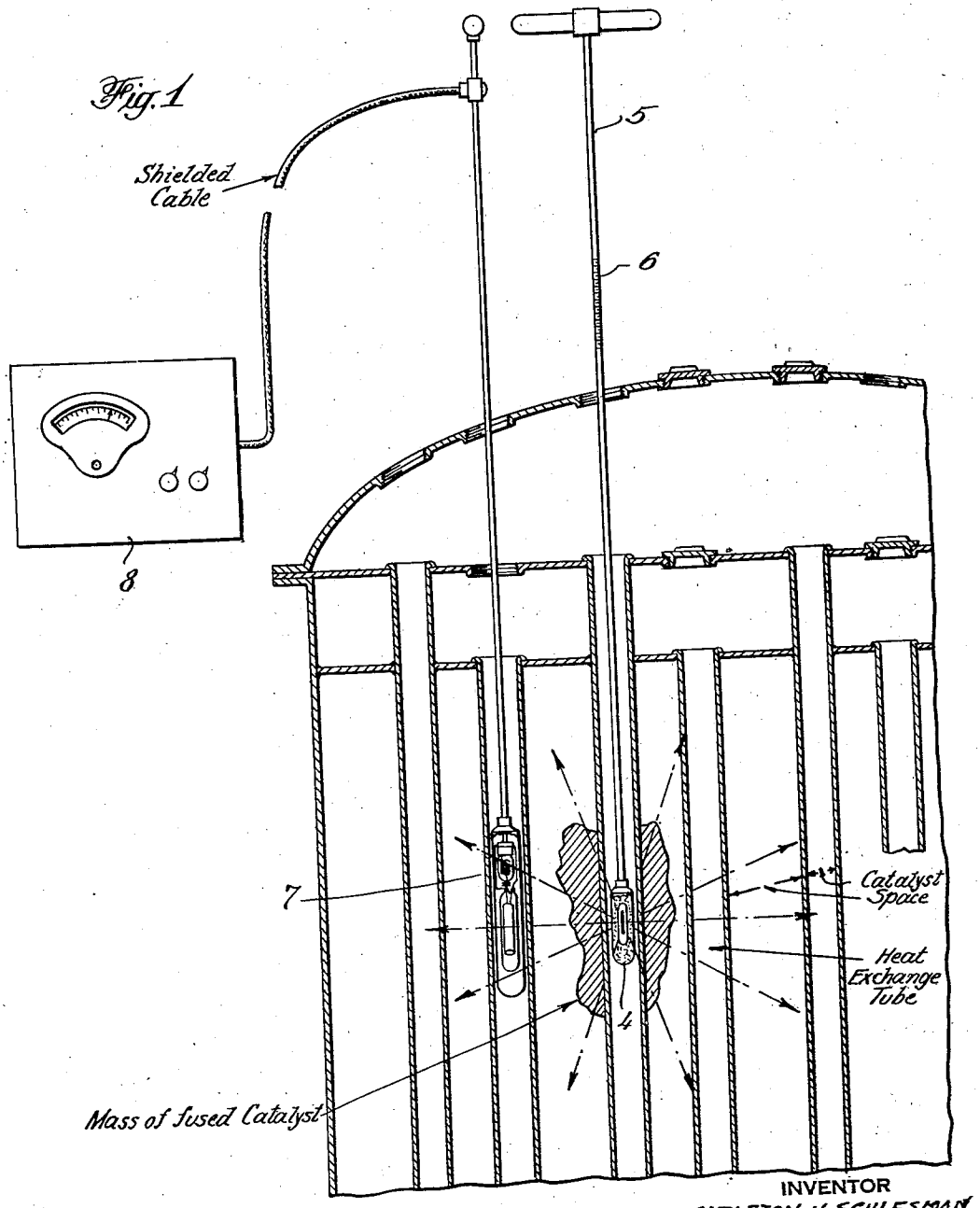
April 6, 1943. C. H. SCHLESMAN 2,315,819

