NBS

Technical Note 237

DISCLOSURES ON VARIOUS SUBJECTS

A Frequency Meter, A Phase Shifter, A Double-Tuned Transformer, and A Ram-Controlled System

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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This Note presents four devices embodying interesting and unusual solutions to problems prevalent in their respective arts. These devices, developed at the National Bureau of Standards and the U. S. Weather Bureau, comprise a pulse frequency meter; a variable phase shifter; a variable bandwidth, double-tuned transformer, and a control system for any hydraulic ram-operated press.

A Pulse Frequency Meter

Donald A. Mathews

The pulse frequency meter. described herein, converts pulses of varying amplitude or shape or duration to direct current. In this way, the average direct current output is linearly proportional to the input pulse frequency, with the maximum value limited by circuit constants.

Prior to receipt of a negative pulse on an input terminal 10, the source of positive potential 11 charges capacitor 12 by means of a circuit through limiting resistors 13, 14, diode 15, choke 16 and the load resistor 17. The Shockley four-layer diode 20 is open. (Diodes 15, 21 comprise a half-wave rectifier; choke 16 and capacitors 22, 23 form a suitable filter.)

When a negative-going pulse is applied to input terminal 10, a negative voltage is developed across potentiometer 26 and is coupled through capacitor 27 to the Shockley four-layer diode. The total voltage exceeds the switching voltage of the diode, and it closes. Once closed the diode is essentially a short-circuit, and capacitor 12 is discharged through a circuit that includes resistor 14 and diodes 28, 21. Since the Shockley diode remains closed as long as enough current flows through it to hold it closed, the value of resistor 13 is selected to pass less than the holding current. Thus, as capacitor 12 discharges, when the current falls below the holding current, diode 20 opens.

As successive negative pulses are applied to terminal 10, the operations just described are repeated. The successive charging of capacitor 12 across the load resistor 17. develops a voltage that has a linear relationship with the frequency of pulses applied to terminal 10.

At the start of operation of pulse amplifier 30, Shockley four-layer diode 31 is open. Depending upon the position of switch 32, one of the capacitors 34 is charged by source 36. When a negative pulse is applied to terminal 10 to discharge capacitor 12, a negative-going voltage pulse is transmitted from capacitor 37 to the Shockley diode 31. The total voltage exceeds the switching voltage of the diode, which then closes. A circuit is completed through diodes 31, 38 and loudspeaker 40, discharging capacitor 34. Because the value of resistor 41 is selected to pass less than the holding current of Shockley diode 31, as the capacitor discharges, the current falls below the holding current and the diode opens. Capacitor 34 then recharges.

Successive pulses, applied to terminal 10 cause the operations, just indicated, to be repeated developing an a-c voltage that drives speaker 40 in dependency upon the pulse frequency. The volume of the speaker is controlled by the values of resistors 41, 42 and the selection of one of the capacitors 34.

