The ANOD gives directly on digital counters

Illustrations at end of paper.

of air which has a Dk of essentially 1.00. Thus, if a probe with a standard capacitance of 17.5 Micro-Micro-Farads in air is filled with oil

SPE 1374

DATA GATHERING COMES HARD!

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is tuned to a minimum when the resonant fre-
quency of the L-C is slightly above tha. of the
natural crystal frequency. A slight value
change in the probe changes the L-C resonant

stallations follow this pattern [Fig. 5], al-
lowing free water to settle, leaving a stable
and de-gassed emulsion and pumping each stream

DATA GATHERING COMES HARD!

When El Paso Natural Gas Company first decided to gather some data from two or three outlying points and relay that information to a central location, there did not appear to be any great or insurmountable problems involved. We are still convinced of the veracity of the original conclusion, but we are also now aware of some of the myriads of small problems and able to give the reader a feel for our particular problems and their solutions.

As originally planned, there were some 41 quantities of analog information (15 second pulse duration) to be gathered from the locations of Phoenix, Tucson, and Casa Grande, Arizona. (See Figure 1). These quantities were to be relayed to a central Dispatching location in El Paso, Texas. So far, how they were to be relayed, was open to good engineering practice, economics, and growth requirements.

ANALOG TELEMETER

The most straight forward method would be to relay the signals, or quantities, as they were, in analog form to the El Paso Dispatcher. Assuming that the Dispatcher could live with a time shared reading, three quantities could be displayed on a single recorder in the El Paso office. This would also necessitate 14 leased lines between El Paso and the outlying points. This requirement did not seem to fulfill our need of economics or future growth, to say nothing of good engineering. Just the array of recorders would eventually outgrow the wall space available.

USE OF INFORMATION

At this point it would be well to digress a moment and outline the use to which these particular readings will be used in order to clarify the following points.

The information to be gathered is natural gas pipeline static pressures and differential pressures obtained across orifice plate meters. The information is used to calculate instantaneous flow rates, accumulate gas volumes, figure line-packs, to monitor pipeline conditions and to note trends.

The information was previously recorded on circular charts at the outlying locations and periodically the required information was phoned or teletyped to the Dispatcher in El Paso. The Dispatcher at the outlying point calculated all of the volumes and merely transmitted the end result.

factors be close.

the accuracy desired, the higher the cost.

THE LOWLY CHART READING

A moments analysis will reveal that a 24 hour circular chart fulfills the requirements of a dispatching group admirably and to attempt to replace the chart calls for imagination and some ingenuity. For example:

1. A chart provides a perfect trend recording, easily digested at a glance.

2. The differential and static pressures required for calculation of a volume are recorded simultaneously on the same chart. Integration of flow rates is a simple problem.

3. Alarm contacts may be added to a circular chart so that pressures which deviate past a predetermined limit will be alarmed. Thus, pipeline conditions have been noted.

This is the simple, straightforward device that we have selected to be eliminated in our plans. The elimination caused many problems, much thinking, and we hope a better solution for a fast expanding technology.

COMPUTE ON SITE

One solution that appeared in the early stages was the computation of the gas flow on the involved site, and the relaying of the rate and accumulation to El Paso. The pipeline static pressures would be monitored on the site and alarmed when they deviated past pre-set limits. Additionally the static pressures were to be relayed to El Paso quantitatively.

This approach had one distinct advantage, and that was the retention of accumulated totals on site in the event of loss of communications. Another advantage was the continuously dynamic calculation of gas volumes which would contribute to the accuracy.

One problem with this approach, hovever, was the fact that a remote station to accommodate this sophistication would be costly initially and could become a maintenance burden as the total number of remotes increased. The consideration of these problems alone dictated a search in another direction.

DIGITAL TRANSMISSION

The method finally selected was the use of a Digital data gathering and digital control system combined. Three field locations were selected and the analog data was fed to these three remote locations for digitization. (See Figure 2).

