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A NEW CONTACTLESS TACHOMETER

electronic

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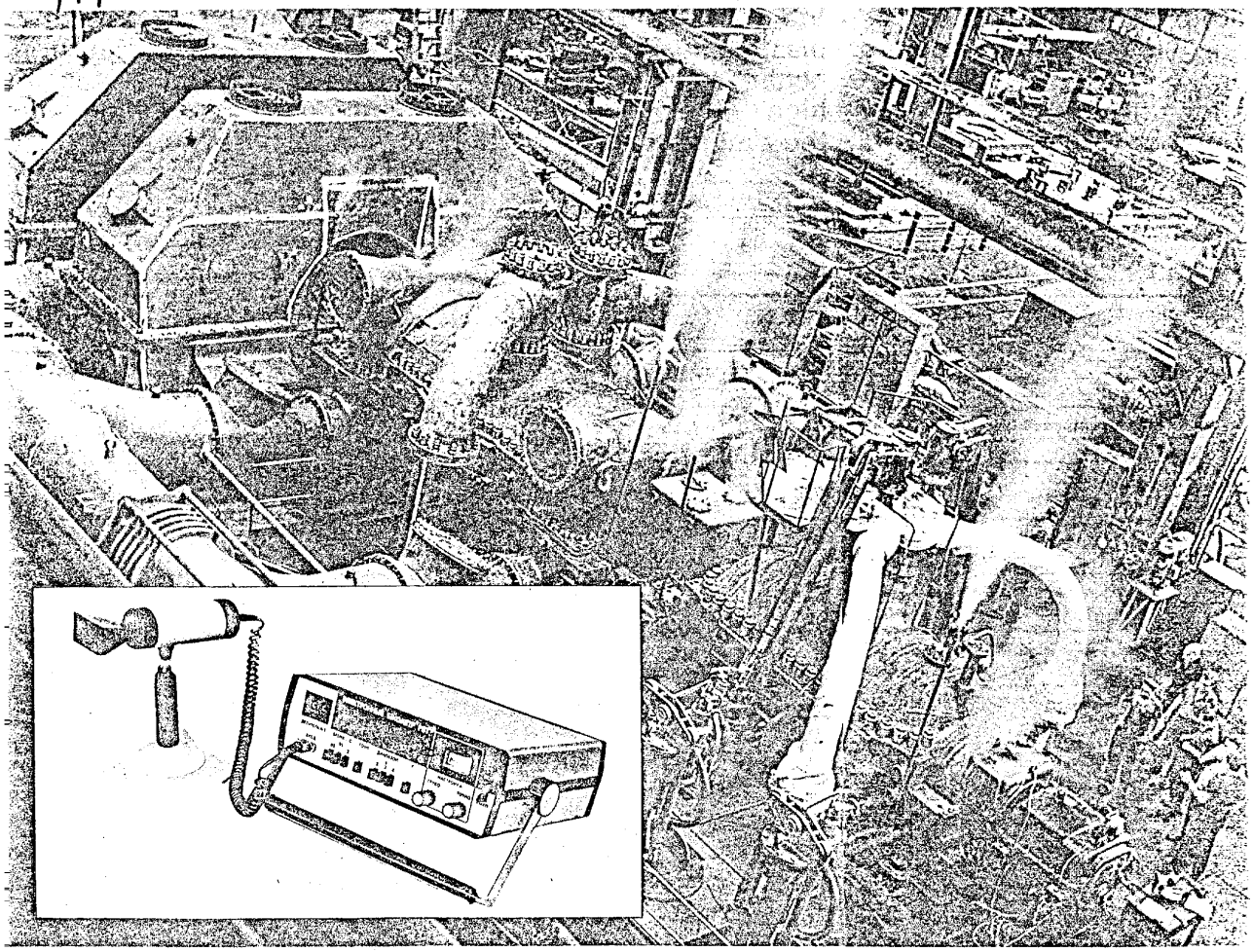
V. A. KONSTANTINOV, Engineer

P. 1 N.C. also in FID# K200938



The instrument in question — the RVT electronic tachometer — is a radiowave measuring instrument connected with the object through the microwave-band electromagnetic field.

Radio Methods More Convenient Than Stroboscopic Ones

The RVT radiowave tachometer measures the rotational parameters of various machine parts from any distances, practically in any requisite frequency range, no matter what materials these parts are made of, and irrespective of their shape and size. Electromagnetic energy passes through dielectric walls and, what's no less important, spreads over the machines' natural waveguiding elements such as the engine exhaust pipe to the turbosupercharger rotor, to the valves, etc.

