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AN INSTRUMENTAL SYSTEM FOR THE

MONITORING OF VINYL CHLORIDE MONOMER IN

PLANT AND LABORATORY WORK AREAS

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Summary

An analysis of the problems relating to the monitoring of vinyl chloride monomer (VCM) in laboratory and production work areas has shown that two different types of monitoring capabilities are required; a fixed analyzer with multi-point remote sampling capabilities and a portable analyzer for rapid area survey analyses and leak detection.

An evaluation of commercially available instrumental methods has revealed that the flame ionization method for monitoring low concentrations of VCM in ambient air has distinct advantages over other procedures investigated. These advantages include outstanding sensitivity (0.01 ppm minimum detection), and good linearity and response (±2%) over a wide range of concentrations (0-1000 ppm). Additionally, the analyzer is moderate in cost (approximately $2,000) and can e easily interfaced to a multi-point sampling system and continuously operated on a two minute per sample point cycle for long periods of time with a minimum of operator attention or maintenance.

A fixed monitoring system utilizing a flame ionization instrument (Bendix 8401 Total Hydrocarbon Analyzer) has been in continuous operation in a PVC poly building, at the B.F.Goodrich Chemical Company plant in Avon Lake, Ohio, for approximately six months. This system which includes, in addition to the analyzer and a six point sampling system, a multi-point recorder, interfacing hardware and a programmable calculator for data reporting on a hourly and shift basis. The operation of this system has been essentially trouble free during this period and has provided the types of measurements

required to determine VCM concentration in a multi-story building and to minimize employee exposure levels.

An important adjunct to this system is the portable survey instrument that has outstanding utility in rapidly determining the source of VCM leaks in processing equipment. This instrument (Century Organic Vapor Analyzer[1]) also uses the flame ionization principle. It is light weight, easily portable and has sensitivity and linear response roughly equivalent to the fixed analyzer. Equally important, and highly essential in leak detection, is this instrument's instant response to VCM.

A brief, summary comparison of the advantages and disadvantages of the various instrumental methods explored are given in Table I (Fixed Monitoring) and Table II (Survey Monitoring). These comparisons are not specific to any differences that might be noted between different suppliers of instrumental hardware but are inherent differences in the basic principles or methods described. Except for the portable flame ionization instrument (Century Orangic Vapor Analyzer), all of the instrumental methods are available fr m a number of instrument manufacturers.

A schematic of the recommended VCM fixed monitoring system is shown in Figure 1 and includes interfacing hardware for the sampling system. Figure 2 shows a six point sampling system and including a manifold for the hydrogen and span gases used for operation and calibration of the instrument. Figure 3 details the interfacing of a six point recorder and Wang calculator to the flame ionization analyzer.

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(1) Century Systems Corporation; Arkansas City, Kansas

The analyzer package includes an internal sample pump and sample pressure regulator as well as the necessary capillary flow controls and indicating pressure gauges to provide a very stable flow of hydrogen, air and sample gas. The analytical components in contact with the sample should be either glass or stainless steel to minimize corrosion. Some of the components in the flame ionization cell (bonnet and guiderods) should be Teflon coated to prevent corrosion from the HCl produced from the combustion of VCM.

This type of analyzer can operate over a wide range of temperature and humidity conditions without adverse effect on measurement accuracy. The sample is introduced at a controlled rate into the flame ionization cell where a hydrogen flame is burning in an atmosphere of air. As the sample enters the flame a percentage of the molecules are ionized, forming positive and negative ions. The extent of ionization depends on the compounds present (composition and structure) and the temperature of the flame. As a general rule, compounds must have carbon-carbon or carbon-hydrogen bonds to be detectable. The degree of ionization is roughly proportional to the number of carbon atoms per molecule. Inorganic materials such as hydrogen, oxygen, nitrogen and water are not ionized. The positive ions formed in the flame are collected on a negative electrode producing a signal that can be measured using the output of an electrometer preamplifier.