8. In a previous paragraph it was stated that oil has a Dk of 2 and water a Dk of 80.

base signal whose amplitude is directly proportional to time [linear sawtooth]. The DC input

The majority of the telemeter transducers were already in place and are pulse duration with 15 second cams. Hence, all figuring was based on the retention of existing equipment. We also use pulse duration telemetering almost exclusively in the rest of the company.

One problem that did exist, however, was the fact that at many of the measurement locations, a single telephone line was rented and the telemeter readings were on a time shared basis. In order that these readings be digitized at a central location and transmitted to El Paso, it was necessary that each quantity be transmitted continuously to the digitizing central point. This was accomplished by using tone transmitters in the Voice band for each quantity to be transmitted. By this method, the same single telephone channel could be used.

BACKUP

Since this was our first attempt at digital data transmission and control, it was felt that the system would be adequately backed-up in the event of failure.

Our first backup was at the remote digitizing points Phoenix, Tucson, and Casa Grande. All of the quantities digitized at these points were available at these points on telemeter chart recorders. Thus, if El Paso communications should fail, the charts would be continually in service at the above mentioned points.

As well as data gathering, there are valve controls that were initially controlled out of the remote locations of Phoenix, Tucson, and Casa Grande. These valve controls also are extended to El Paso. Additionally, they are retained at the remote locations for operation by the field personnel in the event of a communications failure.

While these measures may not be followed in future installations, it affords a measure of confidence to operating personnel who are first faced with digital techniques.

DIGITIZING PULSE DURATION SIGNALS

There is no great problem in digitizing resistance, voltage, or current, but the digitization of time presents specialized approaches.

The most accepted method of digitizing pulse duration analog 15 second signals is by the use of shaft position slide wires attached to the telemeter recorder or receiver. This method is straightforward but presents problems:

1. Initial cost is high.

2. Maintenance can be a problem.

3. Space for slide wires and recorders needed.

For those of you not familiar with pulse duration systems, the 15 second is directly proportional to the measure variable in the following manner:

1. Three seconds to line zero.

2. Nine seconds represents full scale.

3. Three seconds sychronization.

So actually nine seconds is directly proportional to the measured variable.

The ideal method of digitization would be to accept the pulse duration signal from the transmitter and digitize it directly, without the necessary recorder or slidewire. This was the method we pursued jointly with the supplier of the system.

The method decided upon involved the pulse count technique and storage of the counts in memory for each quantity. Since all inputs are scanned at a high rate of speed 4.5 milliseconds, all quantities at a remote are digitized and stored for transmission in approximately 20 seconds. The digitizing at the remote is carried on continuously so that all information is the latest available as of 20 seconds ago.

There are several scale factors involved in the system such as 0-1000 PSI, 0-500 PSI, 0-250 PSI, 0-100 inches, 0-250 inches, 0-320 inches, etc. While it would be possible to scale factor all of these readings at each remote station, it was decided to scale factor the system at El Paso. Therefore, the readings sent to El Paso from the remotes are not in engineering units but are converted at El Paso by a central processing unit in the supervisory equipment.

EL PASO EQUIPMENT

At El Paso, there are several things that are required for the dispatching operation. (See Figure 3).

One requirement was the logging of the static and differential pressures, which is accomplished on the 30" logging typewriter. The equipment is so arranged that a demand readout can be called for at any time, or it can be

MOTOR-CAPACITOR

Fig. 3

programmed to automatically readout every 10 minutes, 20 minutes, one hour, two hours, or 24 hours as required.

In addition to logging, there are three readout devices, (projection type) of three digits each which can be placed in service at any point in the system. With this type of arrangement, the dispatcher can place a readout on a pressure at El Paso, one at Tucson, and one at Phoenix for example, and constantly observe any changes that are taking place.