All this gives the RVT instrument considerable advantages over stroboscopes.

Adequate Accuracy

The radiotachometer measures rotational speed with an accuracy to within $\pm 0.017\ s^{-1}$. If the rotor carries an impeller or a pinion, measurement accuracy can be increased K times, where K is the number of blades or teeth. All it takes is a no less than 3-mm blade or tooth pitch.

By dialling the number (from 1 to 99) equal to that of blades, teeth and other such elements of a rotating object, the operator reduces the instrument's reading to ordinary units of measurement. If r tational speed fluctuates more than thre times per second, the automatic spee change tracking system goes on.

Many Uses

The radiowave principle of measureme extends the range of the RVT tachometer application considerably. It is suitable f measuring surface vibrations accurately within 0.1 Hz, as well as running speed cars, for instance, from as far as 600 away.

Combined with an oscillograph or with recorder, the RVT instrument can be us for measuring relative amplitudes a phases of various objects' surface

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BASIC SPECIFICATIONS OF THE RVT RADIOTACHOMETER

Measurement ranges:
rotational speed, s^{-1} ..... $1 \cdot 10 - 1{,}6 \cdot 10^4$
vibration, Hz ..... $1 \cdot 10 - 2 \cdot 10^5$

	Measurement ranges			
	Rotational speed, s^{-1}			Vibration frequency, Hz
	$1 \cdot 10^1 - 1{,}6 \cdot 10^2$	$1{,}6 \cdot 10^2 - 1{,}6 \cdot 10^3$	$1{,}6 \cdot 10^3 - 1{,}6 \cdot 10^4$	$1 \cdot 10^1 - 2 \cdot 10^5$
Error: s^{-1} Hz	± 0.017 —	± 0.17 —	± 1.7 —	— ± 0.1
Minimal measurement time, s	0.3	0.5	3.0	—
Automatic frequency change speed tracking range, %	from +300 to −70			—
Maximum distance to object, m	10			10
Linear movement speed measurement: speed, km/h error, %	20—200 ±1			
Power consumption, W	36			
Supply voltage, V: a.c. (50 or 400 Hz) d.c.	220 12 or 24			
Mass, kg	4			

orations, as well as for periodic structure inegrity checks. Such checks can reveal a broken pinion tooth or a mechanical flaw in a turbocompressor rotor blade, for instance.

The RVT Succeeds Where Stroboscopic and Induction Tachometers Fail

A typical application of the RVT radiotachometer is measuring the rotational speed of the IC-engine's supercharger compressor. This is a very important job as any deviation of the turbosupercharger's work from normal impairs the technical and economic indices of the engines. Such measurements are essential to the development and operation of aircraft engines, centrifuges, turbines of various kinds, electric motors (low-power ones, in particular), gyroscopes, etc.

The RVT radiotachometer cuts down to a third or even a fifth the time it takes to measure the rotational speed of the basic elements of an internal combustion engine, for instance. Measurement speed is 10 to 20 times higher as compared with the stroboscopic method. The RVT radio-tachometer measures the r.p.m. of the centrifugal oil cleaner rotor in 6—8 sec, and of the turbocompressor rotor, in 10—15 sec.

A New Circuit for Measuring the Reflected Signal Modulation Spectrum

In measuring turbocompressor rotor r.p.m., a typical reflected signal modulation spectrum contains, apart from the fundamental harmonic the frequency of which equals the rotor rotational speed, a number of harmonics with different frequencies — components connected with the operation of the turbine, with valve and engine piston movements. The amplitude distribution of the harmonics depends, in general, on the incidence angle of the microwave signal, on the distance of its travel, on the shape of the object, and other factors. Sometimes a reflected signal is superimposed by modulations caused by the movement of several components, although only one component's rotational speed is to be measured.

The way out was offered by a transceiving aerial whose designing and right positioning relative to the rotating object involved a number of technical problems. We have devised a method of filtering the reflected signal modulation spectrum, of finding the requisite harmonic and of tracking it automatically.

Measurement results are brought out to a four-digit indicator. An output to an analogue recorder is provided. As a result, the instrument can be used for automatic control of most various objects' rotation speed change dynamics.

The use of standard microcircuits and opto-isolators has simplified the instrument to a maximum.

