term variations due to respiration are averaged out when reading the chart.

The sensor on the thumb sends an impluse to the preamplifier, filter, rectifier, and power amplifier, which make up the servosystem control for the motor. The motor activates a pump which sends impulses back to the bulb around the finger as well as to the manometer.

The first units contain silicon transistors. Svensson says second-generation devices will have hybrid integrated circuits. This will improve reliability rather than reduce size, since the graph holder and clock cannot be made much smaller and still produce a readable chart.

Updating an old trade

Armaments have been an important export item for Sweden since the Thirty Years' War more than 300 years ago. The business is now taking a new direction: the exporting of complete and highly sophisticated defense systems.

The Paris Air Show, May 26 to June 4, marked the first marketing effort abroad by Swedegroup, a consortium quietly formed about a year ago by six Swedish companies in the defense electronics, aviation, and munitions industries.

Establishment of this venture doesn't mean the companies will drop their individual operations, but Swedegroup will handle the promotion of large joint projects. "The offer by major Swedish companies of a complete defense system will be more attractive than bids from each firm for a piece of the business," says Frank Cervell, managing director of Swedegroup.

The most obvious potential customers are neighboring Scandinavian nations and neutral countries elsewhere. A big selling point will be the claim that the independence and stability of nations will be served if they build up their defense systems with equipment supplied by neutrals like Sweden rather than by one of the major powers. "I'm thinking of nations in Africa and Asia, for example," says Per Odelberg, managing director of AB Bofors, one of the members of the consortium. "If they buy defense materials from Sweden, they get them with no strings attached."

Swedish policy prohibits the export of arms to nations at war or those at swords' point. This restriction would rule out many potential customers.

At Paris, Swedegroup showed a high-speed radar display unit that uses integrated circuits. The maker, Standard Telefon & Radio AB, says the system displays alphanumerics, symbols and graphics, and will be available in digital and analog versions.

Also shown at Paris was an automatic technique for testing the avionics in the new Viggen aircraft, radar for the latest version of the supersonic Draken fighter, and a miniaturized airborne digital computer.

Japan

What's up front counts

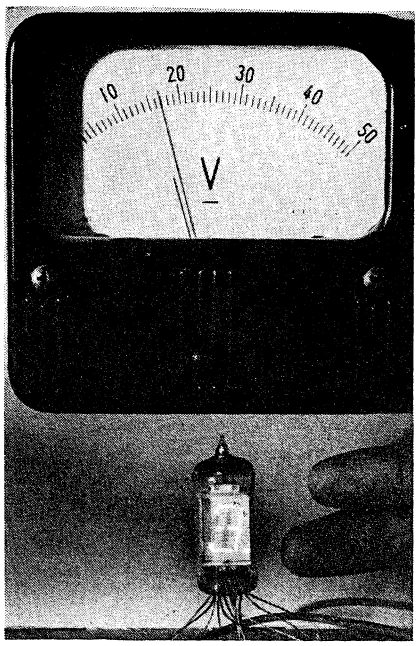
Many variations of the cathode-ray tube have been developed through the years but the latest change may well be the most radical. Now there's an inside-out crt designed as a digital readout tube for electronic desk calculators. Conventional tubes have the cathode in the rear, but the new crt—called the Digitron—has the cathode up front.

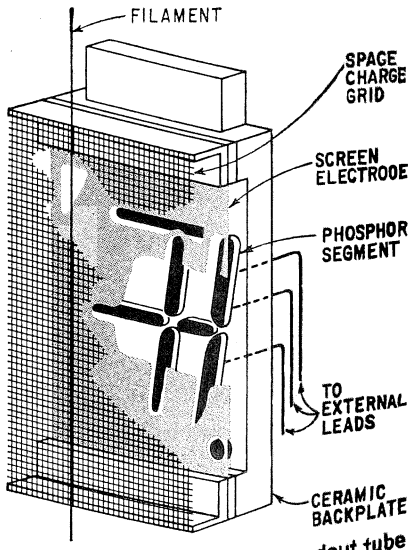
Invented by Japan's Tadashi Nakamura, president of the Ise Electronics Corp., the Digitron is a joint Ise-Hayakawa Electric Co. development effort. Hayakawa is incorporating the crt into a line of calculators scheduled for a fall debut.

Not only is the new tube small, but its cost is low and it requires little power, says Nakamura, who invented the one-gun Colornetron picture tube [Electronics, May 31, 1965, p. 81].

Vanishing cathode. Digitron has phosphor-coated number segments toward the rear. The 30-micron-wide, forward-mounted filamentary cathode is kept at a low-enough temperature so that its faint glow isn't discernible, says Ise. A space-charge grid, consisting of 15-micron wire woven into a 100-mesh-per-inch screen, is located directly behind the cathode. Segments of numerals are outlined by a photo-etched screen electrode that serves as a mask to define the individual segments. This simplifies production by eliminating the need for precisely shaping the segments.

