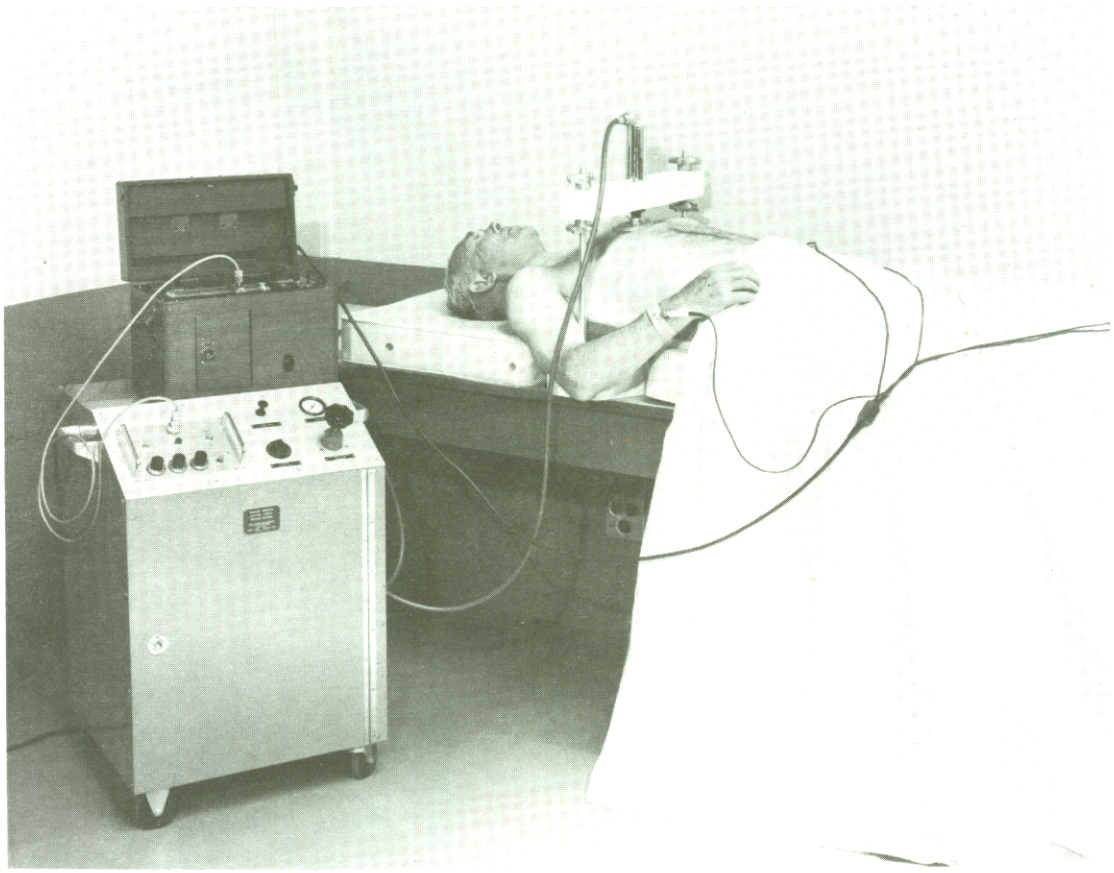
HALLIKAINEN Instruments
SLACO DIVISION
BIOLOGICAL and MEDICAL

THE HARKINS-BRAMSON SYNCHRONOUS ELECTROCARDIAC MASSAGE MACHINE

A Cardiac Resuscitator and Assistor

Model 1318



The Harkins-Bramson machine, utilizing the Johns Hopkins method of closed-chest cardiac massage, delicately controls the circulation of patients in cardiac arrest and extends the use of the same principle to support the failing but still beating heart. Thus, for the first time, there is an available means of directly supporting the circulation of patients in heart failure.

EXPLANATION OF PRINCIPLE

Kouwenhoven, Jude and Knickerbocker have demonstrated that pressure over the lower sternum during cardiac arrest compresses the heart against the vertebral column and forces blood out of the ventricles of the heart. These workers found that a repetitive or pulsating force correctly applied over the sternum produced a sufficient cardiac output to maintain life during cardiac arrest. This method of cardiac massage has become the preferred treatment for the emergency of cardiac arrest, for several reasons. It is more quickly applied than open chest massage; does not require surgery; does not lead to infection; can be used by non-professional personnel; and produces better circulation than open-chest cardiac massage.