METHOD OF EXPLORING OPERATING STRUCTURES

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Fig. 1



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Fig. 2,

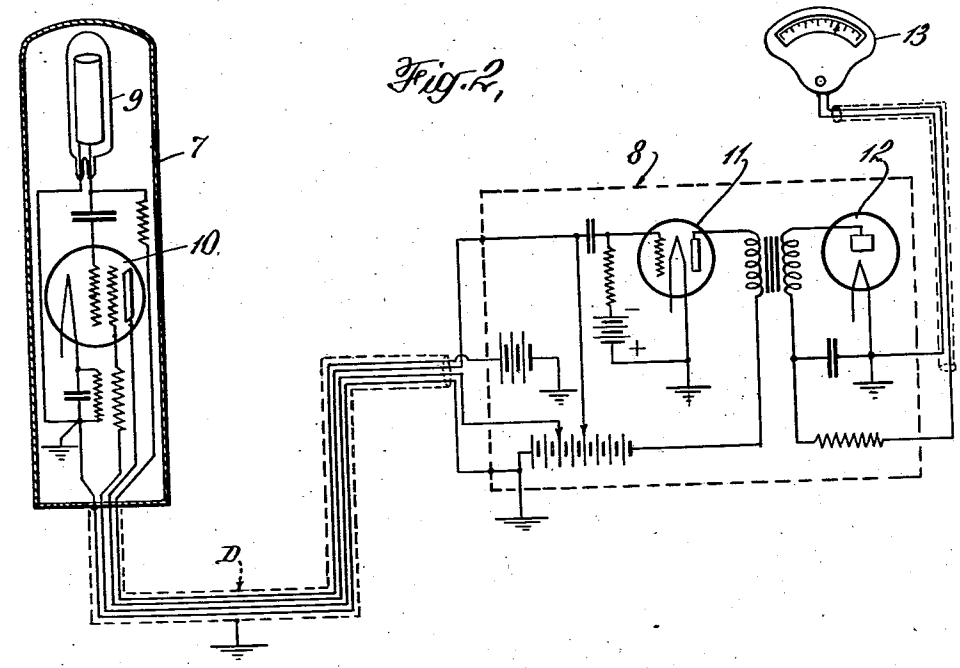
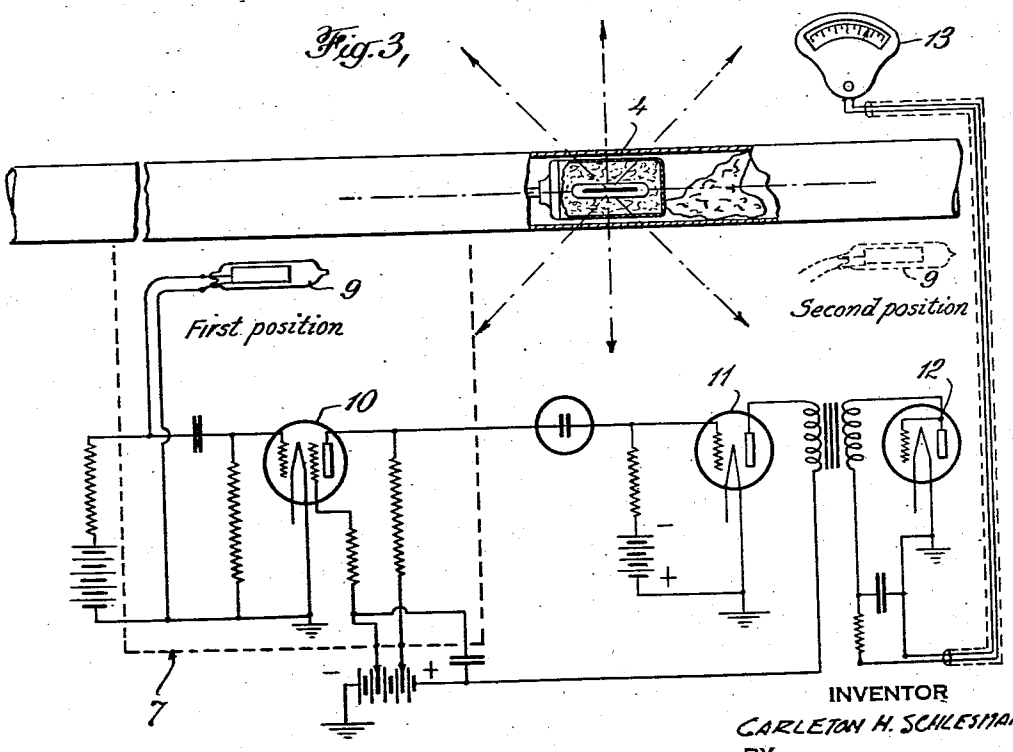