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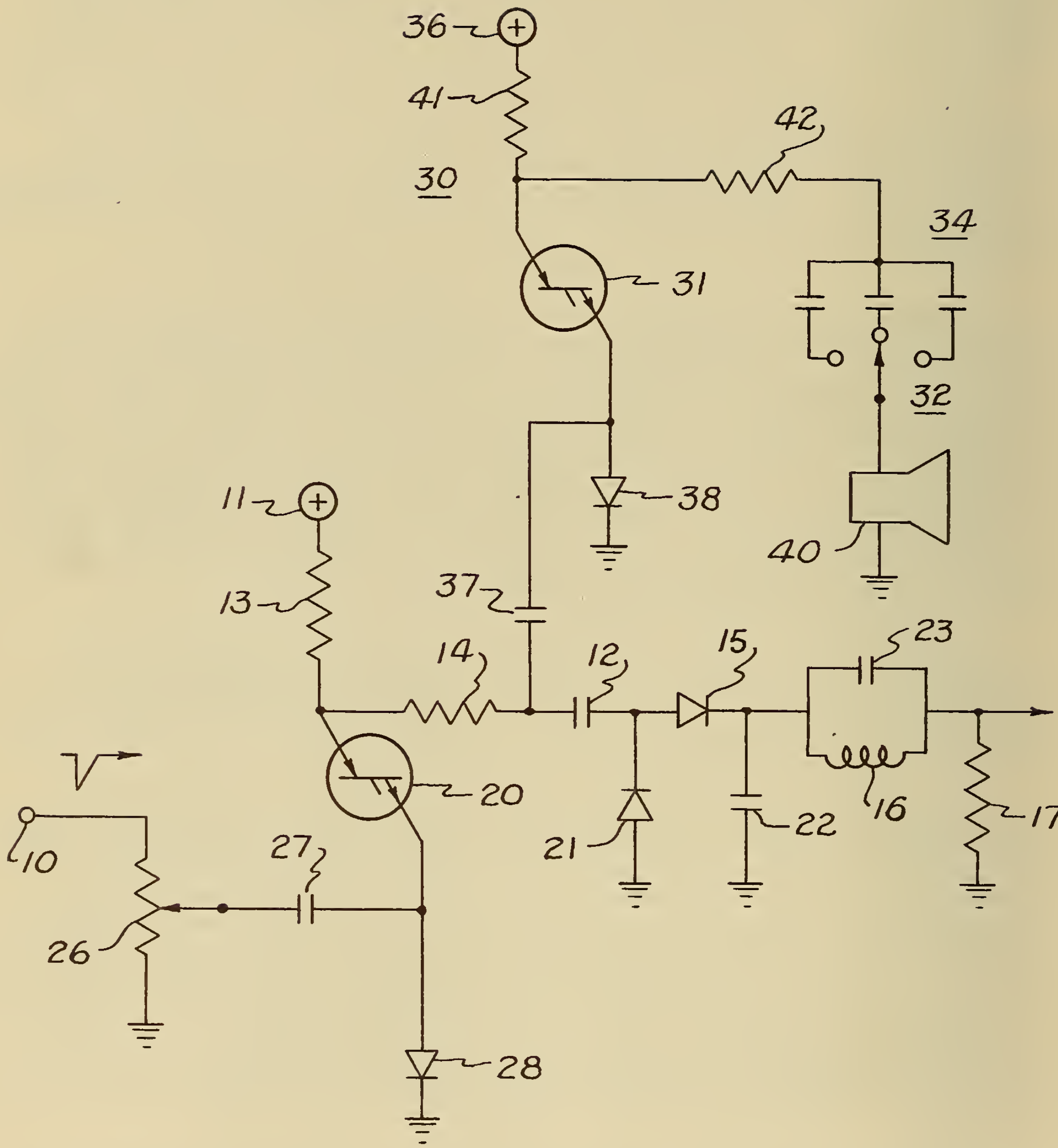
A Pulse Frequency Meter