From the above descriptions of the principles involved in flame ionization detection it is apparent that this type of analyzer is not specific for VCM. Based on in-plant testing that included the simultaneous use of analyzers that are both specific (infrared and gas chromatography) and non-specific for VCM it was found that the presence of atmospheric contaminants, other than VCM, was of little consequence in producing erroneous results. In a majority of work areas specific component identification is not required. However, sufficient air quality measurements should be made using the multiple instrument approach, or other methods, to assure that interfering components are not a major problem.

The previously described evaluation of various instrumental methods and the subsequent testing of a total system in a plant working environment has been sufficient to conclude that these procedures can be easily applied to a variety of work areas where the monitoring of VCM in ambient air is a criteria for employee health and safety. It therefore can be recommended that the identified methods, or their equivalent, be adopted as standard industry practices.

Table I

COMPARISON OF FIXED MONITORING INSTRUMENTS

Method	Advantages of Method	Disadvantages of Method[1]
Total Hydrocarbon Analyzer with Flame Ionization Detector	1. Outstanding sensitivity (0-1 ppm full scale) 2. Linear response (±2% full scale) 3. Good reproducibility (±2% full scale) 4. Rapid response time (almost instantaneous) and cycle time 5. Easy to operate, low maintenance requirements 6. Moderate cost ($2000 w/o recorder)	1. Not specific for VCM
Gas Chromatograph	1. Good sensitivity (low ppm) 2. Acceptable response; good reproducibility 3. Specific for VCM	1. Longer cycle time (5-10 min.) 2. More complex equipment 3. More difficult to operate and maintain 4. More expensive
Infrared Spectrometer w/20m Gas Cell	1. Excellent sensitivity [0.7 ppm MDL[2]] 2. Acceptable response; good reproducibility 3. Specific for VCM	1. Longer cycle time (5-10 min.) 2. More complex equipment 3. More difficult to operate and maintain 4. More expensive
Combustion-Conductivity Method	1. Good sensitivity (low ppm) 2. Specific for halogens	1. Not specific for VCM 2. Longer cycle time 3. Requires excessive operator attention and maintenance 4. Not commercially available

(1) as compared with the Total Hydrocarbon Analyzer

(2) Minimum Detection Limit

Table II

COMPARISON OF PORTABLE SURVEY INSTRUMENTS

Method	Advantages of Method	Disadvantages of Method[1]
Organic Vapor Analyzer (OVA) with flame ionization detector	1. Good sensitivity (low ppm) 2. linear response (1-1000 ppm) 3. Good reproducibility 4. Rapid response (almost instantaneous) 5. Light weight; easily portable 6. Easy to operate and maintain 7. Moderate cost (<$3,000)	1. Not specific for VCM 2. Not approved for use in a Class. I, Group D work area[2]
Gas Chromatography	1. Good sensitivity (low ppm) 2. Acceptable response; good reproducibility 3. Specific for VCM 4. Excellent for multi-component mixtures	1. Lacks instantaneous response for leak detection 2. Not as easily portable as OVA
Infrared Spectrometer w/20m Gas Cell	1. Excellent sensitivity [0.7 MDL[3]] 2. Linear response; good reproducibility 3. Specific for VCM 4. Good for multi-component mixtures	1. Lacks instantaneous response for leak detection 2. Not easily portable 3. Not explosion proof; requires exclosure with N_2 or air purge
Catalytic Oxidation	1. Easily portable 2. Explosion proof 3. Good response at high concentrations	1. Lacks sensitivity (not reliable below 50 ppm) 2. Bad zero level drift