CARDIAC RESUSCITATOR

In the past, external cardiac massage has been applied only by hand. When compared to proper mechanical application however, the manual method is distinctly inferior. Application by hand tends to be uneven; too little force will lead to poor circulation and jeopardize success, whereas, too exuberant an application may lead to unnecessary trauma to the thoracic cage or abdominal organs. External cardiac massage by hand is exhausting, frequently requiring the services of several operators. Mechanical application is more convenient and more apt to result in a successful outcome. The force applied can be delicately controlled; the minimum pulsating force needed to produce satisfactory cardiac output being consistently applied for whatever period is necessary. An optimum regime, once established, can be continuously maintained. This assures satisfactory circulation with minimum hazard of rib fracture or other trauma. Only one operator is needed and he is free to care for other aspects of emergency care, such as attention to airway problems, application of electrical defibrillation, injection of drugs, etc.

CARDIAC ASSISTOR

When closed-chest cardiac massage is used for patients in cardiac arrest, whether in asystole or ventricular fibrillation, the timing of the applied sternal forces in relation to the heart's activity is unimportant. However, as soon as the heart resumes coordinated activity, randomly applied massage will intermittently interfere with cardiac filling and thereby decrease cardiac output. By exact synchronization of the rhythm of external massage with the ventricular contractions, the Harkins-Bramson machine is able to increase cardiac output while the heart is actively beating. The instrument is thus a cardiac assistor capable of increasing cardiac output by external means, and is useful in the treatment of a variety of conditions of circulatory failure.

DESCRIPTION OF THE INSTRUMENT

There are two components, the cardiac massage unit (Fig. 2) and the pulse generator (Fig. 3). The cardiac massage unit is placed astride the thorax of the patient with the massaging pad in contact with the lower sternum. The posterior brace transmits the necessary reaction forces to the vertebrae directly below the pad. Lateral movement of the patient is prevented by two adjustable wedges, while a divided mattress makes the position comfortable for the subject. A source of compressed gas (wall oxygen, or a cylinder of air, nitrogen, CO_2, or O_2) provides the energy that drives the massaging piston pad. The compressed gas is led through a pressure reducing valve into a reservoir at whose outlet a three-way solenoid valve is fitted. When energized, this valve connects the reservoir to the cylinder of the cardiac massage unit, and results in a downward force applied through the pad to the sternum. When not energized, the cylinder is exhausted to atmosphere via a second reservoir which serves as a silencer. The force applied to the sternum by the massaging pad can be delicately and continuously controlled by the operator between 0 and 90 lbs. A circular waterfilled bladder fitted to the massaging pad prevents local bruising by applying the necessary force in the form of fluid pressure, uniformly distributed. When the instrument is used as a cardiac assistor, the pulsating force is triggered by the "R" wave of the ECG through an electronic synchronizer in such a way that the impressed sternal force is applied to the heart at precisely the instant of ventricular contraction. The duration of imposed systole, which is to say the time interval during which each mechanical stroke compresses the heart, is also controlled by the operator. This is an essential adjustment, since too short an interval allows insufficient time for ejection of blood from the ventricles, and if too long, it interferes with the refilling of the heart. When used for the treatment of cardiac arrest (when there is no "R" wave), coordination with the heart is neither possible nor necessary, and the frequency of the pulsating force is then controlled by the operator. The duration of imposed systole is then a preset but adjustable fraction of each cycle.

