Automatic Tank Batteries

By W. B. Banks
Southwest Control Company
Odessa, Texas

INTRODUCTION

In competitive industry there has always existed a trend toward the application of automatic equipment. This trend has been stimulated by efforts to conserve two principal business elements; time and money. The inherent advantages of automatic methods over manual methods have been (1) higher degree of accuracy in control (2) greater speed of response (3) lower operating expense and in most cases, (4) lower initial investment.

The application of automatic methods has not been ruthless. It has actually made possible the production of more goods per man-hour which is in itself a true measure of a standard of living. It is not prophecy but proven history that automation does strengthen an economy. Many companies engaged in oil production realized the advantage of automatic methods and surveyed their operations for automation applications. The results of the surveys showed that a great portion of conventional lease functions could be performed by automatic methods. Although a number of installations were tested and utilized with substantial success, the most important information gained was that the ultimate potential for automation was tremendous. It became evident that a re-appraisal must be made of heretofore accepted operating techniques so that oil production might also profit fully from the advantages of automation.

AUTOMATION POTENTIAL

In re-appraising very basically the operation of a producing reservoir, there are six fundamental operations which lend themselves readily to automation.

1. Well flow control.
2. Individual well testing.
3. Custody transfer of products.
4. Communication of production data to centralized point.
5. Computing at central point to serve best interest of numerous producing leases.
6. Feedback from central computing point to lease.

Systems, thusly described (Figure 1), and the efforts to maintain them, constitute the major functions of oil production.

Automation, to a limited degree, is presently being employed in certain phases of these fundamental operations. Nevertheless, the unexplored advantages of automation in each phase are vast. It should be expected, however, that replacement of conventional methods by automation will occur gradually. This gradual replacement will also be a self-perpetuating process for each new successful application will pave the way for subsequent development. Although replacement of conventional methods by automation will occur step by step, it is logical to set a rather futuristic goal so that each step may be placed in its scope. It is also logical to draw a brief analogy between the futuristic goal and conventional methods *realizing fully that the best solution for today is a compromise somewhere between the two limits.*

1. Well flow control—

Conventional: Manual operation of rate and time interval of production are manually governed by allowables, records of well tests, efforts to level gas production to plant, etc.

Future: The rate and time interval of production for each well will be controlled automatically. The set points will be determined by a composite signal from central computing.

2. Well testing—

Conventional: Wells are manually diverted to an isolated storage tank and meter run. Well performance is manually gauged, manually correlated, and manually reported.

Future: Wells will be automatically sequenced and individually diverted through testing equipment. Results of the test will be transmitted directly to central computing. Test results will contain correlated well performance data. Continuous sequencing or testing of specific wells will be scheduled by a signal from central computing.

3. Custody transfer—

Conventional: Oil production is stored on leases in huge storage facilities until a convenient time exists whereby manual measurements can be made and reported.

Future: Total oil and gas production will be assessed automatically. Assessment data will be transmitted directly to central computing. Assessment will be made without lease storage in closed pressure systems.

4. Communication—

Conventional: Production data is carried manually and transferred by hand from field personnel to office personnel.

Future: Production data will be transmitted electrically directly from production equipment to central computing.

5. Central computing—

Conventional: With a few exceptions, most routine calculations and tabulations are performed manually.

Future: All routine calculations and tabulations will be performed by electric computers. As an example, pipeline runs will be automatically calculated and royalty checks automatically typed. Production data will be automatically tabulated. Routine control of lease for optimum operation will be automatically calculated from composite information.

6. Feedback—

Conventional: Information is manually carried and transferred by hand to field personnel who in turn manually operate production equipment.

Future: Composite signals from central computing will be electrically transmitted directily to automatic production equipment.

BEST SOLUTION FOR TODAY

The most practical degree of automation for today's oil production is a matter of opinion. Also, almost every installation is a study in itself and therefore each is somewhat different in design. Even so, numerous automatic lease projects are now in various stages, i. e. they range in progress from planning stages to operation stages.