No special skills are required for operating an RVT tachometer.

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T SPEEDS
F UP TO FIVE METERS PER SECOND

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ıe new ectromagnetoacoustical MA) thickness gauges are ee from the shortcomings the priorart gauges. The MA instruments are ontactless, they measure e thickness of rolled stock any travel speed with a gh accuracy and have a ımber of other important dvantages.

The new method consists, essentially, in citing an ultrasonic oscillation pulse in e metal article being rolled. The thickness the article is judged by the time it takes e pulse to pass through it, bounce off the posite surface and return to the sensor s a reflected signal.

leasurements ontactless

The ultrasonic pulse is excited by means f a pulsed electromagnetic field lasting for out 0.5 μsec. The pulse oscillator induc- r is in a permanent magnetic field which ermeates the article under test. Eddy cur- ents induced by the pulsed electromagne- c field interact with the permanent mag- etic field and thus excite an ultrasonic ave inside the material being tested. The ave extends in depth, reaches the oppo- ite surface and comes back causing vi- rations on the surface which generated this ulse. The vibrating metal in the permanent agnetic field excites eddy currents which re picked up by the inductor now playing ne role of a sensor.

As we see, the ultrasonic pulse is in- luced, and the bounced-off signal picked p, without any contact with the article nder test.

ligh Measurement Speed nd Accuracy

Pulse repetition frequency is high enough — about 100 Hz. Therefore, neasurements can be made at a rolled stock travel speed of up to 5 m/sec. The basic error does not exceed 2% over the thickness range of 3 to 15 mm, with scale inearity guaranteed.

High Level of Interference Suppression

If the distance between the surface of the article under test and the inductor/sensor changes, that has no effect at all on the accuracy of the EMA instrument's operation. This is an important advantage of the new thickness gauge over the ordinary magnetic and electromagnetic thickness gauges.

The neutralisation principle is used to prevent the EMA instrument from reacting to any chance defects of the surface: the "fault" signal is given only in case the rolled stock thickness is indicated to deviate from normal for five times at a stretch.

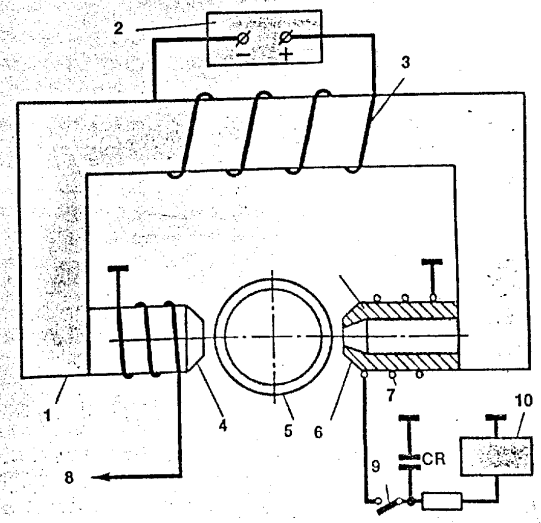
Finally, the instrument's circuit provides for suppressing the interference concomitant to acoustical wave propagation in metal.

No matter how curved the surface of the article under test may be, this causes no measurement error. As a result, the new instrument is best suitable for testing pipe walls as well as sheet metal thickness.

Rolling Mill Operators' Work Made Easier

The EMA thickness gauge gives accurate indications of positive and negative deviations of the rolled stock thickness from normal. The deviation limits are set from the instrument's control panel. The EMA thickness gauge can be fitted into the rolling mill stand control loop to make the operator's work easier. The EMA instrument can be connected with an automatic device indicating, in one way or other, any faults in the rolled stock.

The new instrument has been patented in the USA, the FRG, Japan and France.



Schematic Diagram of Thickness Gauge

1 - Magnetic circuit
2 - Supply source
3 - Constant magnetic field coil
4 - Pick-up coil
5 - Tube
6 - Pole piece
7 - Excitation coil
8 - To detector
9 - Switch
10 - Capacitor supply source

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FOURTEEN NEW FLAW DETECTORS

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1981

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The instruments which detect flaws in ferrous and non-ferrous metal articles by the eddy current or constant magnetic field method keep improving. In this article we dwell on new flaw detectors using these methods. Many of these instruments have no parallels in world practice, and others are much simpler and more reliable than the prior-art ones. They offer new ways of checking for higher product quality.