Donald A. Mathews



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A Variable Phase Shifter

Ernest L. Smith

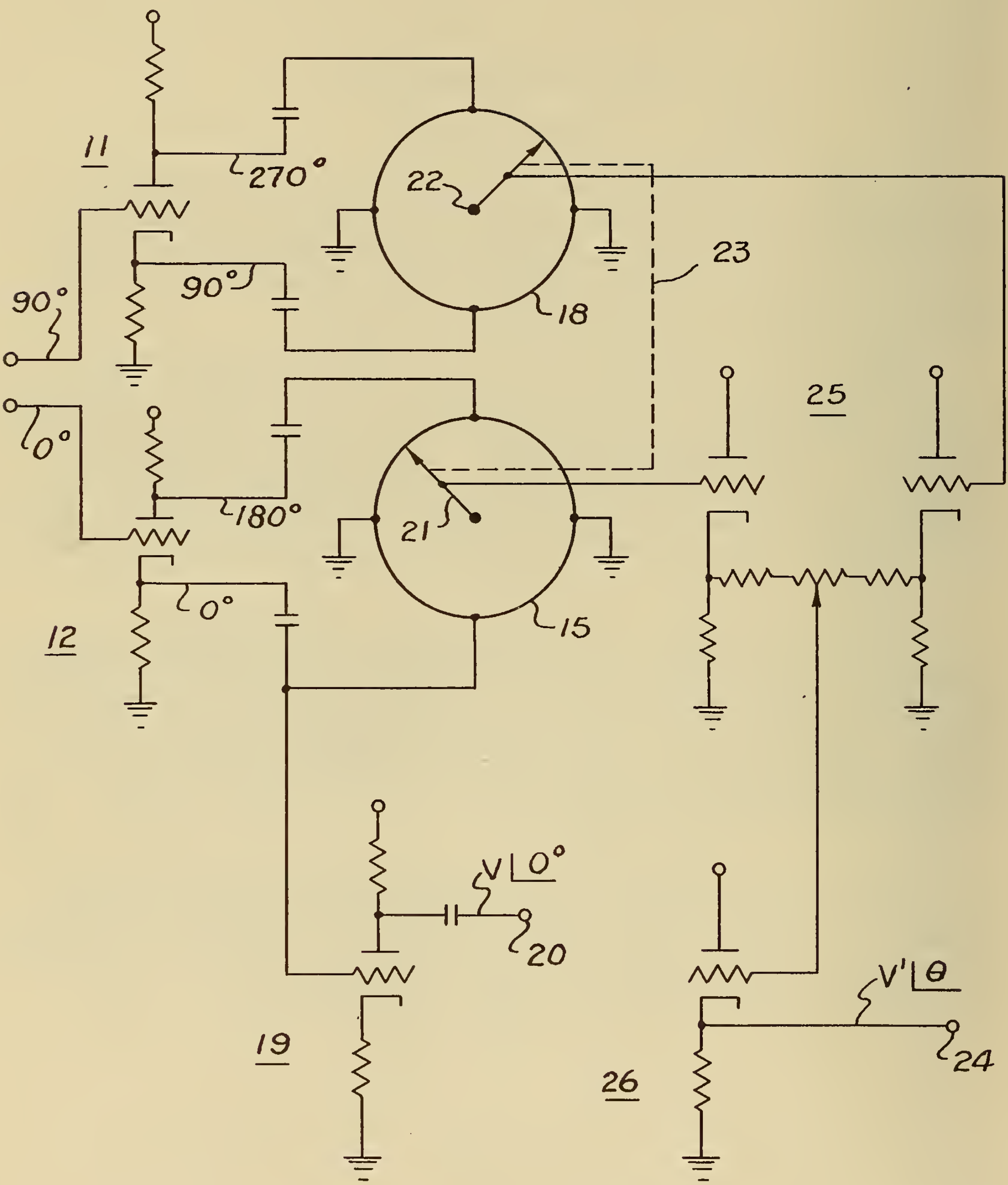
This phase shifter provides a simple and easily adjustable arrangement for obtaining two outputs, one of which is variable from 0° to 360° relative to each other. It may be operated over a wide range of frequencies and may be used in any apparatus requiring the variation of a phase difference between two angles.

In the figure, quadrature voltages of equal amplitude, one of which is designated 0° and the other 90°, are fed to phase splitters 11 and 12, respectively, so that the resulting signals are in the phase relations 0°, 180° and 90°, and 270°. The first pair of signals are coupled to potentiometer 15, while the second pair are coupled to potentiometer 18. The signal 0° signal is also transmitted to amplifier 19 to develop a reference signal V (phase angle θ) on an output terminal 20.

The potentiometers 15 and 18 are provided with rotatable contactors 21 and 22, which are ganged together by a suitable mechanical coupling 23. The signals from the contactors 21 and 22, whose amplitudes vary sinusoidally as the contactors are rotated, are fed to a difference amplifier 25. The contactors are mechanically maintained in a fixed position relative to each other such that their electrical functions are 90° out of phase.