Figure 2 illustrates an automatic lease typical of projects underway. This project incorporates:

1. Well flow control.
2. Well testing.
3. Tank switching.

Well flow control is accomplished through the use of automatic manifolds which are triggered electrically. The desired flowing schedules for individual wells are pre-set (Item 9). Manifold valves (Item 2) control flow of the wells and by being programed electrically, open and close flows as desired. With the use of electrical well flow scheduling, it is possible to achieve any desired flow combination deemed desirable.

Well testing is accomplished through the use of automatic manifolding (Item 9) triggered electrically. Individual walls are diverted in sequence for a desired interval through an automatic testing system which integrates fluid production (Item 5) and gas production (Item 6). This information is correlated and continuously recorded (Items 10 and 11) together with length of time individual wells are on test. Individual well samples are indexed and stored (Item 4). Well testing in this manner gives a constant record of production which may be used to re-adjust well flow schedules for decreased GOR's and to meet allowable schedules.

Tank switching is accomplished by routing flow of oil through proper

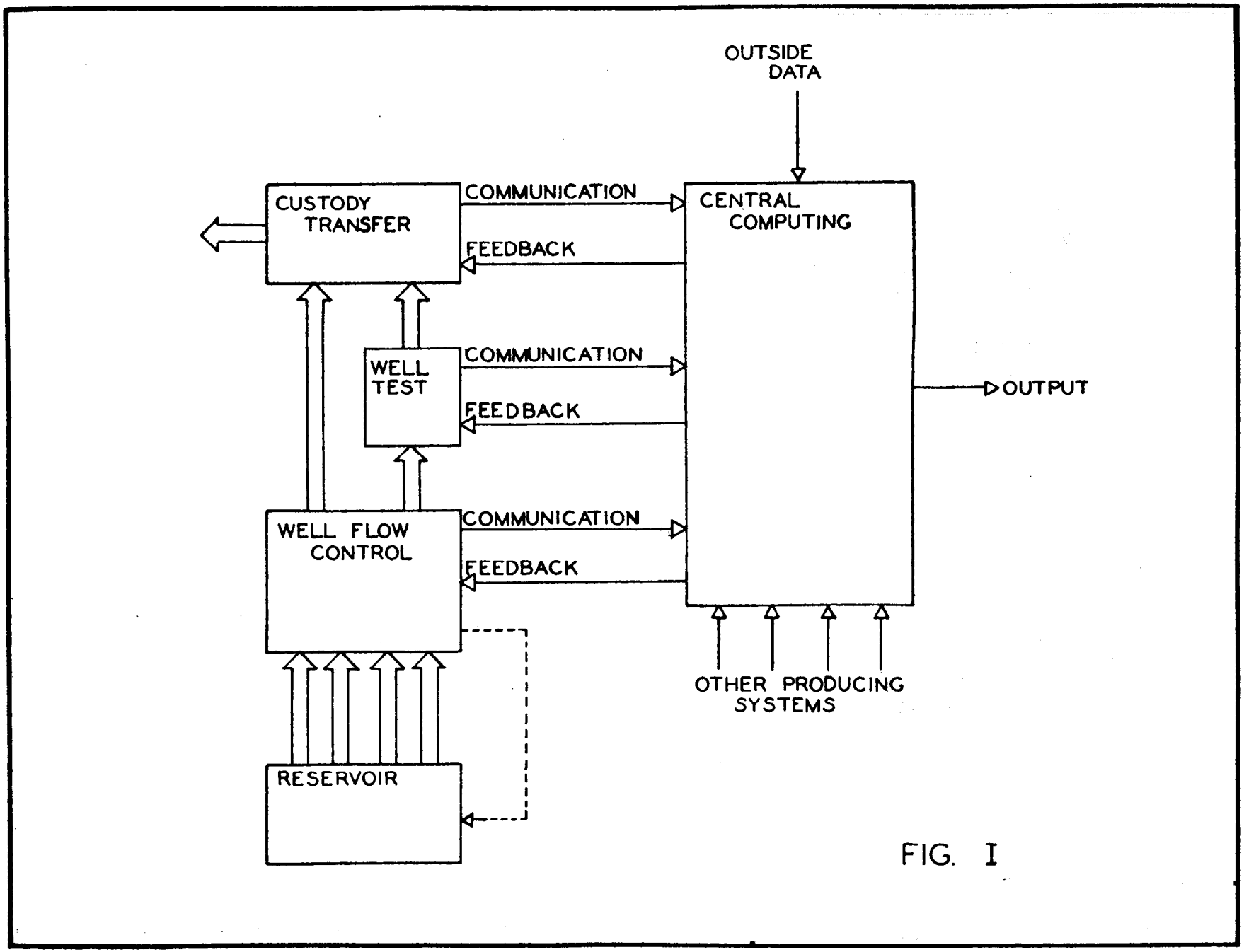
OUTSIDE DATA
CUSTODY TRANSFER
COMMUNICATION
FEEDBACK
CENTRAL COMPUTING
WELL TEST
COMMUNICATION
FEEDBACK
OUTPUT
WELL FLOW CONTROL
COMMUNICATION
FEEDBACK
OTHER PRODUCING SYSTEMS
RESERVOIR