The VD Flaw Detectors for Checking Quantity-Produced Articles

These instruments check wire, pipes, round billets, round and hexahedral rods from 0.05 to 200 mm in diameter, and square billets from 50×50 to 250×250 mm in cross section for surface defects by the eddy current method. A distinctive feature of this method is that it brings equally accurate results for ferrous and non-ferrous metals. The article under test is put either through a ring on which transducers rotate, or through a stationary transducer.

As compared with the prior-art flaw detectors with rotating transducers, the instruments of the VD series are more reliable, simpler in design and take less time to maintain. Testing pipes and rods with a curvature of up to 5 mm per one meter of length is no problem at all. Variations in the clearance between the transducer and the surface under test within ±2 mm have no effect on the flaw detector's sensitivity, as distinct from the prior-art models. Hence the possibility to test oval-shaped as well as round articles.

The VD-40N, VD-41N, VD-43N and VD-60N flaw detectors are fitted with a facility pinpointing the flaws in the rolled articles under test. They provide for sorting the articles into three categories: "OK", "Reclaimable spoilage", "Reject".

The VD-30P flaw detector can by right be described as universal. It gives invariably accurate indications over a wide range of diameters, configurations and metal grades thanks to its easy-to-detach interchangeable transdu with the appropriate dian of the through hole and to cial filters. Indications are livered to counters, a rapi tion automatic recorder a computer.

The VD-10P and VD flaw detectors test wire n of any material with ele conductivity ranging from 60 Mohm/m. The result ana unit indicates the length number of the inadequate lity sections and their loca in the wire coil. The same formation is delivered to printer and to the programm unit which controls the gra assembly of the autom machine making various cles out of tested wire.

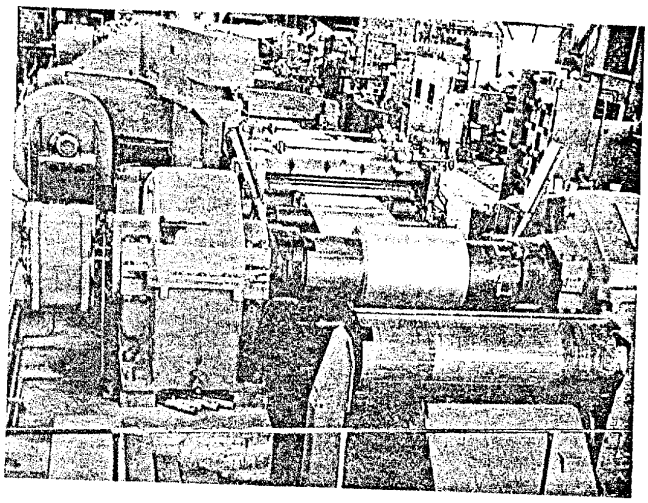
The design of these flaw tectors' transducers me special mention. Usu transducers intended for

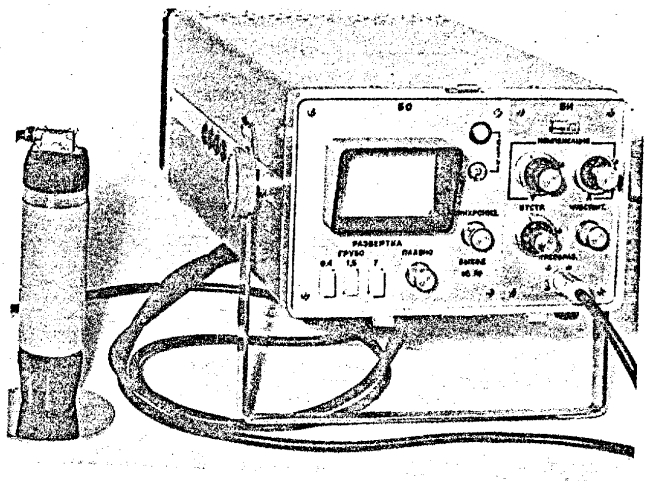
BASIC SPECIFICATIONS OF THE VD-SERIES FLAW DETECTORS

Detector model	VD—10P	VD—20P	VD—30P	VD—40N	VD—41N	VD—43N	VD—60N
Transducer type	Stationary			Rotary			
Object configuration	round	round	round annular hexahedral	round or annular			square
Diameter, side length, mm	0,05—0,2	0,2—0,6	1—47	30—120	10—50	100—200	50—250
Minimum size of flaw detected, in depth: mm	—	—	—		0.2-0.5**		0.5***
% of diameter	10	10	1-2*		—		—
Maximum object travel speed, m/s	5.0	5.0	3.0		1.5		1.0

* depending on diameter;
** less for sized articles, more for hot-rolled articles;*** including those on edges.

v stationary flaw ectors have proved efficient means of ed stock testing (1). table flaw detectors very convenient for ing various items t on the workbench, ing the assembly and inting of large-size cles and construc- s (2).





ting thin wire are made by hand. The new transducers do not require handwound coils and are much longer lasting than the prior-art ones.