(1) as compared with the Organic Vapor Analyzer

(2) Requires Hot Work Permit

(3) Minimum Detection Limit

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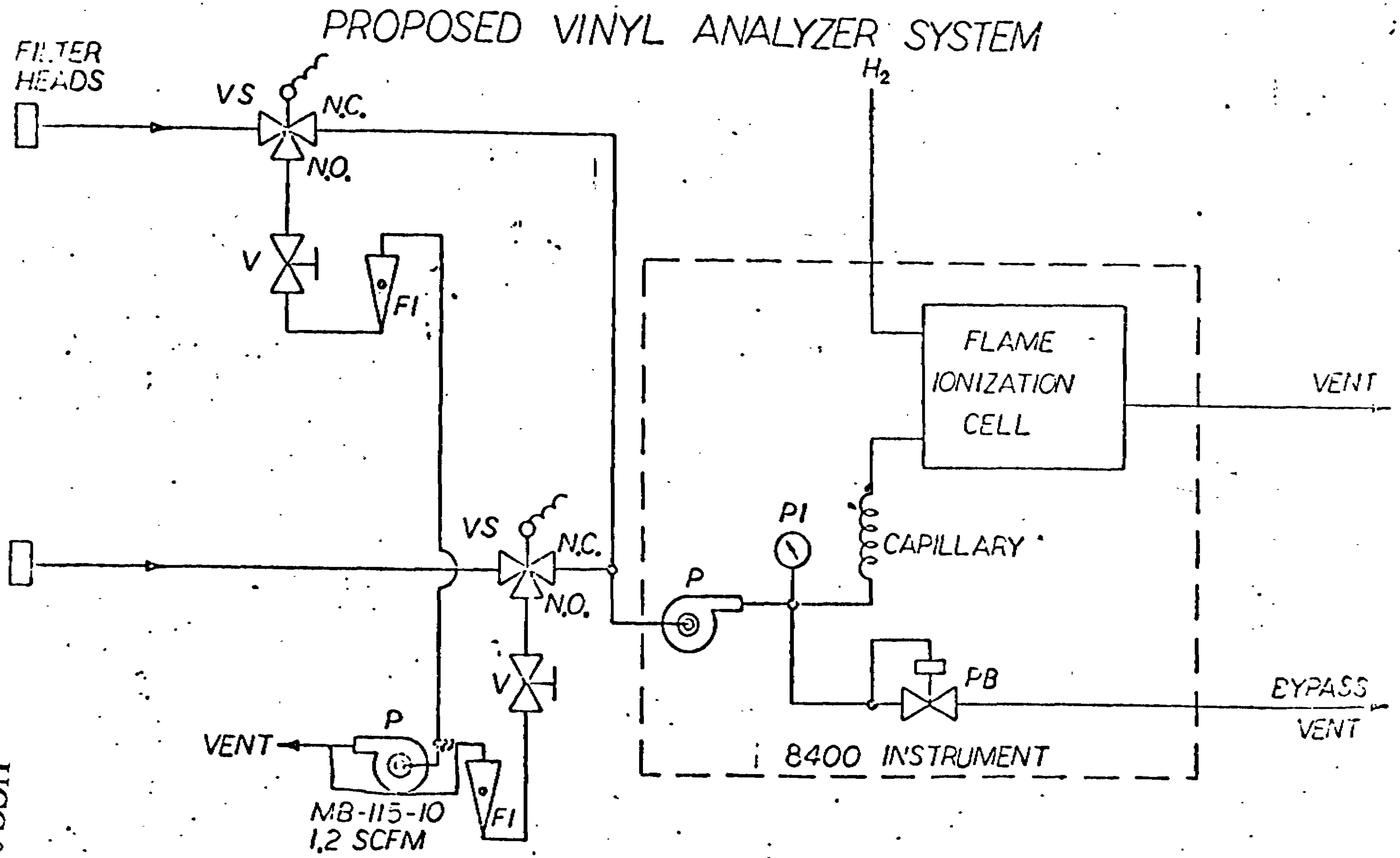
PROPOSED VINYL ANALYZER SYSTEM
FILTER HEADS
VS
N.C.
N.O.
V
FI
H_2
FLAME IONIZATION CELL
VENT
CAPILLARY
PI
P
PB
BYPASS VENT
8400 INSTRUMENT
VENT
MB-115-10
1.2 SCFM

