the small measuring condenser from the side of the apparatus whereupon the instrument pointer settles at zero. Correct occasional inaccuracy of zero indication by turning the knob of potentiometer "ADJ" /P 11/. Now connect the measuring condenser to the side of the apparatus and set the switch /S 1/ to position 1.

Set the upper and lower locking device of the measuring condenser to position "OFF" and pour the test substance into the funnel. At least 300 gramm sample is required so that it should cover completely the inner electrode. Bring the upper locking device into the "ON" position whereupon the sample will drop into the measuring condenser.

It should be emphasized that the sample must entirely cover the inner electrode or else the calibrated scale values will prove misleading. After the sample has been poured in, the instrument pointer deflects, indicating the particular range of the basic scale in which the measurement is to be performed / in the present instance range 3/. Now set the proper scale /e.g. the WHEAT scale if wheat is the object of the test/ on the meter. Set the switch /S 3/ on the front plate to the "METER OFF" position, and the switch /S 1/ in position 3, thereafter turn the switch /S 3/ to the "METER ON" position and determine the correct value directly in humidity percentage by a reading from the wheat scale. The sample can be removed from the measuring condenser by opening the lower locking device. To this end bring the lower locking device into the "ON" position and allow the sample /e.g. wheat/ to drop into the small vessel supplied for this purpose.

To achieve an accuracy higher than 0,5%, repeat the test at least three times and find the arithmetic mean of the findings /each test takes 30 seconds/.

$$N \% = \frac{\text{Sum of test results}}{\text{Number of tests}}$$

$$f.i.N \% = \frac{14,5 + 14,2 + 14,7}{3} =$$

$$= 14,466 \text{ rel.hum.\%}$$

Calibration refers to a temperature of 20°C. Any deviation of the test substance from that temperature must be duly taken into account.

According as the temperature is above or below 20°C 0,1 % after each centigrade must be subtracted from or added to the measured value /see Technical Data/.

Example: Let it be assumed that the relative humidity of 14,466 % in the former instance has been determined at a temperature of 24°C i.e. four degrees above 20°C . Hence $4 \times 0,1 = 0,4$ % must be subtracted from the value measured which gives the real humidity as $14,466 - 0,4 = 14,066$ % rel.hum.

The pouring aperture of the measuring condenser can be varied through the insertion of fittings delivered together with the device. When measuring wheat, rye or barley it is advisable to use the biggest fitting type ORION-EMG 2829-11/T with a diameter of 30 mm.

The other fittings assures the uniform penetrating of smaller granular goods, like poppy-seed, lentile, tea or the same, in the calibrating process.

MEASUREMENT /with condenser type 2829/2

Maize, peas, sunflower seeds

For these tests use a cylindrical condenser of larger diameter. Otherwise the test is performed exactly as described above. The minimum quantity required is appr. 400 grammes.

Calibration

The apparatus has been calibrated along the standard drying cabinet principle. According to national standards, which specify 4 hours for humidity determination at $105 \pm 2^{\circ}\text{C}$, the apparatus has been calibrated at constant weight.

TECHNICAL DATA

for measuring condenser type 2829/1

Test substance	WHEAT
measuring limits /ranges	
3 and 4/	8 to 22% rel.hum.
measuring accuracy	
/at 20°C/	±0,5 % rel.hum.
Test substance	RYE
measuring limits /ranges	
3 and 4/	10 to 23% rel.hum.
measuring accuracy	
/at 20°C/	±0,5 % rel.hum.
Test substance	BARLEY
measuring limits /ranges	
2, 3, 4/	10 to 22%rel.hum.
measuring accuracy	
/at 20°C/	±0,5 % rel.hum.

for measuring condenser type 2829/2

/on request only/

Test substance	MAIZE
measuring limits /ranges	
3, 4, 5/	8,5 to 35%rel.hum.
measuring accuracy	
/at 20°C/	± 1 % rel.hum.
Test substance	PEAS
measuring limits /ranges	
3 and 4/	10 to 21%rel.hum.
measuring accuracy	
/at 20°C/	±0,5 % rel.hum.
Test substance	SUNFLOWER SEEDS
measuring limits /ranges	
2, 3, 4/	10 to 20% rel.hum.
measuring accuracy	
/at 20°C/	±0,5 % rel.hum.