The MD Flaw Detectors for Testing Steel Sheets and Pipes

In many cases the eddy current method proves less effective than that of constant magnetic field. This is true of testing thick rolled sheets and pipes when inner as well as surface flaws are to be detected. Such sheets and pipes can best be tested, at the rate of their manufacture, with the MD flaw detectors depending on constant magnetic field for their operation.

The MD-10F flaw detector comes complete with devices for magnetizing a pipe perpendicular to its axis (circularly) and for rotating transducers around a pipe. An electronic system processes the signals coming in from the transducers and delivers commands to the sorting mechanism, with data on the outer and inner flaws of the pipes arriving separately. The MD-10F flaw detector has a self-checking unit which signals any mechanical failure and any disturbance of control settings.

BASIC SPECIFICATIONS OF THE MD-SERIES FLAW DETECTORS

Detector model	MD-10F	MD-90I	MD-100I
ducer type	Rotary	Rotary and stationary	Stationary
under test	Pipe	Sheet	Hot-rolled strip with welded joint
dimensions, mm:			
neter	30—160	—	—
thickness	up to 12	—	—
h	—	560—2,500	⩾ 500
ness	—	0.4—3.0	1—6
detectable crack:			
, mm	0.2 and over	—	—
% of metal ness	10	7	—
ravel , m/s	up to 3	0.5—5.0	0.5—10.0

The MD-90I flaw detector is intended for testing rolled sheets in crosswise and lengthwise metal cutting lines. It sorts out good sheets from faulty ones and indicates the location of flaws.

Magnetic field dispersions in the flaw areas are picked up both by stationary transducers and those rotating parallel to the metal sheet. Depending on the rolled stock width there can be one transducer or several of them. A special electronic circuit precludes mistakes connected with changes in clearance between the transducers and the metal article being tested.

The MD-100I welded joint indicator is an instrument

which delivers signals to the automatic system of a continuous steel sheet rolling mill. The information it furnishes about the joint helps adjust rolling speed and prevent metal strip breakage.

The instrument can also be used in continuous pickling lines, automatic weld cut-out machines and other such units.

An important distinguishing feature of the MD-100I indicator is its high noise immunity which precludes the generation of spurious signals. An ingenious layout of the transducers and a new method of information processing make it possible to single out the weld's magnetic field only, "ignoring" single or group flaws. The instrument comes complete with a sheet magnetizing device.

Portable Universal Flaw Detectors for Transport and Heavy Engineering

Surface defects — cracks, hair seams, laps and other defects of ferrous and non-ferrous metals on planes 30 mm and more in diameter are detected quickly and accurately by the VD-20N-D instrument. Fitted out with a rotary transducer and using the eddy current method, it finds flaws from 0.2 mm deep and 10 mm long even on articles with an electrically non-conductive coating up to 1 mm thick. The flaw detector is equipped with a defect indicator lamp. A more accurate information about the surface being tested can be obtained from the screen of a cathode-ray tube. As the transducer is moved over the metal surface by hand, the instrument has a special electronic circuit to preclude spurious signals and misses which might be caused by variations in the clearance between the transducer and the metal being tested.

The MD-40K flaw detector is very convenient for **checking the quality of coarse threads** of steel components like studs, rods, bolts and hooks. The instrument is fitted with a set of transducers which make it possible to check on threads 30 mm and over (pitch from 1.5 to 12 mm). The instrument detects flaws more than 0.5 mm deep and over 10 mm long. The transducer is moved consecutively along the thread fillets for the purpose. The procedure can be easily mechanized, if necessary.