Figure 1

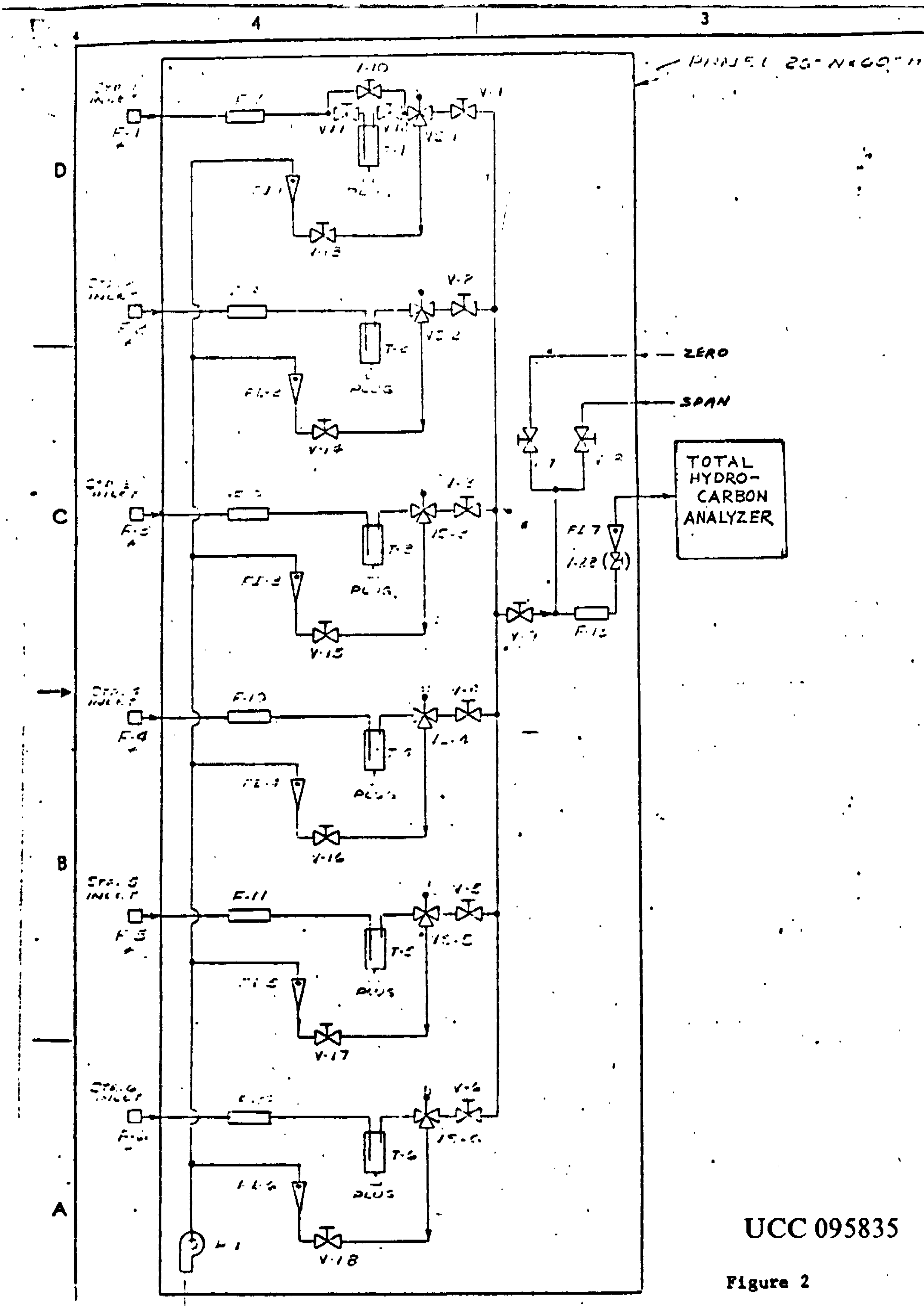

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Figure 2

BY ME F DATE 1-21-74 SUBJECT YCL