Fig. 3,



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METHOD OF EXPLORING OPERATING STRUCTURES

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Application September 14, 1940, Serial No. 356,781

2 Claims. (Cl. 250—83.6)

This invention deals with a means of controlling the operation of certain types of equipment, supplies means of trouble shooting in production equipment without interruption to production, supplies a method of studying the operation of pilot plants and in detecting irregularities in material handling systems, including pipe lines, where conditions of pressure, temperature, location or necessity of continuous operation make ready access to or the frequent disassembly of equipment impossible.

The device here disclosed finds most ready use as a maintenance tool in connection with the operation of catalytic conversion equipment. In constructing plants for the conversion of chemical materials or petroleum products by catalytic means, such as in the Houdry cracking operation, it becomes necessary to provide the catalyst mass with a complex system of conduits or fin pipes for the purpose of distributing throughout the catalyst mass the material being processed, and air or other materials required for regeneration. Other tubes are provided for circulation of liquid medium for the removal or introduction of heat to the catalyst mass.

It will be appreciated that the maintenance of so complicated a mechanical system is a difficult task. For example, when it becomes necessary to replace the catalyst mass—which is frequently accomplished by blowing the catalyst pellets from the case by means of compressed air—difficulty is sometimes experienced with a hanging up of isolated masses of catalyst whose location is unknown.

As a converter of the type described consists of a labyrinth of steel tubing and fins, it will be appreciated that a measuring instrument which can be operated within the case during maintenance operations, or during inspection periods without dismembering the case will be of particular value. So far as we know, no measuring equipment of this type has been described by others.

The device here disclosed is also capable of being utilized for the study of the flow of materials through continuously operating processes, for example long rotary kilns, such as are used in the manufacture of Portland cement, and other processes wherein either fluids, solids, or semi-solids flow through either step by step processing or branched flow processing where usual conditions of volume flow study are difficult to obtain.

This invention has for its object the provision of method and means whereby extensive exploration of complicated piped structures can be accomplished without dismantling. A similar major object is the provision of means whereby study of flow conditions may be made in ramified processes and processes not readily adapted to ordinary means of study.

The present method and device is based upon the idea of placing a source of radiant energy within the equipment under study and determining its location or the like by detection of the emanations. Former devices of this general type exist, but are open to the objection that they are not adaptable, as is the present method and device to quantitative measurements of position, to quantitative measurements of obstructive materials, to operation as an unattended signalling device, to observation of results from a distance, and of considerable importance, to study of flow conditions within a highly ramified system.

The device used in the invention involves three parts:

(1) An indicator capable of emitting penetrating radiation. In the case of a tube in a catalyst case, for example, a small amount of radioactive mineral enclosed in a suitable capsule may be lowered into it and subsequently recovered; or, in the case of a rotary kiln, material such as pitch blend, which is capable of emitting rays capable of penetrating the wall of the kiln, may be introduced into the kiln in the form of a powder. In other cases, an electronic or cathode beam device such as, for example, a source of X-rays might be utilized.

(2) One or more detector heads. These are devices which originate weak signal currents, etc., which are a function of the intensity of the radiation being received. These may consist of small gas-filled glass tubes containing suitable electrodes such as, for example, are used in Geiger Mueller counters. The tube may be enclosed in a bakelite tube, etc., to permit forcing into a packed mass of catalyst, or may be enclosed in similar protection for permanent installations; such detector units to be connected to the receiving and indicator units by one or more cables. In some cases it may be advantageous to attach a preamplifier to the counter tube, which is attached to the main amplifier and the batteries by a flexible cable of the desired length.