Electron tubes

	1-ECC 40
	1-VR 150
	1-6X4
Pilot lamp	6,5 V/0,1 A
Mains supply	110/220 V, 50 cycles
Consumption	appr. 20 W
Finish	varnished sheet-steel case with leather handle
Dimensions	200x265x150 mm
Weight	appr. 17.5 lbs /8 kg/

Accessories:

2829/1	- measuring condenser
2829/9	- pouring dish
2829/11 s	- wheat scale
2829/12 s	- rye "
2829/13 s	- barley "
2829-11/T	- pouring hole diminishing fitting diam. 30 mm
2829-12/T	- pouring hole diminishing fitting diam. 25 mm
2829-13/T	- pouring hole diminishing fitting diam. 20 mm
2829-14/T	- pouring hole diminishing fitting diam. 15 mm

One of the above mentioned fittings is delivered placed in the measuring condenser No.2829-1, three others are separately wrapped.

Delivered only on separate order:

- 2829-2 - measuring condenser /for maize, peas, sunflower grain/
- 2829-21/T - pouring hole diminishing fitting, diam. 40 mm
- 2829-21/S - maize scale
- 2829-22/S - peas scale
- 2829-23/S - sunflower scale

Service-Instructions

Operation and maintenance are identical with those of any other electronic appliance. On loosening the screws at the rear and removing those at the side, the unit can be lifted out of the case. The fuse is mounted on the board of the voltage change-over switch. The user is emphatically warned against replacing a blown-out fuse by a piece of wire or altering the wiring in any other way. The blown-out fuse should be replaced by one of identical rating and of no other type than specified by the manufacturer. In case of break-down the manufacturer should be informed for any unauthorized interference with the apparatus invalidates the given guarantee. The measuring condenser should be handled with particular care. The apparatus is to be protected from moisture.

List of Components:

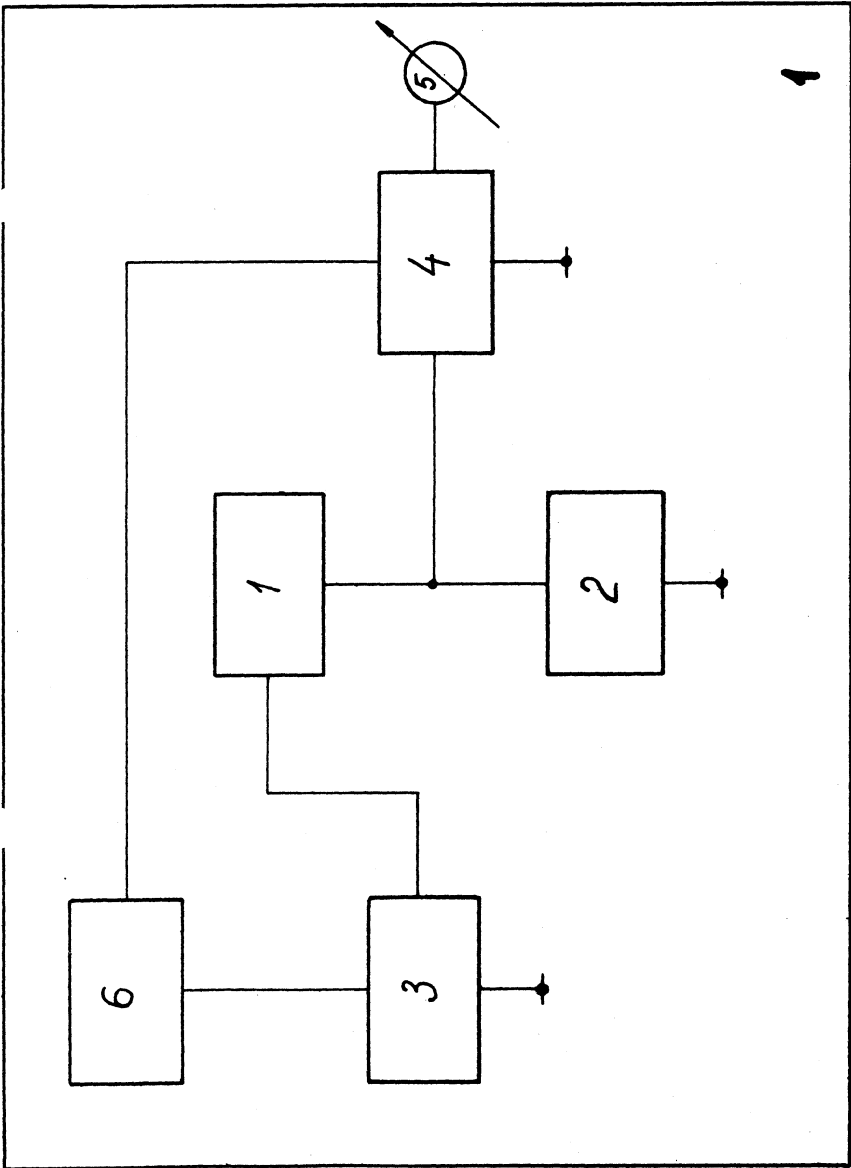
Refer- ence	Denomination	Value	Toler- ance - %	Work- ing volt- age V	Load capa- city W
C 1	Ceramic capacitor	100 pF	1	500	
C 2	" "	500 "	1	500	
C 3	Trimmer	"			
C 4	Ceramic	50 "	1	500	
C 5	" "	50 "	1	500	
C 6	Paper	10 nF	10	200	
C 7	" "	10 "	10	200	
C 8	Electrolytic	16+16µF		450/500	
L 1	Oscillator coil				
M	Indicating meter				
P 1	Wire potentiometer	500 Ohms	10		1
P 2	" "	500 "	10		1
P 3	" "	500 "	10		1
P 4	" "	500 "	10		1
P 5	" "	500 "	10		1
P 6	" "	5Kohms	10		1
P 7	" "	5 "	10		1
P 8	" "	5 "	10		1
P 9	" "	5 "	10		1
P 10	" "	5 "	10		1
P 11	" "	500 Ohms	10		3
R 1	Carbon resistor	33-40 Kohms			
R 2	" "	15-20 "			
R 3	" "	1,8-2,2 "			
R 4	" "	1 Mohm	10		0,5
R 5	" "	200Kohms	5		0,5
R 6	" "	3 "	10		3
R 7	" "	3,9 "	10		3
R 8	Wire resistor	2,2 "	5		
R 9	" "	2,2 "	5		
R 10	" "	1,4 "	5		
R 11	" "	1,2 "	5		
R 12	" "	1,05"	5		

