Kingsbury
Thrust Measurement Systems

Kingsbury, Inc.

Catalog TMS

By accurately measuring thrust loads in rotating machinery, the Kingsbury equalizing thrust bearing instrumented with load cells becomes an invaluable performance-measurement tool for the designer and the production manager as well as for the end user. Designers of compressors, turbines, fans and feedpumps can use the load cell bearing to determine if the equipment is performing in accordance with design specifications.

Production management can use the bearing to evaluate identical machinery and pinpoint performance inconsistencies that might be caused by a manufacturing shortcoming. The end user can utilize the Kingsbury bearing as a diagnostic tool to track the efficiency of the equipment and be forewarned of potential efficiency-robbing deposits on the rotating elements.

Thrust load is an especially important vital sign which must be monitored in rotating machinery using balance pistons to counterbalance residual forces. Should the counterbalance mechanism fail, the machine can go into overload condition and eventually destroy itself. Here, the load cell can be used to signal the operator and/or trip the system to prevent costly damage.

Kingsbury installs the load cells in either the upper leveling plates or in the shoes of its thrust bearings. The load cells used by Kingsbury have been in successful continuous operation for more than a decade and have demonstrated their reliability under heavy-duty use. The materials used in load cell construction have been further refined and improved by virtue of field experience to ensure that the cells will provide the years of maintenance-free service for which Kingsbury bearings are noted.

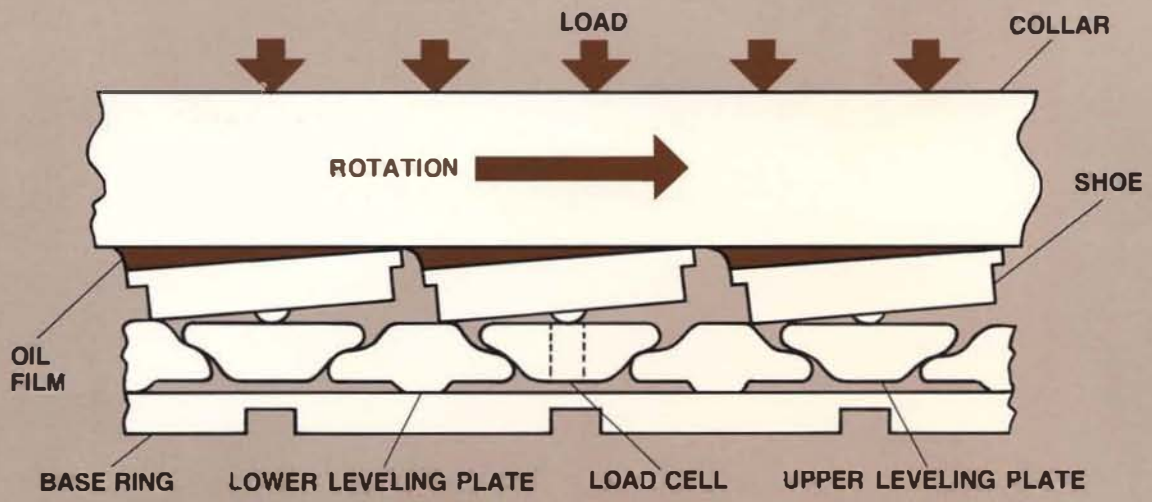
Understanding the equalizing thrust bearing

Kingsbury thrust bearings are designed to transmit axial loads from the shaft to the support structure of rotating machinery. The simplified representation depicts the path followed by the load. It travels from the shaft . . . to a forged steel bearing collar rigidly attached to the shaft . . . to a self-renewing film of oil which is set into rotation and pressurized by the frictional forces generated by the rotating collar.

The force is then transmitted to shoes which are free to pivot about their circumferential and radial axes . . . thence to leveling plates whose function is to equalize the load transmitted to adjacent shoes. The load is passed on to the bearing base ring which is supported and positioned in the thrust bearing housing.

Since the total thrust load is equally distributed among the bearing shoes, the load cell rating represents only a fractional part of that load. One load cell in a 6-shoe bearing measures ⅙ of the total load; one load cell in an 8-shoe bearing measures ⅛ of the total load.