There are five valve controls to be exercised in the system from El Paso. The valves are located at Phoenix, Casa Grande, and Tucson. The method selected for the controls is the jog variety in where incremental steps may be taken by jogging the valve in the direction required. Examination of the problems involved in a digital type set point for valve operation was deemed excessively costly in purchase and maintenance.

Since a telemetered value was being received from the valve location, any action taken by the controls are immediately reflected in the pressure reading from the site. It was felt that this would be adequate for our operation.

The jog controls are timed for operation for a period of 5 seconds to 60 seconds, field adjustable, at the sites. Additionally, the same controls are manually operable from the field locations of Tucson, Phoenix, and Casa Grande.

SUMMING UP

Up to this point we have described the following courses of action or functions to be performed:

1. How the information is to be utilized, such as display only, log only, or in calculations of gas flow.

2. Analog telemetering to a central point will not be used.

3. Digital telemetry will be used.

4. Gas Flow computations on site will not be used.

5. Valve controls will be jog variety.

6. A digital system as described is a supervisory control system available from several suppliers.

7. The system will consist of a master station and four remote stations.

Fig. 5

8. Duplicate information (in analog form) will be retained at the remote stations.

OTHER FUNCTIONS NEEDED

Just to keep things from becoming dull, one of the other things needed was a device that could detect changes in pressure at the remote sites, alarm the dispatcher, and center on the newly established value. We discovered that there was such a device for sale that could be added at each pressure recording point for approximately $750 per point. A little arithmetic reveals that $750 x 41 points amounts to $30,750.

The above mentioned devices are field adjustable for a deviation figure of 1 - 10%. This means of course that field personnel must be called out to make adjustments needed.

Another function that kept rearing its head was the computation of the gas flow at various critical points in the system. It was felt that the accumulated volumes and instantaneous projected rates would be of asset to the dispatcher. There appeared to be approximately 10 of these sites involved and the cost of flow computers and associated equipment was approximately $35,000.

ENTER THE COMPUTER

As many of you have realized, the only method to economically handle these requirements plus future expansion is by means of a central computer. (Digital variety).

Now our equipment at the central location is altered to accommodate the digital computer. The system is still composed of two separate functioning systems, the computer and its devices and the supervisory system and its equipment. (See Figure 4).

For stand alone capability, the supervisory system can work entirely independent of the computer. The emergency logger will still log all raw data gathered by the supervisory system any time when the computer is off line or out of service.

As shown in Figure 4, the supervisory system feeds the computer through the 24 bit buffer. The buffer when filled will have the following information for each point in the system:

24 BITS

A	B	A	C	STATION #	MESSAGE #	DATA

Fig. 7

A = Bit position A will always carry a zero. (Reserved for future applications)

B = Bit position B will contain a 'one' or a 'zero', depending on whether information was available or not. A 'one' for no reply and a 'zero' for reply.

C = Bit position C will be a 'zero' if information is valid and a 'one' if it is not valid. (Validity checks are performed by the supervisory system).

Station # = Four bits expressed a BCD number to identify the station polled.

Message # = Four bits expressed as a BCD number to identify the point polled.

Data = Twelve bits in BCD code to represent the value of the data received.

Thus approximately every second, the supervisory system fills the 24 bit buffer and the computer accepts, identifies, and stores the information for further calculations and logging.