Refer- ence	Denomination	Value	Toler- ance ± %	Work- ing volt- age V	Load capa- city W
S 1	Switch				
S 2	Mains switch				
S 3	Press-button switch				
T 1	Mains transformer				
V 1	Electron tube	ECC 40			
V 2	" "	VR 150			
V 3	" "	6x4			
V 4	Pilot lamp				
1	Fuse				
2	Terminal				
3	"				

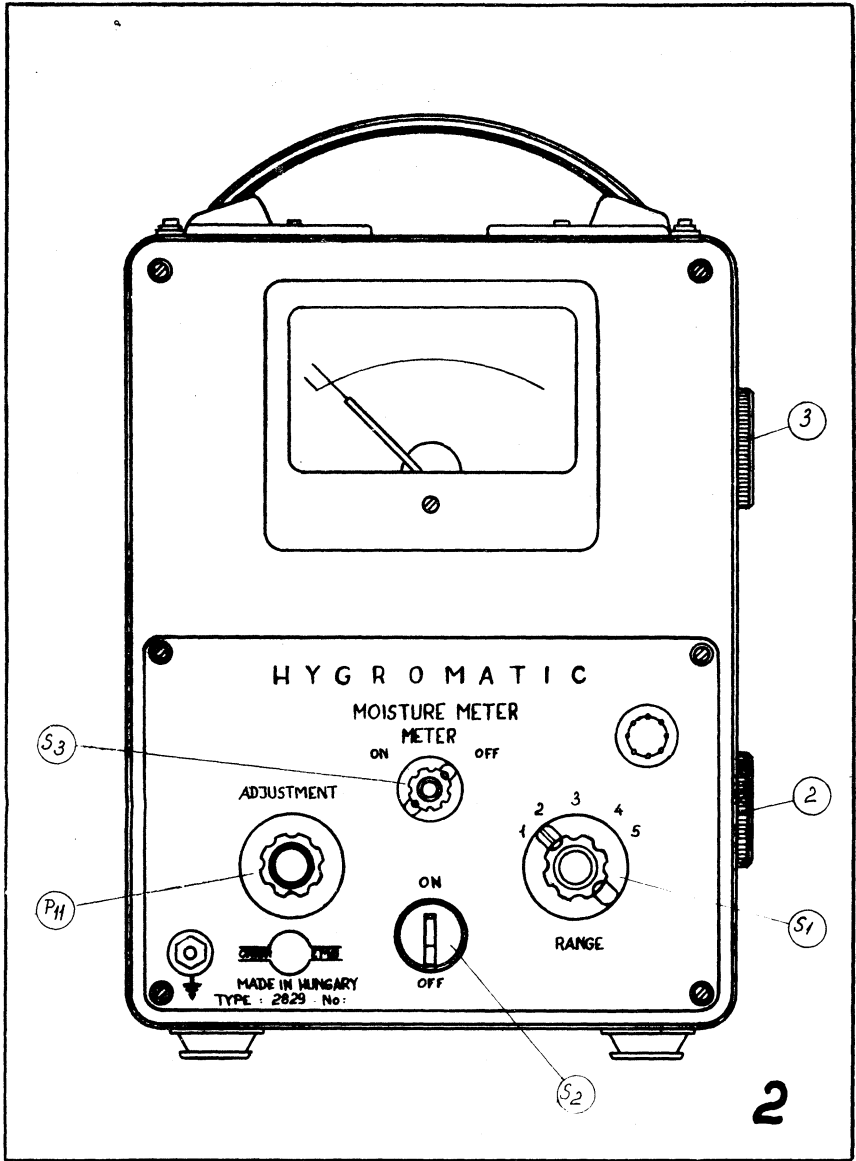
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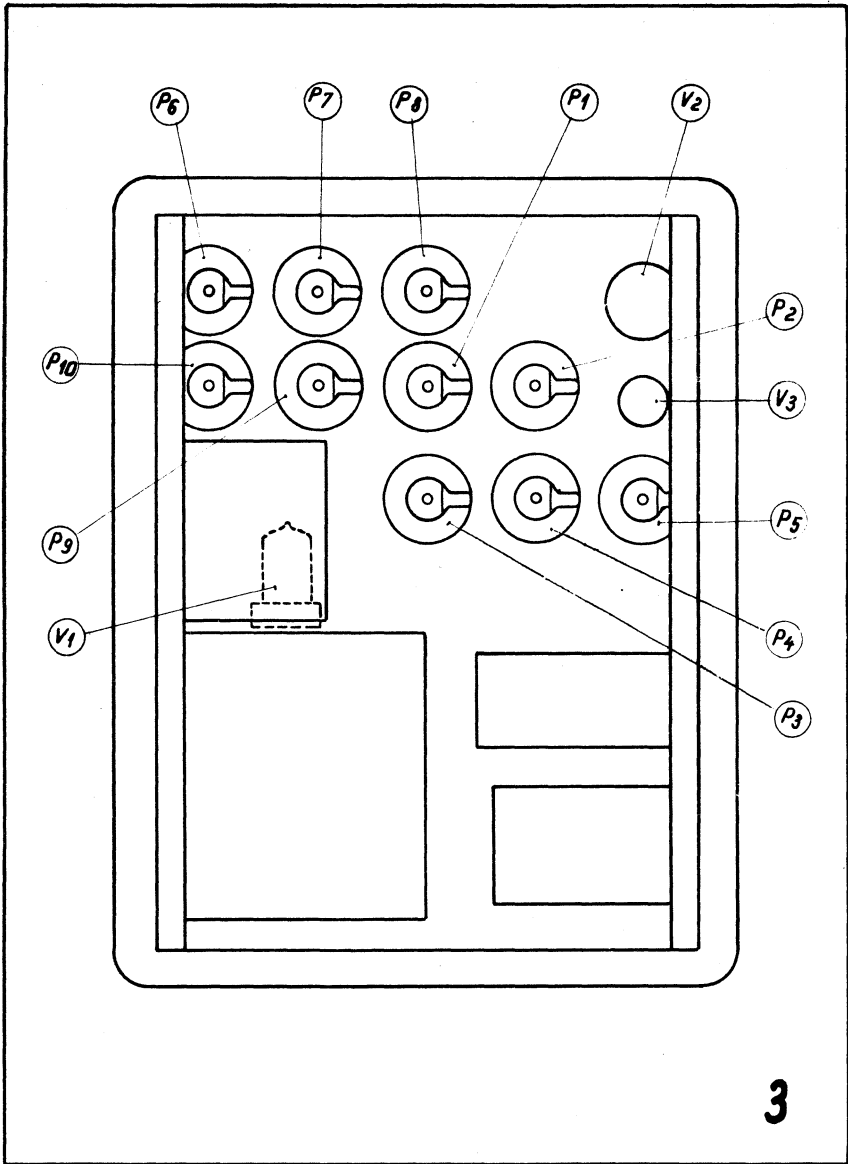
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