Kingsbury equalizing thrust bearings are especially long-lived since working surfaces are continuously separated by the film of oil, except during equipment startup and shutdown.



Load cell installed in leveling plate

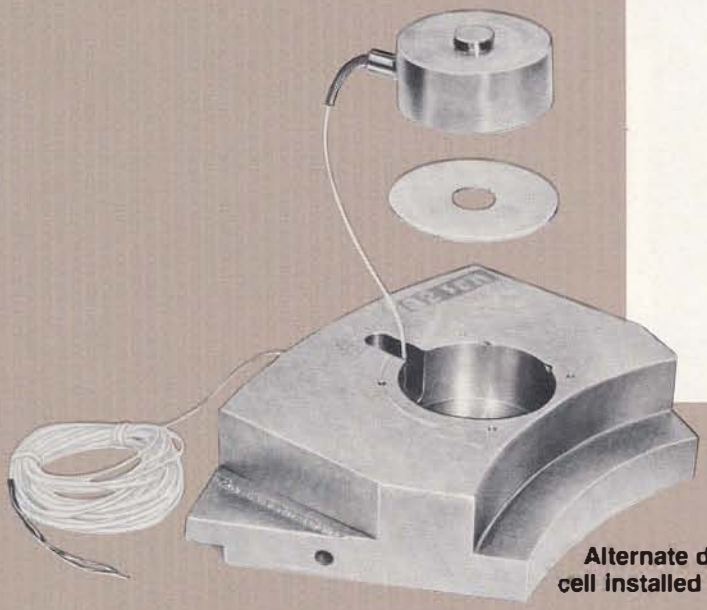
When the load cell is installed in the leveling plate, shoes can be inspected or replaced without disturbing the load cells. No restraint is placed on free shoe action. The ambient temperature of the leveling plate fluctuates less than that of the thrust shoe so that the load cell functions in a stable environment. Lead wires pass through a hole in the floor of the base ring and are led away from the bearing by way of the oil inlet passages to an outlet in the bearing housing.

The standard load cell and leveling plate are calibrated as a unit to obtain maximum accuracy and are marked with serial numbers for positive identification in the field. Each load cell is shipped with its individual data sheet which documents its characteristic sensitivity or change in output for applied rated capacity load. Normally, additional loads between zero and full scale with corresponding output are provided for use in determining a calibration curve. Outputs are expressed in millivolts output per volt input.

Typical 9″ leveling plate with 3000-lb. capacity load cell

Typical 12″ leveling plate with 6000-lb. capacity load cell

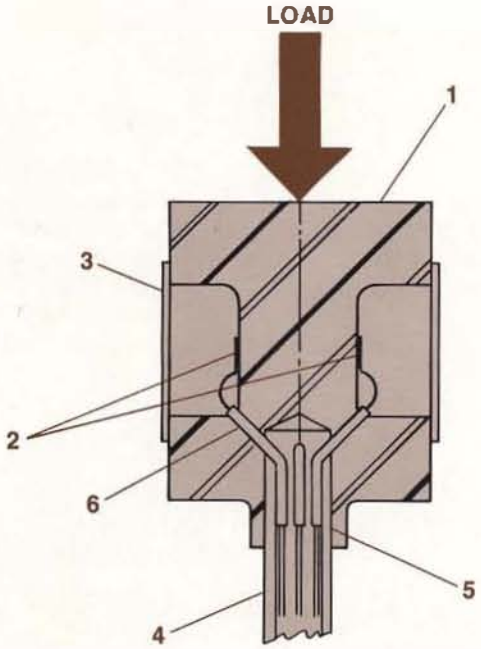
Equalizing thrust bearing shown installed in lower half of a self-lubricating housing



Alternate design has load cell installed in shoe

Load cell installed in shoe

Kingsbury offers an alternate design that is particularly well suited for use with non-equalizing bearings which do not have leveling plates. In this configuration, the load cell is an integral part of a shoe support which is itself installed in the shoe. This assembly is ideal for retrofitting and makes a relatively easy task of routing lead wires out of the bearing housing. Performance specifications are identical to those of the standard load cell.

