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URBANA

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THE PRINCIPLE OF THE SAFETY CYLINDER AS AN
EXPLOSION PREVENTER IN AIR-GAS COMPRESSION

BY
FREDERICK SQUIRES

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THE PRINCIPLE OF THE SAFETY CYLINDER AS AN EXPLOSION PREVENTER IN AIR-GAS COMPRESSION

By Frederick Squires

THE dangerous shortage of crude-oil stocks due to war consumption in addition to domestic needs has turned the attention of the industry as never before to the necessity of increasing the supply. This can be done in only two ways, finding new fields and increasing the production of the old fields.

There is a probability, although no certainty, of finding new production, but increases from the old fields by secondary recovery is sure. This is already attracting more attention than ever in the past.

Technologists have greatly improved the methods of secondary recovery and it is toward removal of one of the remaining difficulties experienced in repressuring that this experiment is directed.

Secondary recovery by injection of mixtures of air and gas into oil sands involves danger of surface explosions. Since gas is depleted sooner than oil and since most gas drives have been confined to old producing properties, the principal problem has been to obtain an adequate supply of gas for the pressure medium and fuel for the compressor and pumping engines. This problem is usually met by making up the gas deficit of the pressure medium with air. This practice often results in explosions in the compressors and lines after the mixture of air and natural gas has reached the explosive range.

There are several ways to overcome the difficulty. The most usual, which is only temporary, is to use two separate compressors, one of which delivers natural gas only and the second air only, the mixture taking place at the injection wells or at points in the pressure lines far distant from

the plant. In these cases the danger is not entirely eliminated because air dilutes the gas in the sand. Even before this happens the gas may be gathered by a vacuum on the oil-producing wells, and even in the best vacuum systems, leakage above-ground dilutes the gas with air. Gasoline plant operators try to avoid leakage of air into vacuum gathering lines because added pressure on the gas-air mixture is necessary to keep up the optimum pressure on the gas itself. When gasoline yield is of minor importance, as is usually the case in repressuring operations, less care is used to eliminate air leakage; this results in enough dilution to present a constant danger of explosion.

A second method used to overcome the danger is to test the amount of oxygen in the gas supply to the compressor by means of an Orsat analyzer and to keep the air-gas mixture outside the explosive limit. This is of course an expensive precaution and one which requires greater technical skill than is usually available in the field.

The use of air alone presents the difficulties of too great dilution of the pressure medium and of the fuel gas so that it cannot be used in the engines. Gas is usually too scarce in depleted fields to be used alone and is too expensive to purchase from gas lines. The use of all the available lease gas plus enough air to provide an adequate volume for recycling (after taking the gas needed for fuel) has proved to be a practical expedient. The problem involved is the danger of exploding the mixture, and it was to provide a simple, cheap, and effective preventive against such a danger that this study was undertaken.

Analogous Methods of Control in Industry

There are several highly technical devices dependent on constant regular electric current which would solve the problem, were it not for the skill required to install and operate them and the lack of depend-

able electric current at most of the compressor plants. To be of use in the oil field, especially when the field has reached the low productivity usual before secondary recovery is adopted, any device must be simple. Highly trained technicians are not available because the narrow margin of profit does not permit their employment. All operations, to be successful, must be within the skill of the average field man.

The simplest test of whether a mixture of air and gas will explode is to try to burn it. Up to 500 lb. per sq. in., pressure does not affect ignition. The working of the apparatus presented in this paper depends on these two principles. It is presented in the hope that engineers who are familiar with secondary recovery will test and perfect the device to the point where any pumper can build and operate one.

The older Packard cars were equipped with means for drawing off a part of the air-gas mixture from the carburetor and passing it against the constant fire of a spark plug, which ignited the air-gas mixture, the hot products of combustion being drawn into the engine cylinders with the unburned air-gas mixture from the carburetor. Such an ignition of the air-gas mixture is the method used in the safety device.

Suggested Equipment

In the drawing (Fig. 1) is shown a section of 4-in. pipe provided at each end with a casing cap. This is called the "safety cylinder." Into the bottom cap is screwed two sections of 1-in. pipe that are connected by a flanged union. Between the flanges is a Davies wire screen, to avoid back-firing into the compressor. Through the side of the safety cylinder is inserted an extra long spark plug. (An alternate position for the plug is in the elbow on the 1-in. pipe below the safety cylinder.) Above is a "look box" through which the operator can see what is going on in the way of combustion. The upper casing cap is drilled and threaded for a 2-in. open end exhaust pipe, a thermometer well, and the tube at the end of a siphon valve. A Fulton siphon