EXPANSION

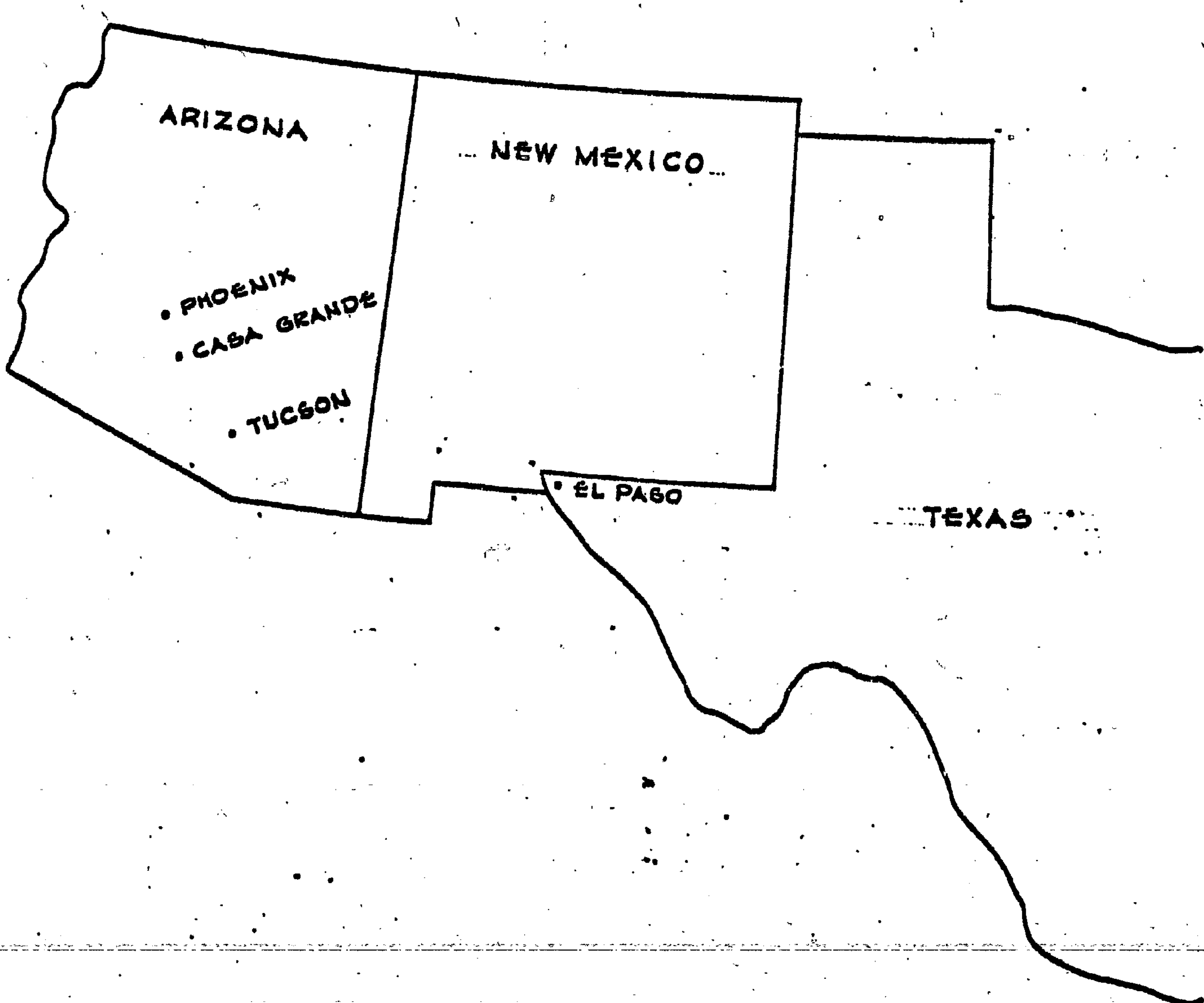
Originally the system was to gather 41 data quantities and control 5 valves. Before the system was installed, there were 91 quantities to be gathered and nine valve controls to be exercised.

Each of the static pressures and some of the flow rates are watched by the computer for rate of deviation. Additionally a log is prepared as required.

SUMMATION

So what started out as a very simple system to gather 41 data quantities has evolved into a more complex system, involving a general digital computer.

The most difficult task, not yet solved, is providing the dispatcher with a device that gives as good a representation as the lowly chart. Yes, data gathering does come hard!