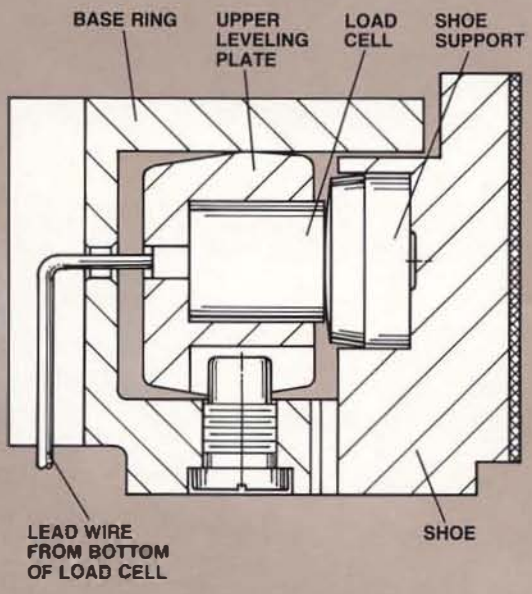


Features of Mechanical Construction

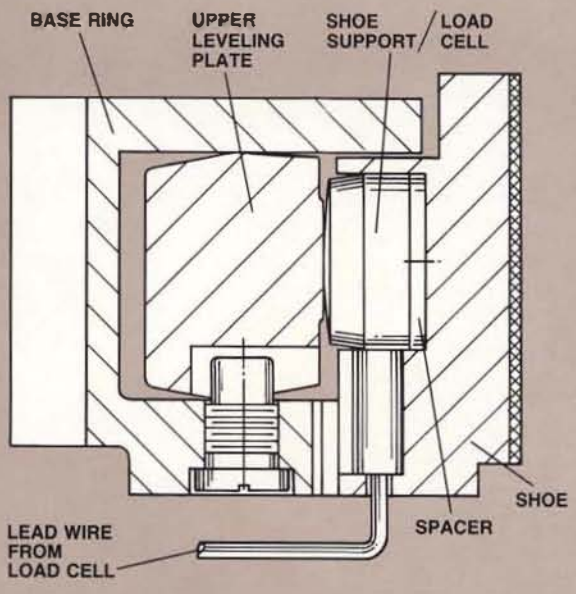
The load cell is fundamentally a steel column (1) stressed in compression by thrust force. Wire resistance strain gages (2) are mounted on this column. At rated capacity, metals used in fabrication of the cell are stressed well below their 10^{10} cycle endurance limits, thereby assuring a longevity equivalent to that of the bearing itself.

Positive environmental sealing prevents the deterioration of cell performance with time. A fusion-welded stainless steel sheath (3) encloses the strain gage chamber. The abrasion-resistant Teflon™ outer cable sheath (4) is bonded to the steel column with epoxy (5). The individual lead wires enter the strain gage chamber through drilled holes, and the wires are sealed and bonded in the holes with epoxy (6).