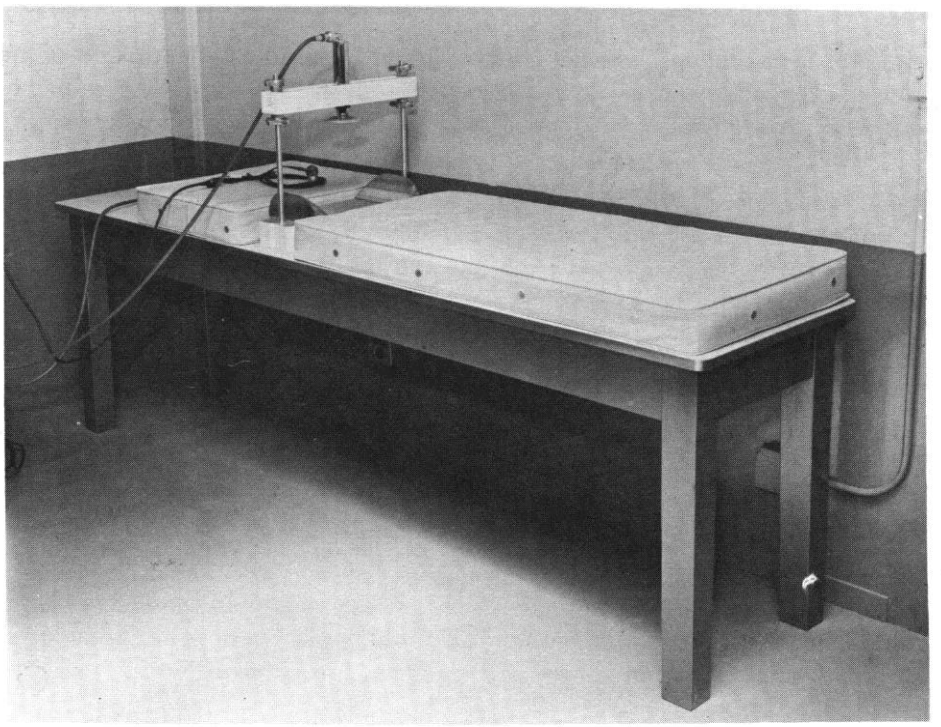


Figure 2

An additional feature of the instrument is a device which automatically switches the timing control from synchronization with the ECG to a pre-set frequency, or vice versa, as the patient moves into, or out of, cardiac arrest. This automatic feature can be switched on or off by the operator; if it is "on", and if the patient moves into cardiac arrest, the necessary change to a pre-set pulse rate is electronically delayed (about 3-4 seconds) sufficiently to distinguish the arrest from a mere irregularity of pulse. This delay is also adjustable.

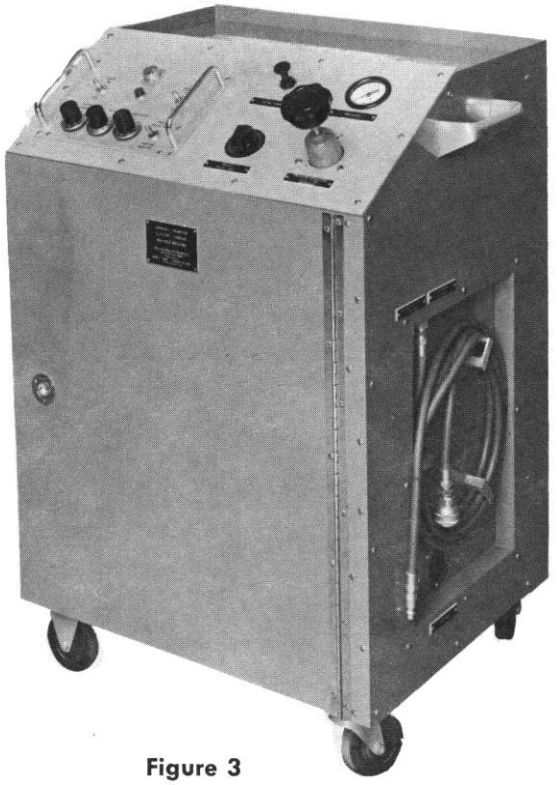


Figure 3

APPLICATION

a) **Resuscitation:** Provided that the cardiac arrest does not yield to manual massage immediately, the Harkins-Bramson machine should be applied. The instrument is especially devised for quick application. Inasmuch as manual massage can be maintained while the instrument is adjusted to the patient, no time need be lost in switching from manual to mechanical support. The instrument is then adjusted to provide the optimal massaging rate and force as determined by peripheral arterial pulsations or blood pressure measurement. With optimal circulation maintained by the machine, attention can then be directed to other aspects of emergency care.