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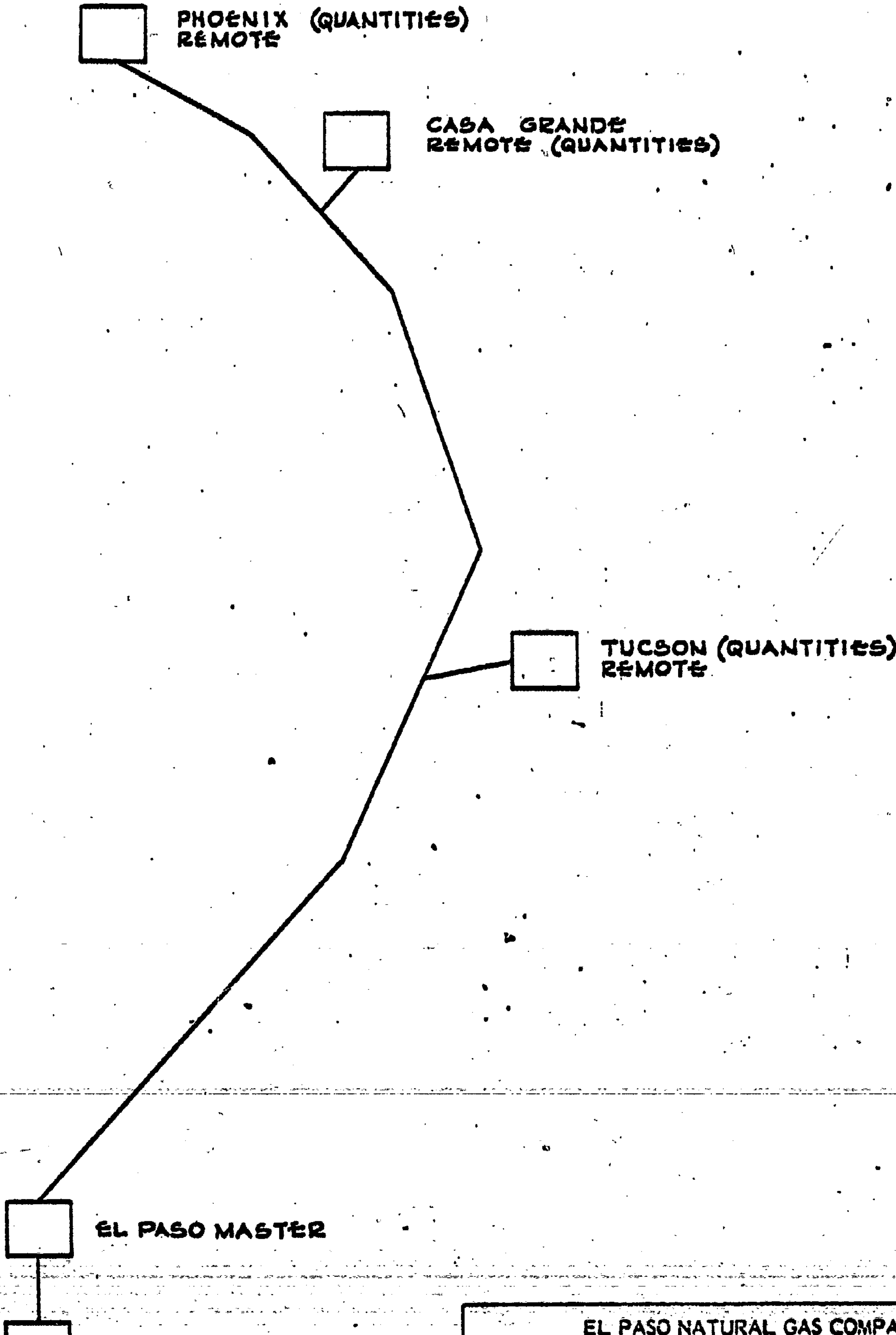
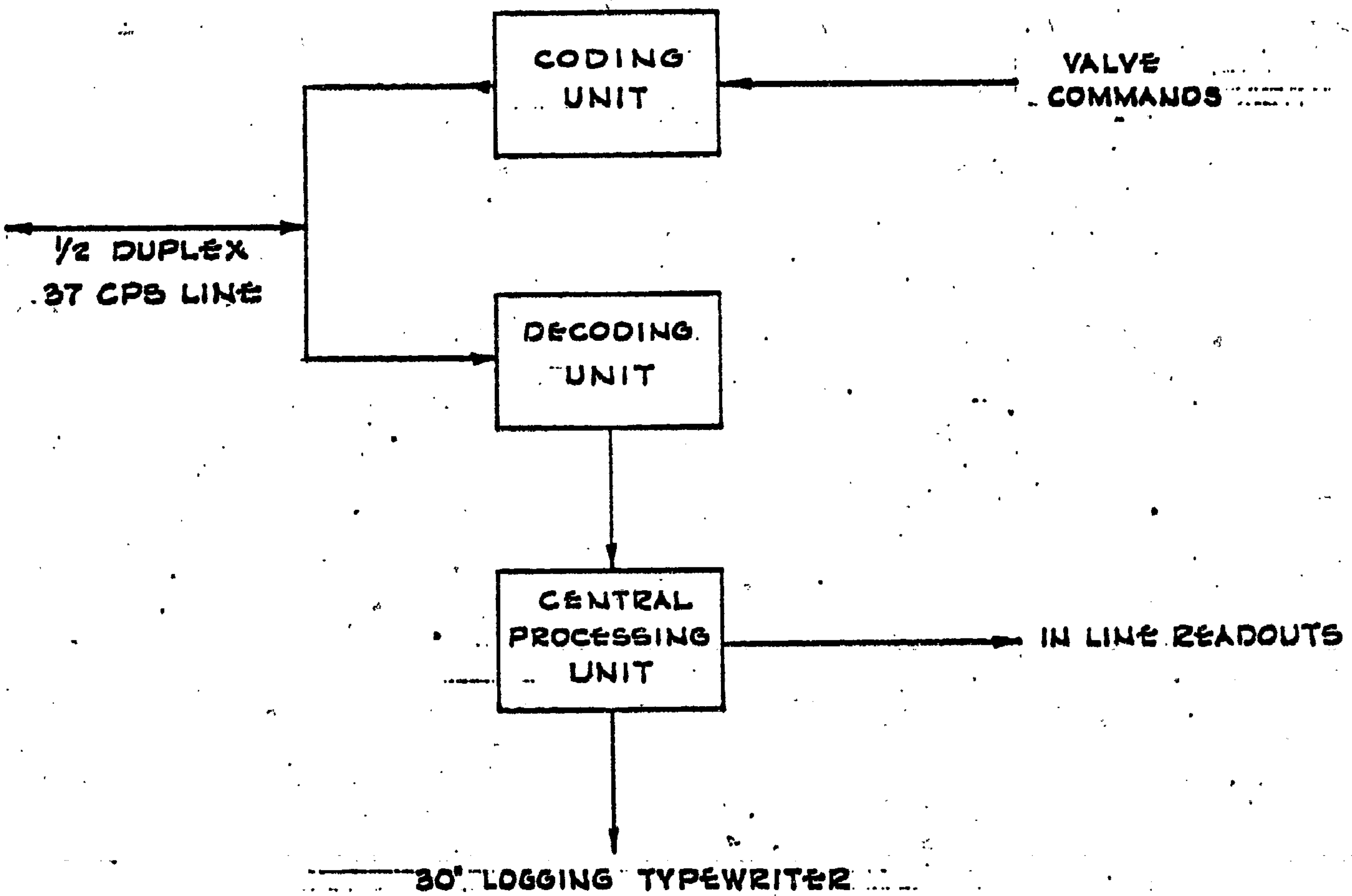