Load cell installed in leveling plate



Load cell installed in shoe also available

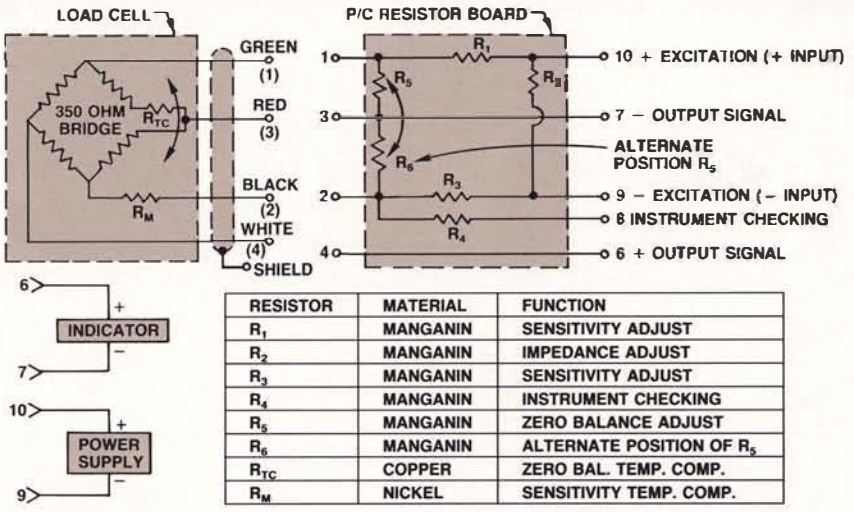


Features of Electrical Construction

Wire resistance strain gages are mounted on the load cell column and wired in a Wheatstone bridge circuit. Changes in gage resistance, produced by strain, unbalance the Wheatstone bridge, thereby producing a force-input to bridge-unbalance relationship. The bridge balance is affected by factors other than strain and it is necessary to compensate for these irregularities.

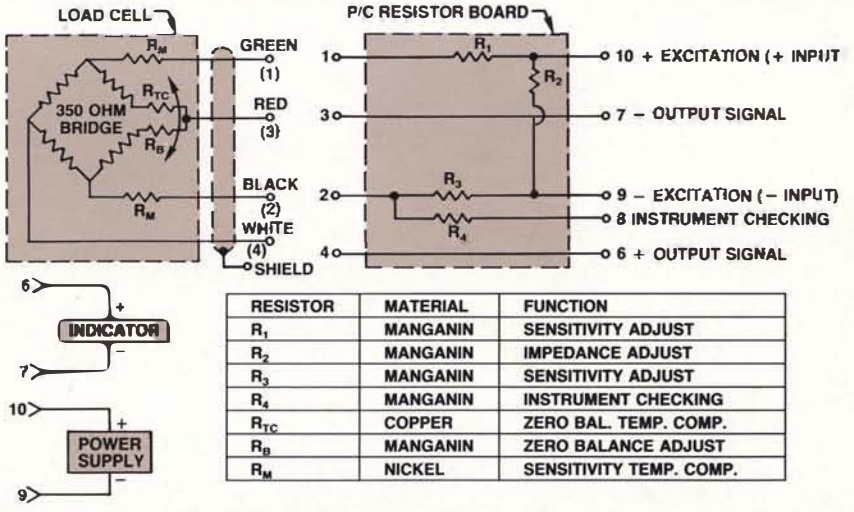
A temperature-sensitive resistor in the load cell compensates for thermally-induced resistance changes within the Wheatstone bridge circuit as well as for changes in the modulus of elasticity of steel caused by temperature variation. To overcome the unbalance caused by the insertion of this resistor as well as to overcome unbalance due to the slight resistance difference between the gages, a zero load balance adjusting resistor is inserted within the bridge. The strain sensitivity of the resulting circuit is relatively constant from 15°F to 222°F.

Schematic for leveling-plate mounted load cells rated up to 3000 lbs.



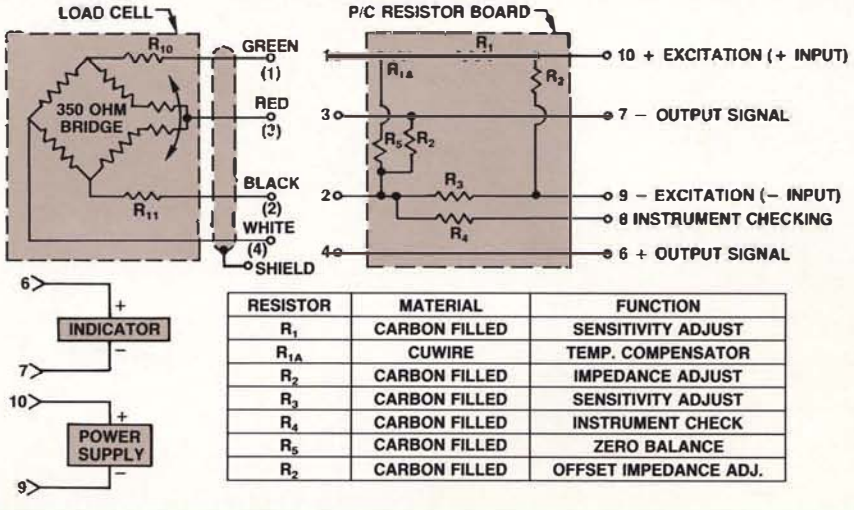
RESISTOR	MATERIAL	FUNCTION
R_1	MANGANIN	SENSITIVITY ADJUST
R_2	MANGANIN	IMPEDANCE ADJUST
R_3	MANGANIN	SENSITIVITY ADJUST
R_4	MANGANIN	INSTRUMENT CHECKING
R_5	MANGANIN	ZERO BALANCE ADJUST
R_6	MANGANIN	ALTERNATE POSITION OF R_5
R_{TC}	COPPER	ZERO BAL. TEMP. COMP.
R_M	NICKEL	SENSITIVITY TEMP. COMP.