When heart action returns (should the heart go into fibrillation, an external defibrillator should be applied), the rate previously set by the attending physician will immediately be overridden by the patient's own heart rate and massage will coordinate to provide support to the heart not only while arrested but also during the critical moments of recovery following arrest.

Following successful resuscitation, whether accomplished by hand or with the aid of the machine, it is recommended that the machine remain connected to the patient on a stand-by basis and that the electrocardiogram be monitored continuously for several hours so as to provide the best safeguard in the event of subsequent heart failure or arrest.

b) **Support of the Failing Heart:** When called upon as an assistor for the beating heart, the instrument will be used on an elective basis and leisurely application is possible. After placing the cardiac massage unit in the correct position around the patient, the ECG signals are fed into the pulse generator and the massage commenced in synchrony with the beating heart. The force of massage is gradually increased until cardiac output is sufficiently improved. The control of "duration of systole" is then adjusted so as to yield maximum cardiac output from that force. Thereafter, the force of the massaging pad can be readjusted to the minimum yielding adequate circulatory support.

Summary of Uses

The Harkins-Bramson machine is designed for use in two large areas of clinical medicine—resuscitation of the arrested heart, and support of the circulation during heart failure.

a) **Cardiac Arrest**

It is now well established that external massage is the safest means of cardiac resuscitation. In the event of the catastrophe of cardiac arrest, external massage should be applied manually without delay. If spontaneous heart action returns immediately, manual massage should be discontinued because randomly timed external massage will then interfere with cardiac filling.

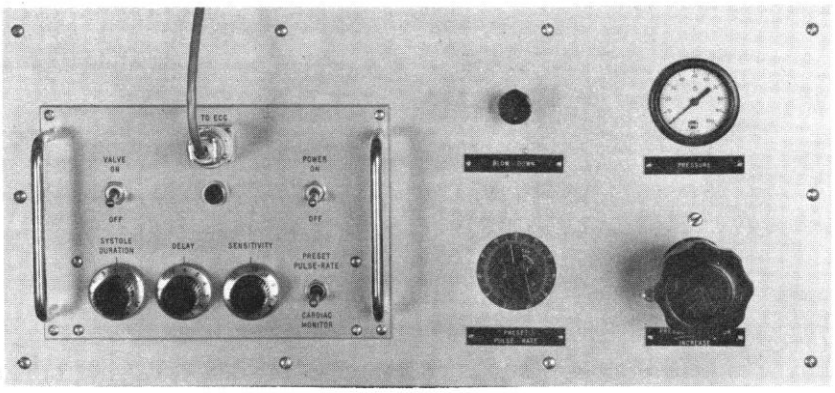
If the heart does not respond promptly to manual massage, the patient should be placed on the massage unit immediately. The proper force and frequency for massage can be established quickly and continued with uniformity for as long as necessary.

b) **Heart Failure**

The same principle that permits blood flow to be initiated in cardiac arrest can be applied to increase cardiac output in the actively beating heart, provided that the mechanical force is applied simultaneously with each ventricular systole. The Harkins-Bramson machine accomplishes this by precise electronic synchronization with the electrical excitation wave of the ventricles ("R" wave of the electrocardiograph). External support is provided to each myocardial contraction, thereby increasing stroke volume and cardiac output. By virtue of this feature, the instrument is the first and only cardiac assistor currently available.

It will support the heart in any case of heart failure due to an abnormality of the heart itself. Examples of its numerous applications in this area of clinical medicine include the treatment of the heart failure of myocardial infarction, Stokes-Adams disease, and myocarditis, and post-operative support of the heart after cardiac surgery. Heart failure due to peripheral causes, such as hemorrhage or septicemia, is not amenable to treatment by a cardiac assistor.

It should be pointed out that the treatment of cardiogenic heart failures by the Harkins-Bramson machine represents a mode of therapy that has not previously been available. Although, in some instances, it will replace another form of treatment, more often it will offer hope in a situation for which no other treatment is known.



Control Panel