EL PASO NATURAL GAS COMPANY



EL PASO NATURAL GAS COMPANY

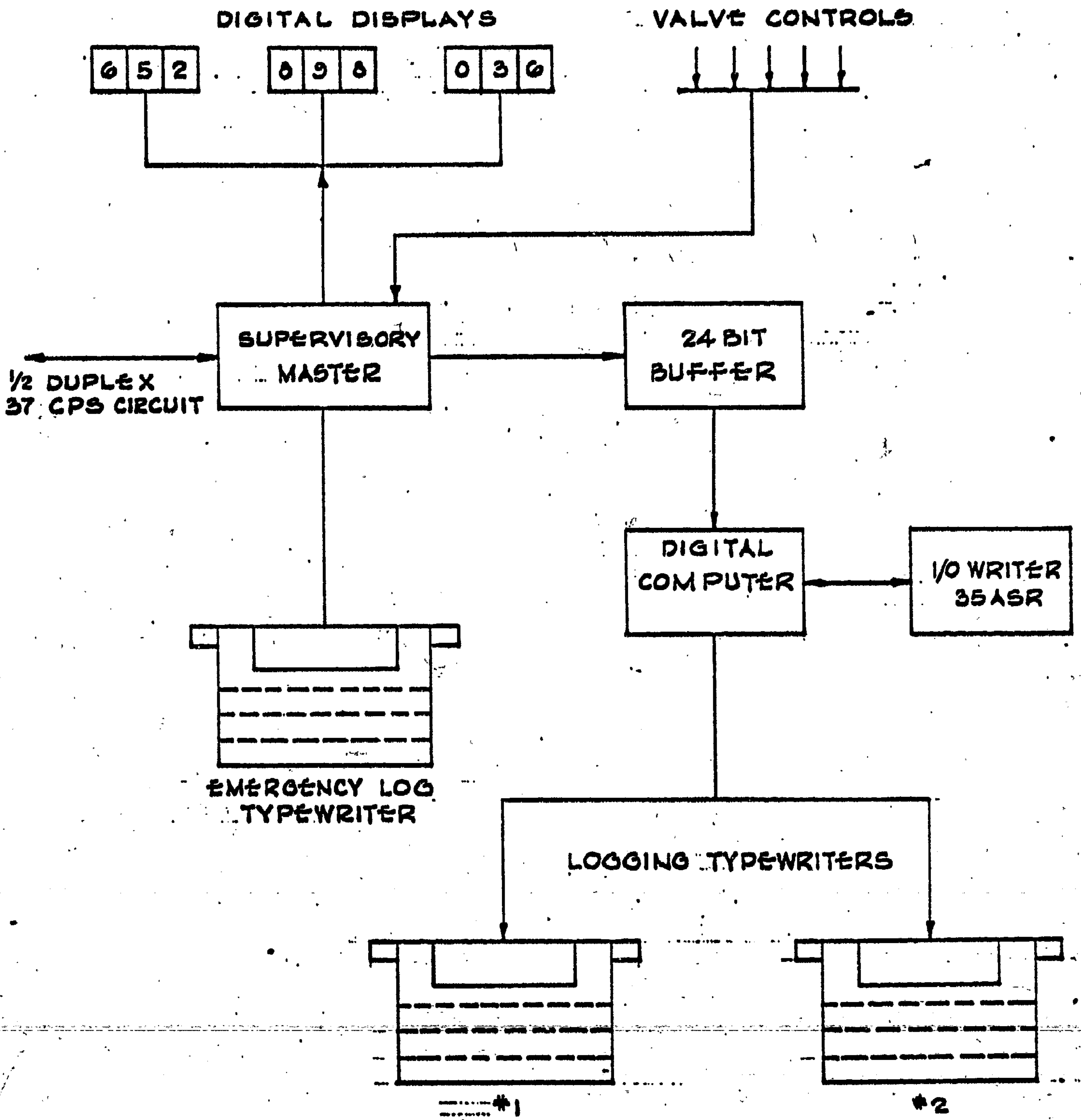


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FIGURE 1