Schematic for leveling-plate mounted load cells rated 4200 lbs. and greater



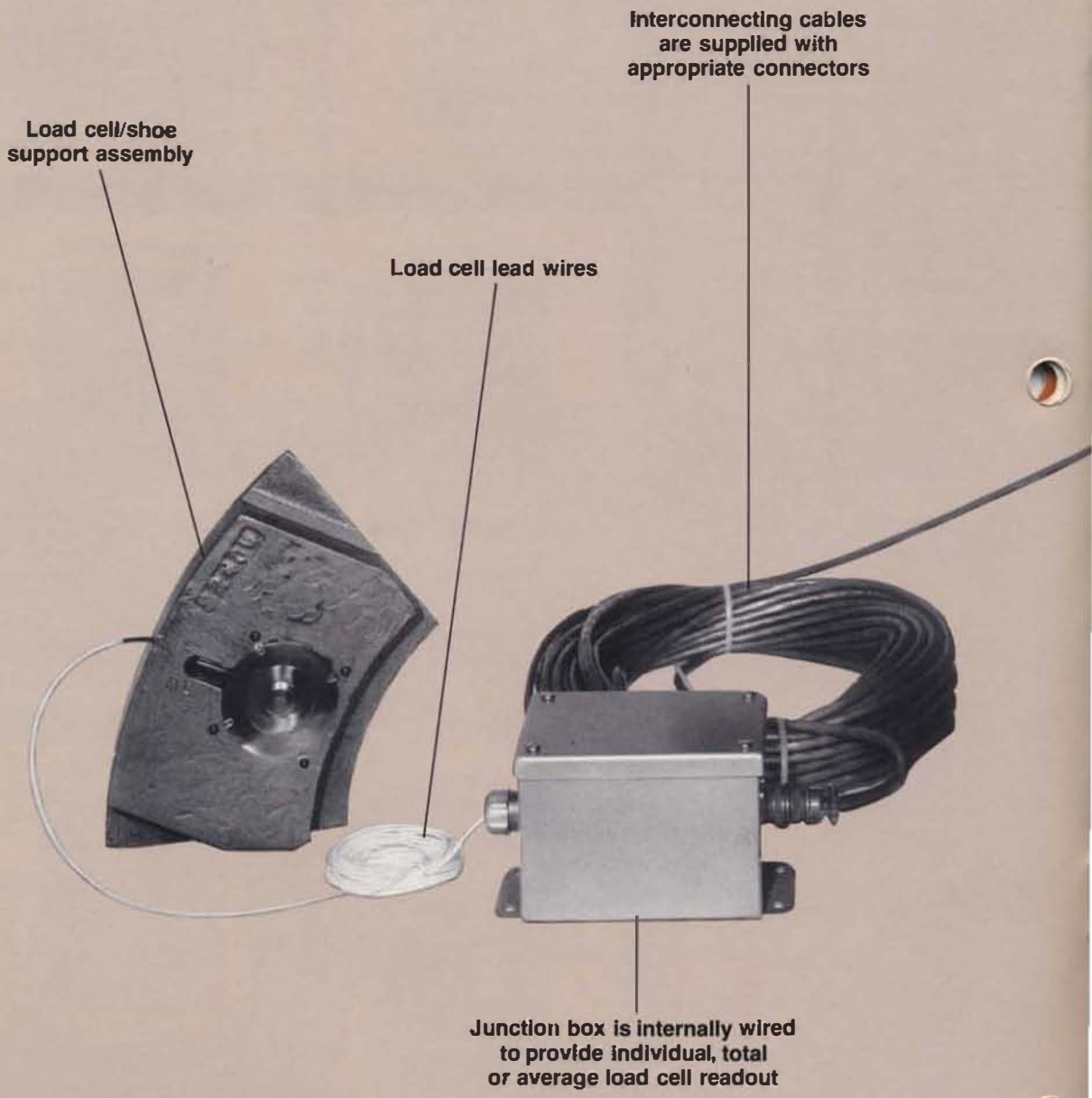
RESISTOR	MATERIAL	FUNCTION
R_1	MANGANIN	SENSITIVITY ADJUST
R_2	MANGANIN	IMPEDANCE ADJUST
R_3	MANGANIN	SENSITIVITY ADJUST
R_4	MANGANIN	INSTRUMENT CHECKING
R_{TC}	COPPER	ZERO BAL. TEMP. COMP.
R_B	MANGANIN	ZERO BALANCE ADJUST
R_M	NICKEL	SENSITIVITY TEMP. COMP.

