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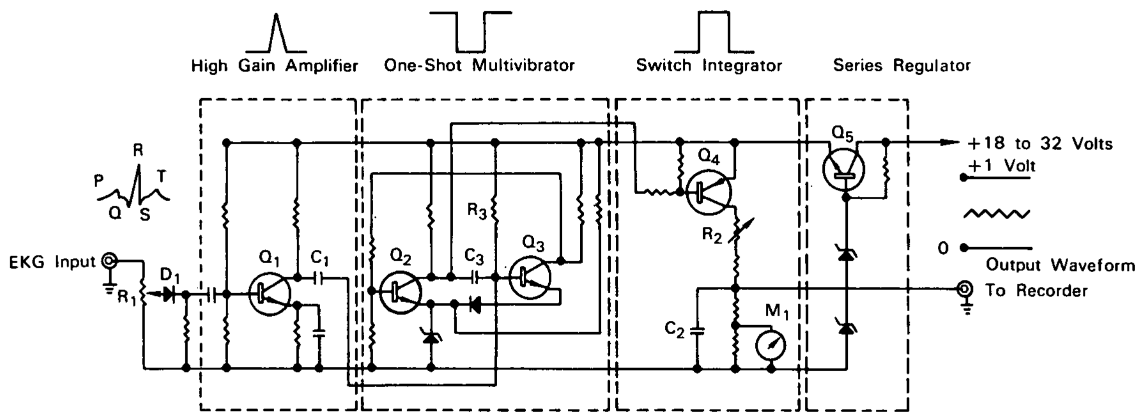
Inexpensive, Stable Circuit Measures Heart Rate



The problem: Although circuits for measuring heart rate have been available for some time, they have either been more complex than basically necessary in order to accommodate a wide range of applications, or have been available only as part of an electrocardiograph (EKG) system. There is a need for a simple, inexpensive circuit that will provide a reliable indication of average heart rate.

The solution: An inexpensive, stable, transistorized circuit that provides an accurate analog indication of average heart rate in response to a preamplified EKG signal applied to its input. The device provides a meter indication of heart rate in addition to a proportional output voltage which may be fed to a high-input impedance recorder.

How it's done: The circuit uses the R-wave (positive spike) of an EKG signal to trigger a pulse generator. The metering circuit is basically an integrator which uses the constant-width, constant-amplitude pulses from the generator to produce a voltage proportional to the frequency of the pulses. The EKG input signal is applied across the trigger level control R_1 which is set so that D_1 passes only the large positive spikes (R-waves) of the signal. This spike is amplified by a high-gain, common emitter amplifier (Q_1 and associated circuitry) and then coupled to a one-shot multivibrator through C_1. The multivibrator (Q_2 and Q_3) produces a constant-duration, constant-amplitude, square-wave output for every input pulse from the amplifier. With no pulse present, Q_3 is conducting and Q_2 is cut off. Arrival of the negative pulse at the base of Q_3 decreases its collector current, producing a positive pulse at the base of Q_2. This causes an increase in the collector current of Q_2 and a corresponding negative shift of its collector voltage. This negative pulse is fed back to the base of Q_3 causing a rapid switch in the conditions of Q_2 and Q_3 (Q_2 turns on, Q_3 turns off). The pulse duration is determined by the C_3R_3 time constant after which Q_2 and Q_3 revert to their original states.

(continued overleaf)

The square-wave pulses from the multivibrator are coupled to the base of Q_4 which controls the average rate of current flow to the resistor-capacitor integrating network. An increase in the frequency of the square-wave signal causes an increase in Q_4's collector current and a corresponding increase in the voltage across C_2. Output for a recorder with a high-input impedance (10,000-ohms minimum at 1 volt) is available directly across C_2. Resistor R_2 is adjusted to provide full-scale deflection of M_1 with an average heart rate of 200 beats per minute. An internal series voltage regulator is provided in the circuit for portable operation with batteries. If a constant voltage source is available, the regulator circuit (Q_5 and associated circuitry) may be omitted.

Note: Inquiries concerning this invention may be directed to:

Technology Utilization Officer
Manned Spacecraft Center
P.O. Box 1537
Houston, Texas, 77001
Reference: B65-10010

Patent status: NASA encourages the immediate commercial use of this invention. Inquiries about obtaining rights for its commercial use may be made to NASA, Code AGP, Washington, D.C., 20546.

Source: Howard A. Vick
(MSC-95)