The output of amplifier 25 is constant in amplitude, but varies in phase from 0° through 360° as the contactors are rotated through a complete revolution. The output of amplifier 25 is applied to the input of amplifier 26 so that signal V' (phase angle θ) appears on terminal 24, while signal V (phase angle 0°) appears on terminal 20.

Ernest L. Smith



Variable Bandwidth, Double-Tuned Transformer

Robert J. Carpenter

The bandpass characteristic of a double-tuned transformer is controlled by the Q of its tuned circuits and the coupling coefficient between them. In this disclosure, the coupling coefficient and the Q of one of the circuits are varied simultaneously to approximately maintain the optimum shape of the response characteristic of the transformer, while at the same time modifying the bandwidth.

The technique is one in which a voltage or current-sensitive reactance is used as the coupling element in the transformer. Coupling is modified by changing the voltage or current applied to the reactance --- the variation being accomplished by a variable resistor which is connected so as to simultaneously change the Q of one of the tuned circuits. By proper choice of constants, a desired transformer bandpass characteristic may be maintained over a substantial variation in bandwidth.

In Fig. 1, a voltage-variable capacitor 10 is used as the coupling reactance between tuned circuits 11 and 12. The control voltage for the capacitor is derived from a voltage divider that comprises resistors 13 and 14. The variable resistor 14 is connected so as to vary the Q of tuned circuit 12.

As an example of operation, assume that when resistor 14 has maximum value, the bandpass of the circuit is represented by curve A (Fig. 2). As the value of resistor 14 is decreased, the coefficient of coupling is increased and the bandpass becomes broader to provide curves B and C. (The bandpass expands only to the lower frequency side.) Simultaneously, the current through resistor 14 increases the loading on tuning circuit 12; the circuit loss, and therefore the Q, of circuit 12 is lowered to maintain the shape of the curve.

It will be apparent that the present circuit could be modified so that a current-sensitive inductor is used, instead of capacitor 10, as the coupling element between the double-tuned circuits. In this case, the variable resistor would be positioned in series with one of the tuned circuits so as to control simultaneously the Q of the latter circuit and the coefficient of coupling between the circuits.

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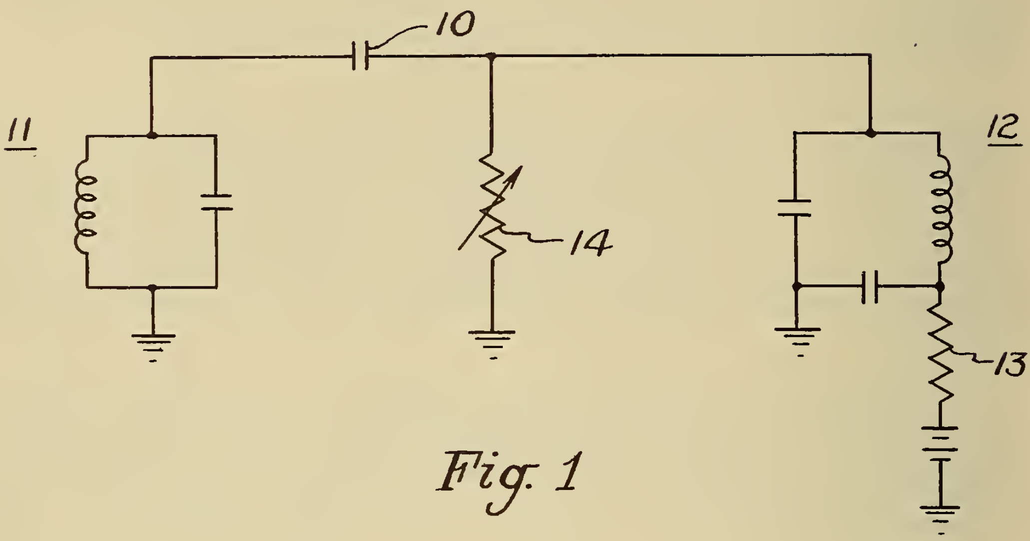