Schematic for shoe-mounted load cell



RESISTOR	MATERIAL	FUNCTION
R_1	CARBON FILLED	SENSITIVITY ADJUST
R_{1A}	CUWIRE	TEMP. COMPENSATOR
R_2	CARBON FILLED	IMPEDANCE ADJUST
R_3	CARBON FILLED	SENSITIVITY ADJUST
R_4	CARBON FILLED	INSTRUMENT CHECK
R_5	CARBON FILLED	ZERO BALANCE
R_2	CARBON FILLED	OFFSET IMPEDANCE ADJ.

A TYPICAL LOAD-MO



Kingsbury can furnish all components as a

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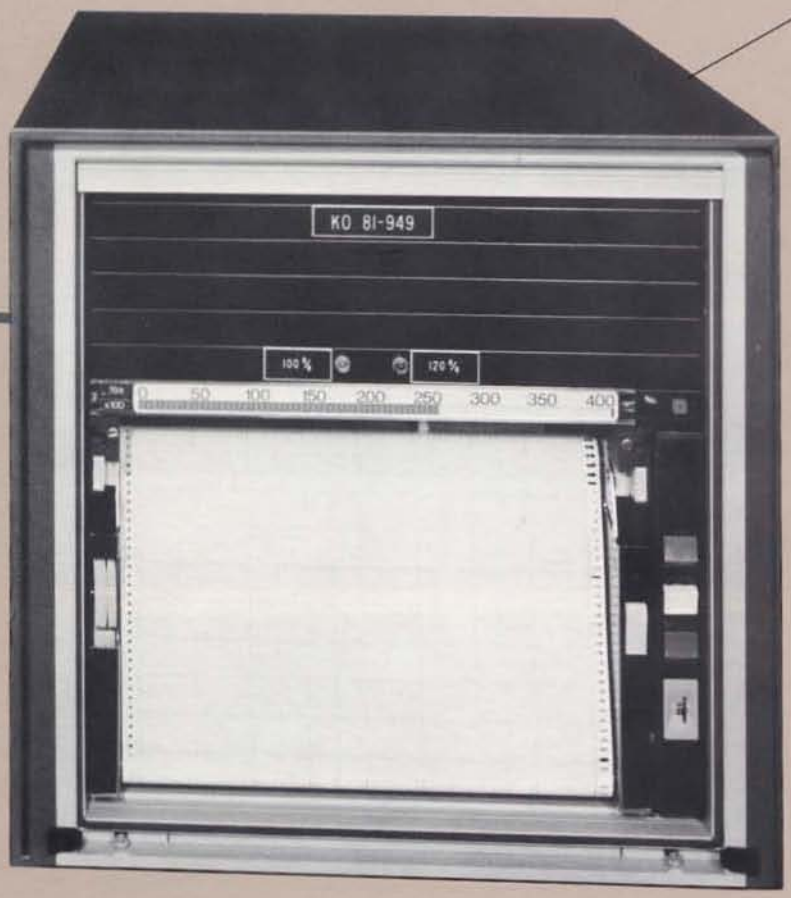
Strip chart
recorder with 6-channel
capability



integrated, performance-matched system

Kingsbury, Inc.

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