FIG. I

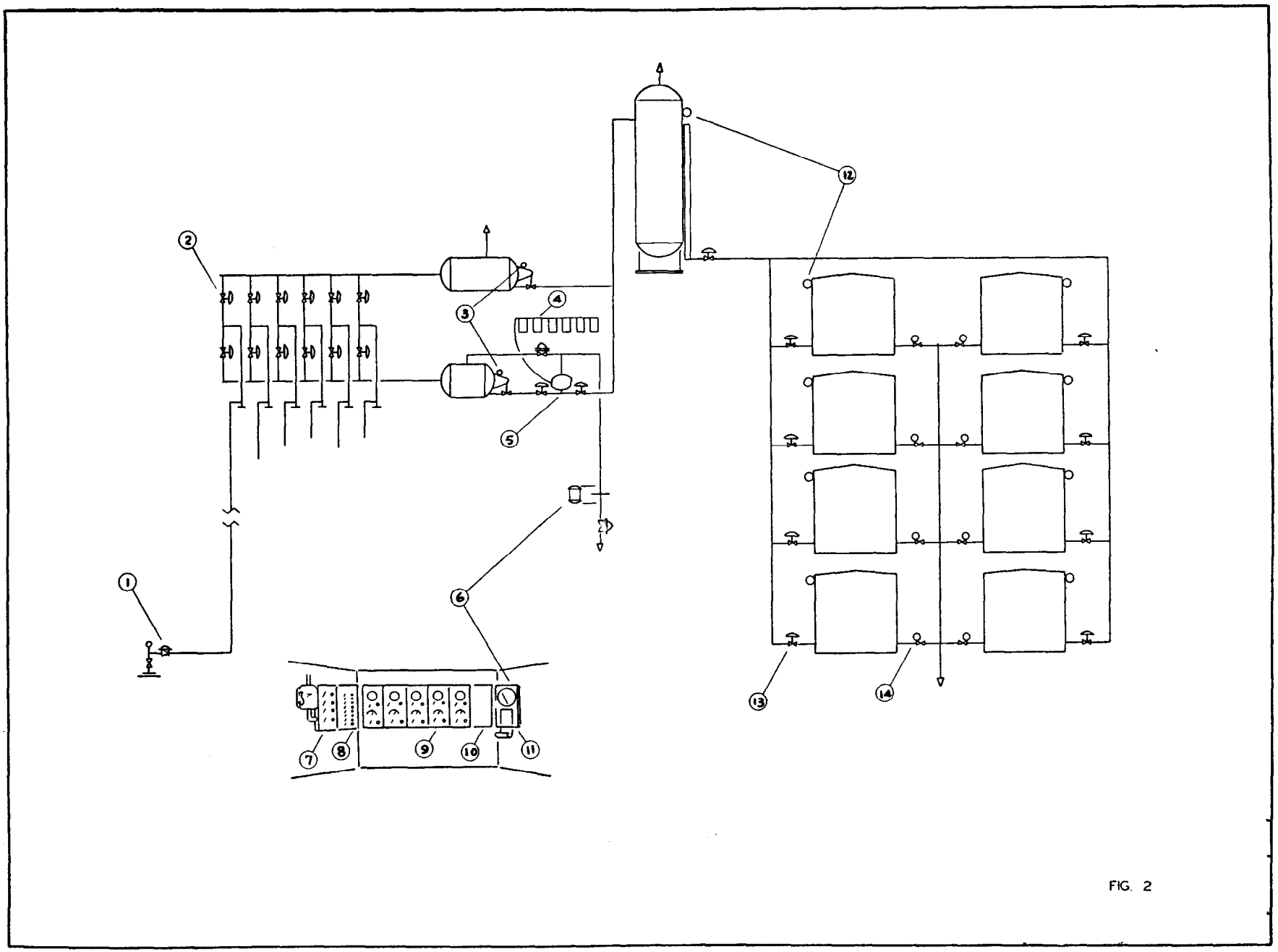

FIG. 2

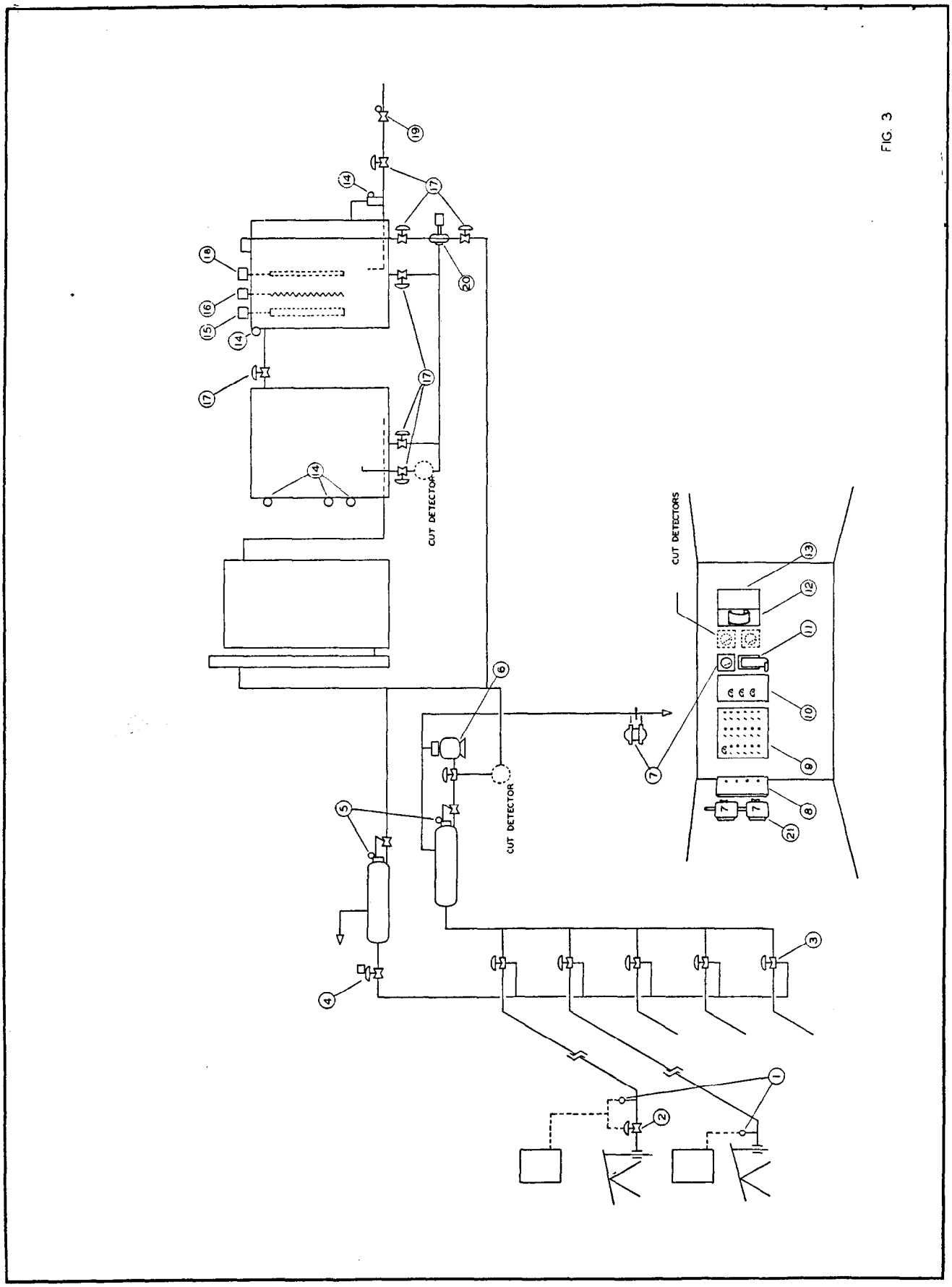

FIG. 3

fill valve (Item 13) into a tank eligible to be filled. A tank eligible to be filled is one not already filled, not being run to the pipeline and not manually by-passed for cleaning, etc. Tanks fill one at a time and in a sequence.

Figure 3 illustrates another automatic lease typical of projects underway. This project incorporates:

1. Well flow control.
2. Well testing.
3. Semi-Automatic custody transfer.

Well production intervals are controlled conventionally by program timers in the pumping controllers.

Well testing is accomplished through the action of the automatic manifold (Item 3) triggered electrically (Item 9). Each well is individually diverted through the testing system which integrates fluid flow (Item 6) and gas flow (Item 7). This information is correlated and continuously recorded (Item 11) on a linear time scale. Experimental electronic cut detectors integrate water production in this installation. Well testing in this manner provides data which may be used to adjust pumping cycles for pump-off protection and to meet allowable schedules.