Fig. 1

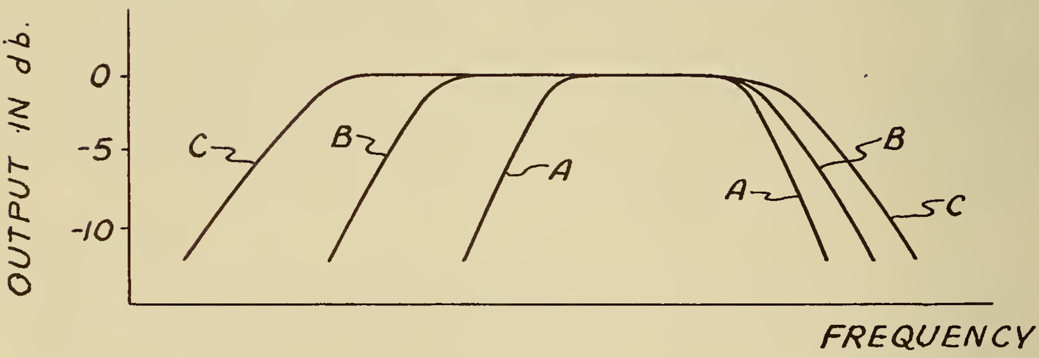

Fig. 2

Control System for Any Hydraulic Ram-Operated Device

Harry S. Parker and Milton D. Burdick

The system described may be used with any hydraulic ram-operated device in which a particularly slow, controlled rate of pressure build-up or release is required without auxiliary mechanical vibration. The system, in many cases, can be precharged by a hand-operated pump or cylinder gases. The applied hold constant force is easily achieved for long periods without constant pumping during the "dwell" time.

The present system may be connected in parallel with a conventional hydraulic system supplied with a ram or press. Valves 1, 2 and 3 serve to isolate this system during periods when normal operation of the ram or press is desired.

At the start of operation, valves 1 and 2 are open; valves 3 to 7 are closed; and the energy-supply accumulator 10 is precharged with gas to an appropriate pressure. (Valve 4 is in parallel with needle-type valve 5, while needle-type valve 6 and valve 7 are in parallel.)

As the first step, valve 3 is opened and oil is pumped through check valve 11 until the accumulator 10 attains a selected pressure within a predetermined range. (The pressure is indicated on gauge 12, and the range is limited by the low pressure relief valve 13 to reservoir 14.) Valve 3 is then closed and the pump is stopped to avoid further vibrations.

Valves 4 and 5 are opened so that oil will pass. This results in a small decrease in pressure on the supply side and a small increase in pressure on the ram side of the valve. The ram-side pressure, as indicated on gauge 15, eventually exceeds the pressure necessary to move the ram, and in the absence of an absorbing accumulator 16, all the oil passing valve 15 is free to cause ram motion.

The introduction of accumulator 16 in the ram-leg of the system imposes a limit on the volume of oil available for ram motion. When oil passes valves 4, 5, a new equilibrium pressure in the ram-leg is achieved. Pressure within accumulator 16 is equalized between oil on the one side and the precharged gas on the other, and a certain volume of oil enters the accumulator and limits the oil available for ram motion. When accumulator 16 is an appropriate size, by an adjustment of its precharge pressure, almost any limitation on the volume of oil available for ram motion can be achieved.

At any given opening of the valves 4 or 5, the thru-flow of oil will be constant except for changes in the pressure-drop across the valve. There is, of course, a continual small change in pressure drop across the valve because of the closed nature of the system. This inevitable change in pressure-drop can be minimized by the selection of a suitable volume and precharge pressure of supply accumulator 10.

After valve 4 is closed, a nearly constant and very small rate of ram travel is attained for any setting of needle-type valve 5; and the ram's travel can be stopped and held constant by closing the latter valve.

Controlled rates of unloading the ram are obtained by valves 6 and 7, which are positioned between the ram and reservoir 14.