(3) An indicating or recording device which amplifies the weak impulses received from the

detector, selects desired signals and rejects spurious signals such as cosmic rays when so desired, and integrates the signal to give the indicating or recording element the desired scale characteristics such as linear, logarithmic, etc.

The operation of the invention may be illustrated as follows: In one commercial type of catalytic converter, vertical tubes are provided for the introduction of the vapor to be passed into the catalyst. Other vertical tubes are provided for the circulation of heat transfer media, and a third set for the introduction of air or other gases when it becomes necessary to regenerate the catalyst. The catalyst, in pellet form, is placed between these vertical tubes. Assuming that during inspection of the unit, it becomes desirable to discover voids in the catalyst mass, this may be accomplished by lowering into one of the tubes—for example, the vapor tube—a device capable of emitting penetrating radiation which will pass through the walls of the tubes, penetrating the catalyst mass, and which may then be detected by lowering a suitable detector in another tube parallel to the first.

It will be appreciated that if the source of radiation and the detector head are passed at equal rates through the adjacent tubes within the catalyst mass, so that both units are continuously at a fixed distance from each other, the presence or absence of catalyst in the space between the tubes can be determined from the indications of the meter operated by the detector head. Since the catalyst mass will impose considerable resistance to the penetration of the radiation, voids in the catalyst mass should be indicated by an increase in the meter reading, while fusion of catalyst at any point would be indicated by a decrease in the meter reading because of the higher density and, hence, increased resistance to radiation of the catalyst at that point.

If it is simply a question of locating a partial obstruction in a tube or pipe, for example, a plug containing a small amount of radioactive mineral is forced through the line until it reaches the obstruction. The progress of the plug is followed with a portable detector and indicator having a linear scale. In addition, a contact may be placed on the meter to show a red light when the plug is within a short distance of the detector. When the obstruction is reached, the tube is marked and scale readings taken at several points on either side of the obstruction. The plug will be found midway between points giving equal scale readings.

When flow through a kiln or branching lines is being studied, or the amount of loss of fluids or solids from leaks is being estimated, material may be introduced into the unit in sufficient quantity in the charge to give a full scale reading when the detector element is in contact with the line. This may be facilitated by providing a meter sensitivity adjustment on the instrument. The meter, if properly calibrated, would then read percentage of total flow passing some other point in the line.

The previous examples serve to indicate the manner in which the invention may be employed. The following description represents the preferred form of apparatus, and alternate forms which may be employed to advantage:

(1) *Source of radiation.*—The preferred source of radiation appears to be a radio active mineral such as pitch blend which, for convenience in handling, is mounted in a jacket fitted with lugs for the attachment of wires or rods for positioning in the tubing being investigated.

A second source, which appears to be particularly attractive for routine inspection of steel tubing for flaws or in other special applications, is a small X-ray tube having a target which will produce a concentrated beam—electrical energy being supplied to the tube by means of insulated cable.

(2) *Detector head.*—The type of detector head will, of course, vary with the character and intensity of radiation employed. The preferred form appears to be a compact electrode unit of the gas-filled type such as a glass-enclosed Geiger Muller counter, which is enclosed, together with a preliminary electronic amplifier tube in a thin protective shell, which is also fitted with lugs for positioning during use. The detector unit is connected to the indicating apparatus by one or more cables.

(3) *Amplifying and indicating equipment.*—An indicating or recording device which amplifies the weak impulses received from the detector, selects desired signals and rejects spurious signals such as cosmic rays when so desired, and integrates the signal to give the indicating or recording element the desired scale characteristics such as linear, logarithmic, etc. In general, this equipment will consist of a vacuum tube amplifier connected to a vacuum tube volt-meter.

The manner in which the equipment is utilized is illustrated by Figure 1. This serves to show the method followed in the location of a fused mass of catalyst within a catalyst case from which the main body of catalyst has been withdrawn.