Crude handling and semi-automatic custody transfer are included in the installation of Figure 3. This system includes only one metering tank connected to the pipeline, one surge tank, and controls for measuring crude properties and transferring and re-routing crude. Upon filling the metering tank to a constant top gauge, crude properties are measured (Items 12, 13, 15, 16, 18) and recorded (Item 12). The metering tank is then placed on the line and run to a constant bottom gauge. One feature of this installation is automatic re-routing of tank bottoms through the treating system after each run. Another feature is the re-routing through the treating system of crude being transferred out of the surge tank in the event that such crude fails to meet pipeline requirements on BS & W content.

Any system thusly described, when operating on a fully automatic basis would, as an example of savings, eliminate the need for huge storage facilities on the lease.

CONCLUSION

The application and degree of automation for any given lease or field requires a study of the particular conditions involved. Some of the advantages possible through automation as compared with conventional methods might prove to be:

1. Lower gas-oil ratios.
2. Conservation of reservoir drive.
3. Scheduled gas flow to gasoline plants.
4. Reduced paraffin deposition in tubing and flowline.
5. Higher crude gravity.
6. Higher GPM of gas.
7. More complete and accurate engineering information.
8. Elimination of tank bleeding losses.
9. Elimination of lease storage.
10. Elimination of stock tank vapor losses.
11. Reduction in required pipeline facilities.
12. More oil and gas produced per man-hour of labor.
13. Reduction in so called "paper work".
14. Paving way for subsequent developments.

The potential of automation, properly applied to oil production techniques, is so advantageous that step by step acceptance as standard equipment appears a certainty.