Control System for Any Hydraulic Ram-Operated Device

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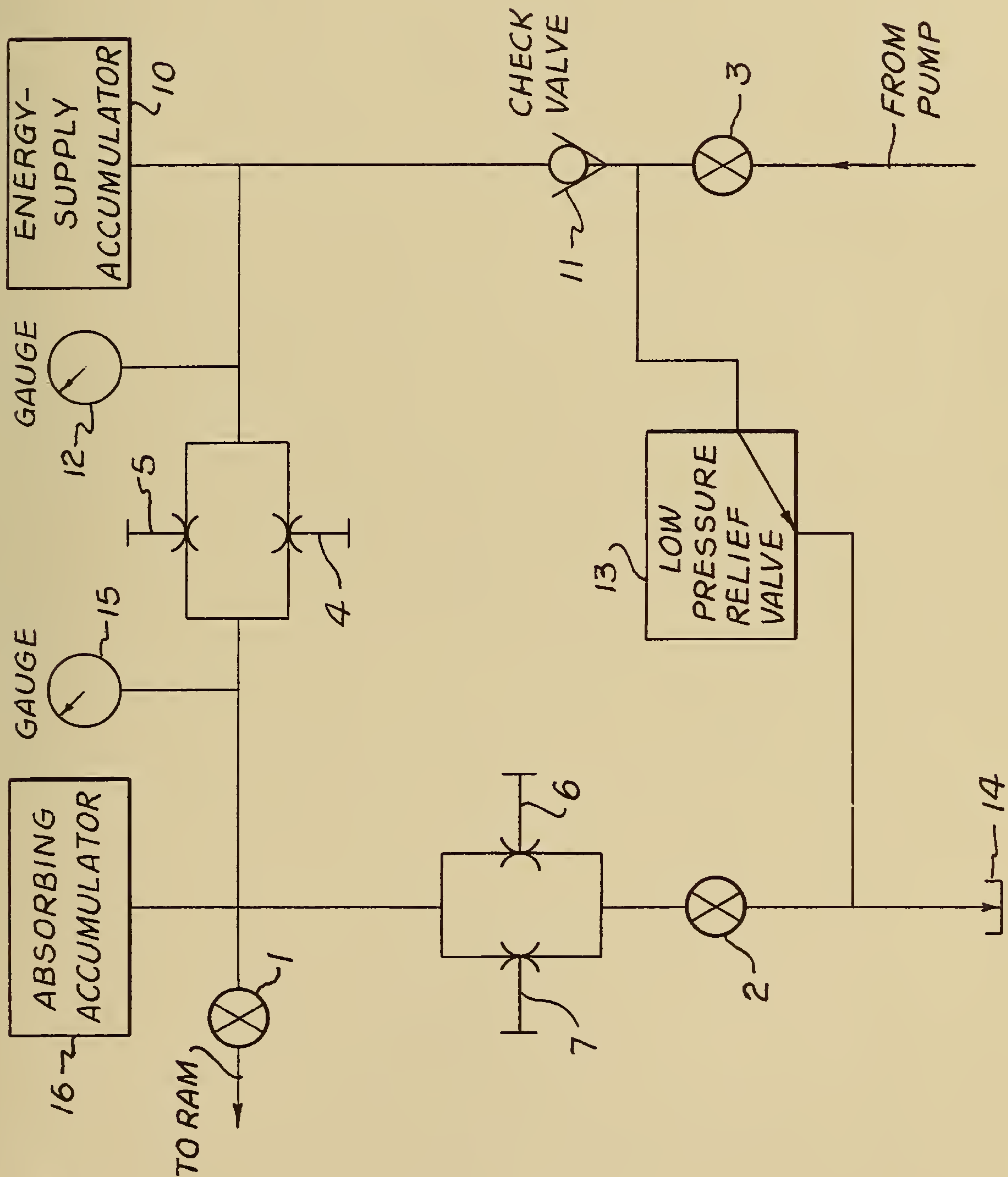

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