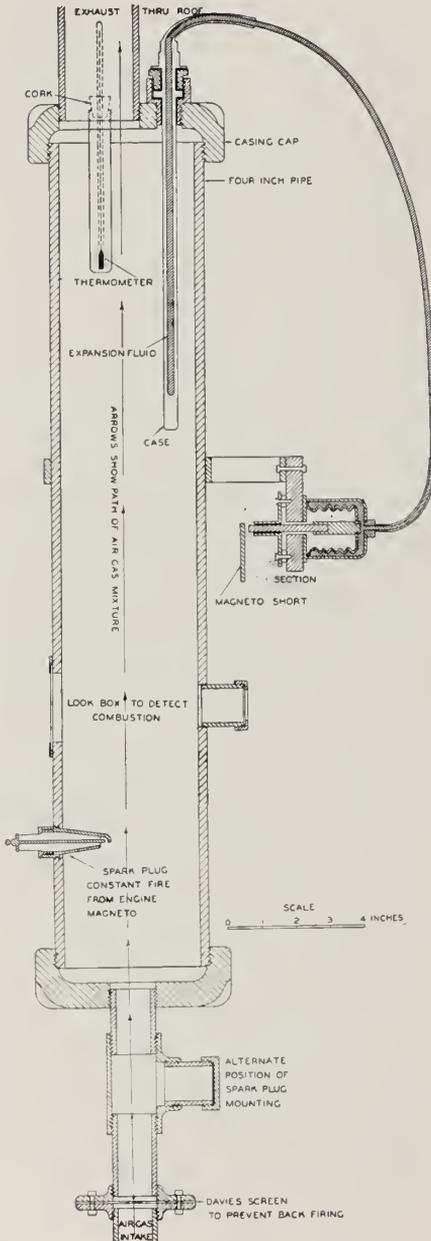


Fig. 1—Scale section of safety cylinder

valve is a device to operate a switch by means of temperature changes. (See Fig. 1.) The remainder of the sylinder valve is supported by a metal band encircling the safety cylinder in a position such that the plunger attached to the accordion part of the sylinder, when forced outward by expansion of the sylinder fluid, will make a contact which will short the engine magneto. This is illustrated in Fig. 3. A bimetal thermoregulator such as is made by the American Instrument Co. may be substituted for the Fulton sylinder valve as a shorting device in cases where the proportions of air and gas in the compressor are not to be automatically changed.

Details of Equipment and Operation

The safety cylinder is hooked up with the air-gas compressor and engine magneto as follows (Fig. 2): It is set up at some convenient place in the compressor house with the vent pipe extending to outside air, preferably through the roof. A wire is run

from the compressor engine magneto to the spark plug on the cylinder. A second wire runs from the shorting mechanism opposite the plunger of the sylinder valve back to the same magneto.

From the compressor discharge line is run a small pipe to the intake of the safety cylinder. This pipe has a valve so that the volume going through it may be reduced to only a small amount of the air-gas mixture at pressure just above atmospheric. The protection operation is as follows: All the while the compressor is running, a small stream of the air-gas mixture is going through the safety cylinder past the hot spark plug, up and out of the exhaust outlet. Whenever this mixture reaches explosive proportions, it ignites in the safety cylinder, raises the temperature which expands the fluid in the sylinder valve and forces the sylinder valve plunger into the contact which shorts the magneto. This instantly cuts off the engine ignition and shuts down the plant. Changes to safe proportions of air and gas are then