The phosphor segments are attached to a ceramic support, which has lead wires extending through





Planar display. New digital readout tube draws as little as 15 volts. Cathode mounted up front in envelope is invisible when number-segments glow.

it. The segments consist of a resistive layer—which makes contact to the segment leads—and a zinc oxide phosphor layer.

The cathode location is not just a matter of departing from a conventional theme. Electrons are emitted from the oxide-coated filament in all directions. Those starting toward the envelope are repelled toward the space-charge grid by the negative charge that collects on the envelope's inside surface. Ise says careful design of the tube geometry assures that an electron shower with constant density at all points passes through the grid which is operated at +25 volts. The screen electrode has the same 25-volt potential, and electrons continue on toward it.

Lighting up. Phosphor numeral segments can be turned on at 25 volts, or as low as 15 volts. The electrons strike only those segments needed to make a selected numeral glow. The remaining segments are held at zero potential.

Heater input is 0.8 volts at a current of 90 milliamperes. At an accelerating potential of 25 volts, the total cathode current is 7.7 milliamperes. Regardless of the number of phosphor segments switched on, cathode current remains constant because of the shielding effect of the space-charge grid. Current within the tube changes, however, depending on the number of segments that are turned on. For a typical numeral, the total phosphor segment current is 0.7 milliampere. The remainder of the current goes to the space-charge grid and screen electrodes, which are internally connected.

Ise says Digitron has a two-digit-per-inch density. The numerals measure 0.46 inch high by 0.35 inch wide, in a cylindrical glass one-half inch in diameter and 1.7 inches high. The display includes a decimal point and a prime mark.

Shines brightly. Since the bright green numerical display is formed by segments that lie in the same plane, numbers do not "dance" as they do in multiple-cathode gas-discharge tubes. Ise says display brightness is at least 80 foot-lamberts. Digitron can provide a display at 15 volts and can be switched directly by integrated circuits. The device can operate from 15- to 25-volt, d-c power supplies.

The company says operational life isn't known yet but reports tubes have been running upwards of several thousand hours.

Calculated entry

The latest entry in Japan's calculator sweepstakes is the Sony Corp., which will be off and running on June 1 with an electronic desk model that uses hybrid integrated circuits and has two memories.

Called the Sobax, for solid state abacus, the unit will be priced at $722. Plans call for a 500-unit monthly production quota initially, with sales limited to Japan.

A first. Although its price is slightly higher than the lowest-priced Japanese calculators now available, Sony's entry seems to be competitive. It is a 14-digit calculator where most of the others have 12 digits and lack a memory feature. The new unit operates from low-voltage d-c power supplies and is the first made in Japan that blanks out all zeros before the first significant digit.

Sobax uses a single ultrasonic delay line—invented by the University of Osaka's Zenichi Kitamura—for five registers, and is believed to be the first to incorporate this feature. Three of the registers are used for arithmetic and the other two operate as memories.

The delay line performs the functions of five registers on a time-division basis. In the multiplexing scheme, the registers are numbered one through five. The first bit for each register is inserted into the delay line in sequence; then the second bit of each, and so on. Coiled in a metal box and housed at the base of the calculator, the 3-meter-long delay line has a capacity of 360 bits and a delay time of 1.5 milliseconds.

Time sharing. The clock frequency is about 40 kilohertz and the time interval of each clock pulse is divided into six phases—one for each of the five registers and one more for synchronizing the delay line.

Although they are now using hybrid IC's, Sony engineers indicate that they may eventually switch to monolithic circuits. Use of hybrid circuits fits in with Sony policy, since one reason for marketing this calculator is to make use of the production at Sony's semiconductor plant. Company officials say that purchase of outside units even at low cost would negate an important reason for building the device.

There are 500 IC's mounted on the calculator's five printed-circuit boards. These circuits have a total of about 8,000 individual components, including 200 transistors and 1,700 diodes. The hybrid circuits are built on alumina substrates and are dip-coated for moisture protection.

Transistors are the only components within the hybrid circuits that are prepackaged in epoxy. The transistors are the same type used in most of Sony's tape recorders, radios, and television sets. Diodes and capacitors are attached to the substrate without prior encapsulation.

There's a difference. Logic circuits consist mainly of diode gates and transistor flip-flops, with a sprinkling of inverters. Among differences between logic circuits developed by Sony and those that are used by most other firms are the connections between gates and flip-flops, and between clock input and flip-flops. Sony uses capacitor coupling between gates and flip-flops, and d-c coupling of clock to flip-flops. Other manufacturers use d-c coupling between gates and flip-flops, and capacitor coupling of clock to flip-flops.

Great Britain

Against the tide

Engineers developing methods of interconnecting integrated circuits for International Computers &