The MD-41K flaw detector reveals **fatigue cracks in gear transmissions with pitches of 4.5 to 8** made of ferromagnetic materials. This instrument, with its electronic circuit similar to that of the MD-40K, comes complete with a set of transducers for checking gears over the entire above-mentioned range of pitches. A transducer is placed in a gear tooth space by hand. An advantage of this instrument is that with it gear wheels can be tested without the gear transmission being taken apart because there is no need for any special preparation of the articles under test. The instrument detects flaws more than 2 mm deep and over 10 mm long.

The magnetographic method of testing welded joints in pipelines up to 1,420 mm in diameter, with pipe walls up to 20 mm thick is more convenient — and much safer for the servicing personnel — than the radiographic one. The magnetographic method consists in placing a piece or ordinary ferromagnetic tape 35 or 50.8 mm wide on a joint and recording the flaws' magnetic field on it by passing a permanent magnet along the joint.

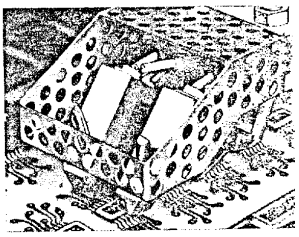
The new UV-30G flaw detector reads the information recorded on tape — the leakage fields of the weld's flaws — and reproduces it on the screen of the cathode-ray tube. Besides, test results are recorded on paper tape. This method of testing is 5-7 times more efficient than the X-ray or radioisotopic ones.

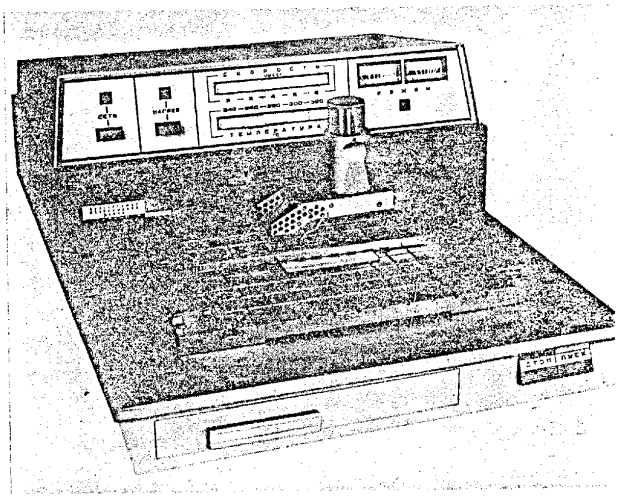
UP TO A THOUSAND INTEGRATED CIRCUITS PER HOUR

A new semi-automatic soldering device is 3 to 10 times more efficient than conventional equipment.

Add to this the excellent quality of soldered joints, the optimum conditions of solder melting, extraordinary soldering efficiency (it takes a mere 0.3 sec to solder one lead), the absence of solder "jumpers" between leads, the light weight and compact size.

Another merit of the device is a simple and efficient facility to prepare microcircuits for assembly. It bends microcircuit leads, trims them to size and applies precisely dosed-o amounts of solder to their enc — all in one working stroke! The semi-automatic solderir device and the integrated ci cuit preparation facility hav been patented in the USA, th FRG, Great Britain, Franc Japan and other countries.





BASIC SPECIFICATIONS OF THE SEMI-AUTOMATIC DEVICE FOR SOLDERING INTEGRATED CIRCUITS AND FACILITIES FOR PREPARING THEM

Semi-automatic device:	
Efficiency, integrated circuits per hour	up to 1,000
Soldering temperature, 0° C	about 300
Temperature maintenance accuracy, 0° C	± 5
Maximum printed card size, mm	210 × 280
Overall dimensions of the semi-automatic soldering device, mm..	400 × 500 × 220
Mass, kg	17
Power consumption, W	150
Integrated circuit preparation facility:	
Press effort, N	700
Rod stroke, mm	20
Solder wire diameter, mm	0.3—0.6
Overall dimensions of facility, mm	150 × 60 × 100
Mass, kg	2

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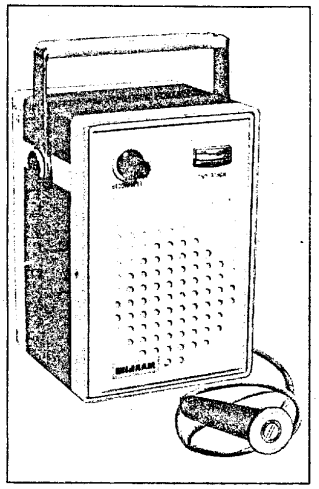