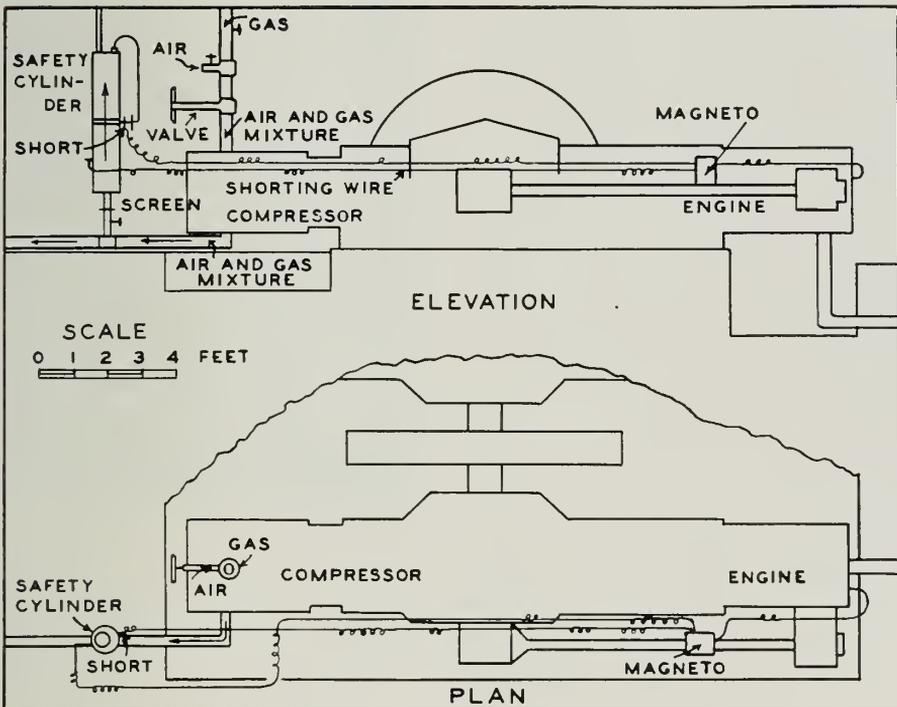


Fig. 2—General layout of the compressor and safety cylinder showing wiring

made before the plant is started up again.

It is possible to use the plunger of the sylphon valve to turn a ratcheted valve handle, automatically reducing the amount of air admitted into the mixture to a proportion below the explosive range. This same principle is used on the valve in the steam line which controls the temperature in incubators.

Protection Against Water Failure

It is usual in repressuring operations to protect the compressors and engines against failure of the supply of cooling water by a somewhat similar shorting device. Water is made to flow through the water jackets by gravity from an elevated tank into which it is raised by pump from a lower water supply. At times the pumps get out of order so that without some precaution the tank would run dry and the compressors and engines would run hot and destroy themselves. An automatic shorting device prevents this. The inflow to the tank passes into a pail with a perforated bottom. The pail is suspended by a rope over pulleys and is counterbalanced to maintain its position when full, and the rope is connected with a shorting device which contacts whenever the pail is empty. If the pumps stop putting water into the pail, it empties through the perforations in the bottom, rises because of decreased weight, shorts the engine magneto and shuts down the plant. This is a good oil-field device because it is cheap, the pumper understands it—he probably made it in the first place and can repair it, and because of its simplicity, he has perfect faith in its ability to do its job. It is such devices that work best under the primitive conditions often found in many parts of the oil fields.

It is the hope of the writer that the safety cylinder may work out to be as simple and useful as the pumper's pail.

The author wishes to acknowledge with thanks the help and suggestions

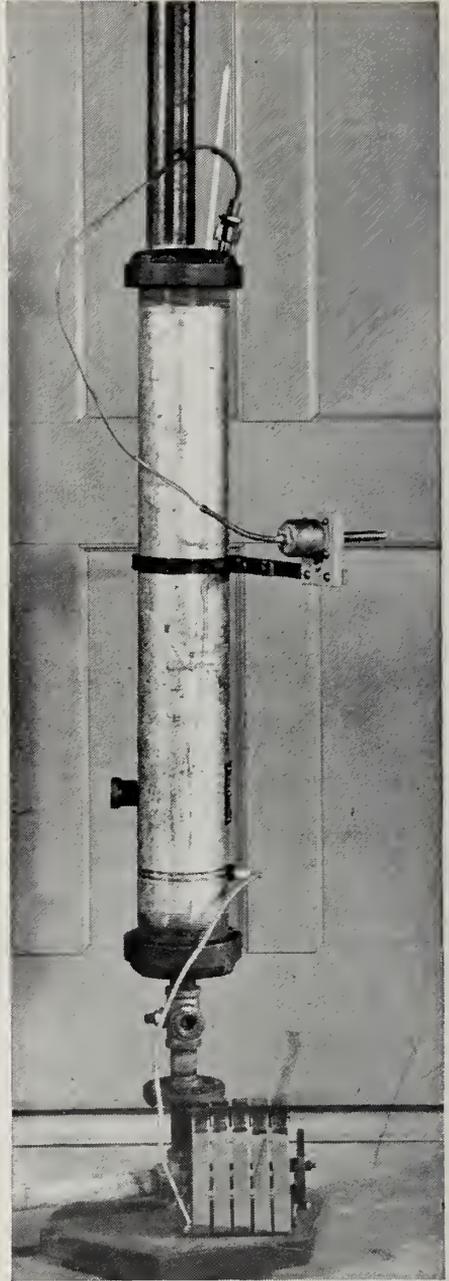


Fig. 3—Photograph of full-size model

of the U. S. Bureau of Mines and of Dr. R. J. Piersol, Dr. A. H. Bell, Dr. F. H. Reed, Dr. J. S. Machin, and P. W. Henline of the survey staff.