MONITORING WANG CALCULATOR SYSTEM SHEET NO. ____ OF ____

CHKD. BY ____ DATE ____ JOB NO. ____

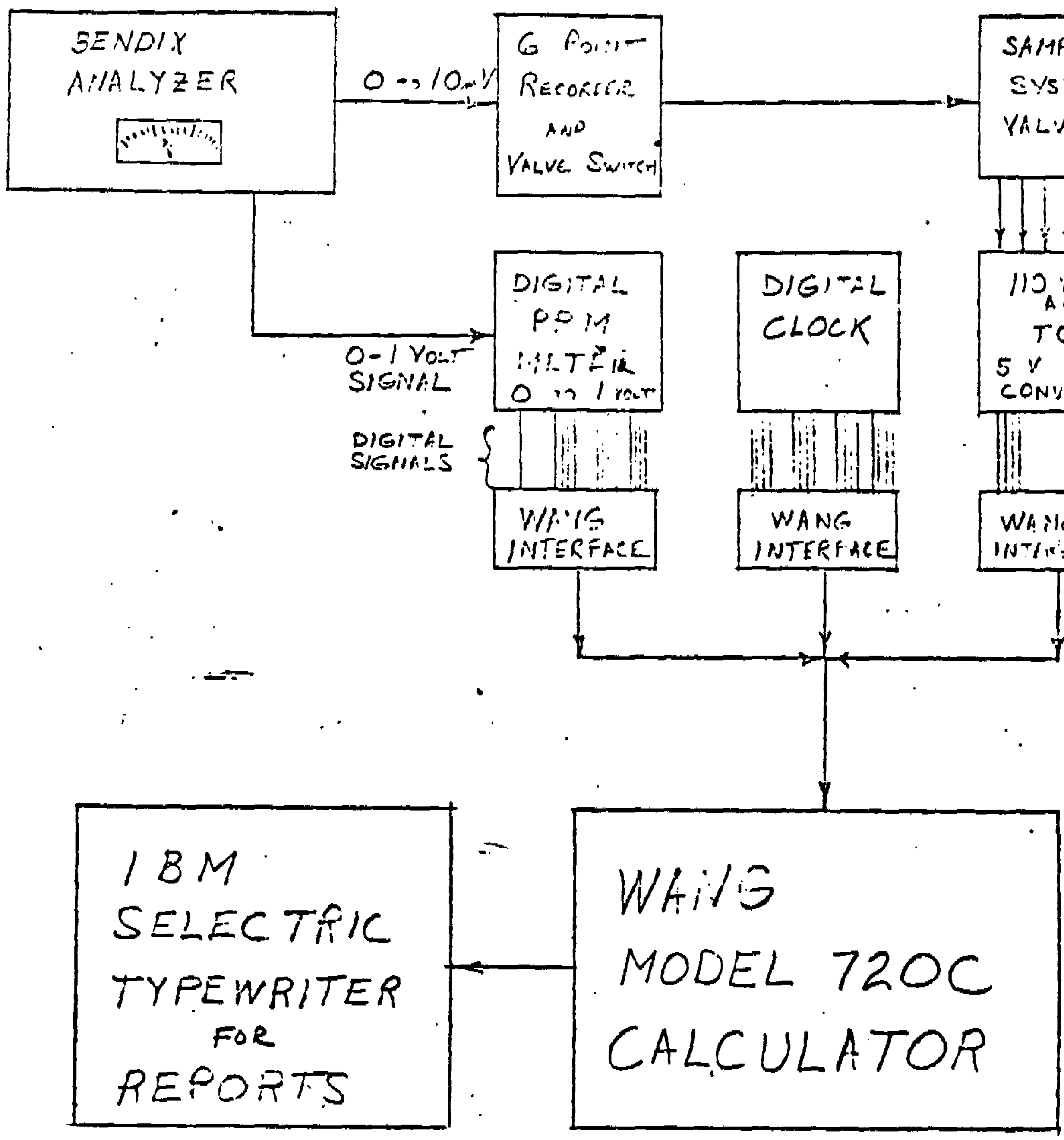

Figure 3