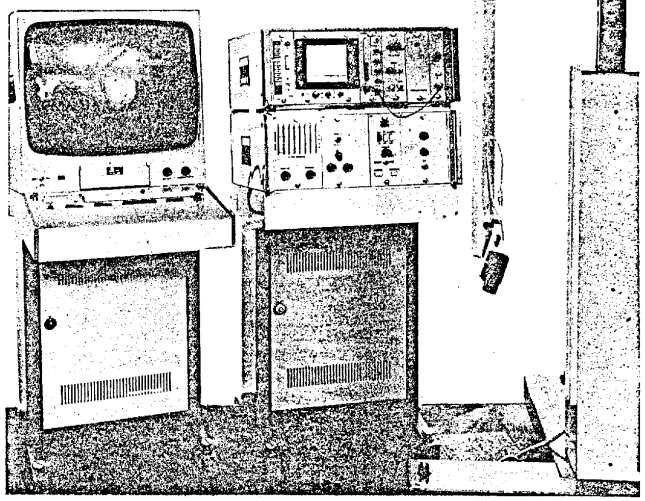

Left — the Malysh portable instrument; right — the Ekran stationary tomograph with two display units (screen sizes: 23 and 50 cm in diagonal).

early diagnosis problem
ved by various methods,
rasonic method (UZ) be-
rtainly the most suitable
r use in obstetrics and
cology.

**ew instrument, Malysh
DM), has been devel-
specially for obstetri-**
Its ultrasonic converter
continuous ultrasonic
tions to the patient's
rough a layer of contact
The signals, reflected
internal structures, are
up by the converter, with
quency of the oscillations
ed from moving struc-
(the heart, blood vessel
etc.) differing from that of
cillations reflected from
ary structures (the Dop-
ect). As distinct from the
scopic methods, the ul-
c converter is not affec-
usual acoustic noises in
se.

design of the amplifier
etector of the Doppler
ncy signal ensures the
noise ratio necessary for sending minimum-power ultrasonic signals to the patient's body. Radiation intensity does not exceed 10 MW/cm^2, which totally precludes any harmful effects on the foetus.

The Malysh can be used for diagnosing palpitation and cardiac disorders in the foetus and for localizing the placenta. Palpitation is detected as early as in the 8th-10th week of pregnancy. Thanks to the converter fitted with focussing lenses of a special design, the locality of the moving structure control has been sharpened, and their differentiation improved. In these characteristics, the Malysh is superior to the prior-art instruments of its kind.

The Ekran (UI-20EM) pulse ultrasonic tomograph is of a still wider diagnostic latitude. It shows sectional roentgenograms of internal organs on a display unit screen.

Upon being processed, the echo signal proceeds to the memory unit where an image is formed by scanning. A vidicon is used as a memory cell; information about the converter's co-ordinates and the reflected pulse amplitude is delivered to the intermediate picture tube. The final signal shaped on the vidicon target appears on the videomonitor screen as a halftone image. This mode of tomograph operation is usually referred to as the "B" mode.

Besides, the image can be formed in the "A" and "M" modes.

In the former mode, the signal is formed on the screen only along the line scanned by the ultrasonic converter at the moment. On the horizontal, the visual display unit screen shows the value of the echo pulse, and on the vertical — the distance inside the body from the converter's point of contact with the skin. This method is commonly used in encephalography to study brain structures.

What the "M" and "A" modes have in common is the immobility of the converter. The difference between the modes is that in the "M" mode the echo amplitude shows as bright luminance in the appropriate point of the screen, and the amplitude of this or that structure's movement — as a "hump" rising over the scan trace. This mode is used chiefly in cardiology for examining heart valves and walls.

Two visual display units with 23 and 50 cm screens (diag.) broaden the sphere of the Ekran device's application considerably. In particular, it is used for diagnosing kidney, liver and other troubles, localizing stones, tumours and inflammations. It enables oncologists to determine the size and position of metastases more confidently.

A distinguishing feature of the Ekran device is its converter of a new design which ensures high pulse resolution of the device.

BASIC SPECIFICATIONS OF DEVICES FOR ULTRASONIC MEDICAL INVESTIGATIONS

	Malych	Ekran
area under examination, mm.	Any	400 × 300
l resolution, mm:		
depth		2,5
ontal		4,0
ing frequency, MHz	3,0	2,5
storage time, min	—	15
consumption, W	1,5	500
supply	From batteries	From 220 V mains
g	3	250