The source of radiation 4, consists in this case of a small capsule containing radium which is enclosed in a bakelite protecting jacket and is attached to the end of a long straight measuring rod 5. The source is lowered into the catalyst case through any convenient opening or through one of the heat exchange tubes. The rod is provided with reference marks 6 which serve to indicate to the operator the level and the source of radiation. The detector 7 which consists of a gas-filled tube and a primary amplifier mounted within a light weight enclosing case is attached to a long tube also provided with reference marks. Power is supplied to this unit by means of a flexible cable passing through the tube and connecting with the amplifier and power supply 8.

The arrangement of the electrical equipment is shown in a diagrammatic sketch in Figure 2. In operation, the source of radiation and the detector head are lowered through the case at a constant rate in such a manner that both remain in the same geometrical relation. During this operation, the operator notes the position of the indicating meter which may be fitted with an alarm or may be equipped to record. This indicator shows continuously the amount of radiation reaching the detector head from the source. If as the equipment is lowered obstructions are encountered, such as, for example, a fused mass of catalyst, the reading of the indicator will immediately fall off allowing the operator to estimate the size of the obstruction. The extent of the obstruction can be calculated by taking readings at several levels or between various adjoining tubes.

The operation of the electrical equipment can be explained somewhat as follows: A source of radiation, such as, for example, radium is continually giving off penetrating rays. (Referring

now to Figure 2), these rays penetrate through the glass wall of the detector head 9 which may consist of a gas-filled tube charged to a high electrical potential and are capable of initiating a discharge between the outer jacket and the inner electrode through ionization of the gas. The occurrence of such momentary discharge causes a pulsating flow of current which alternately lowers and raises the grid potential of the vacuum tube 10. This potential change is amplified by the tube and transmitted through a shielded cable to the amplifier feed which also contains the main power supply. After further amplification by vacuum tube 11 the pulsating current is rectified by means of vacuum tube 12. The rectified current so obtained is fed to indicating meter 13 through a resistance capacitance circuit capable of averaging the pulses for the purpose of obtaining a steady meter reading.

If, when a large and very dense mass of material is interposed between the source and the detector head, the meter is adjusted to read zero and meter reading of 100 may be obtained by the aid of adjustment of the amplifier while the source is separated from the detector only by air. Under these conditions, subsequent meter readings will serve to indicate the amount of any dense foreign material interposed between the source and the detector head. This is the principle which is employed in indicating voids and obstructions in catalyst cases and similar equipment.

To show operation for determining the position of obstructions in a pipe, the same set up is again shown in Figure 3, with like indicia, except that in this case the detector 7 of Figures 1 and 2 is shown in divided form, with the detector head 9 movable independently of the amplifier 10.

When studying flow conditions wherein a radioactive pellet is allowed to pass through a system in the material flowing therein, detectors may be placed at fixed locations. When studying ramified flow conditions when radioactive material is admixed with the flowing material and study is by measuring its concentration at various points, fixed detectors may again be used.

I claim:

1. Method for the exploration of ramified structures comprising moving a source of radiant energy through portions of said structure in maintained geometric relationship with a detector moved through other portions of said structure which detector is capable of translating incident radiant energy into proportional electrical energy, amplifying electrical energy so generated to desirable signal strength, measuring the proportional amount of electrical energy so generated, and determining conditions between the source of radiant energy and the detector by analyzing fluctuations in the amount of radiant energy translated between said source and said detector.

2. Method for determining the position of an obstruction in a ramified tubular structure through which fluids are passed comprising introducing a carrier containing a source of radiant energy thereinto to be carried by said fluids until lodged against the obstruction, placing a detector of radiant energy successively at each of a series of points whose exact location with respect to the ramified structure is known, the detector being capable of translating incident radiant energy into proportionate electrical energy, measuring such proportionate energy for each location of the detector, and from the variations in signal strength between successive locations determining the previously unknown position of the obstruction with relation to the known character of the structure.

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