

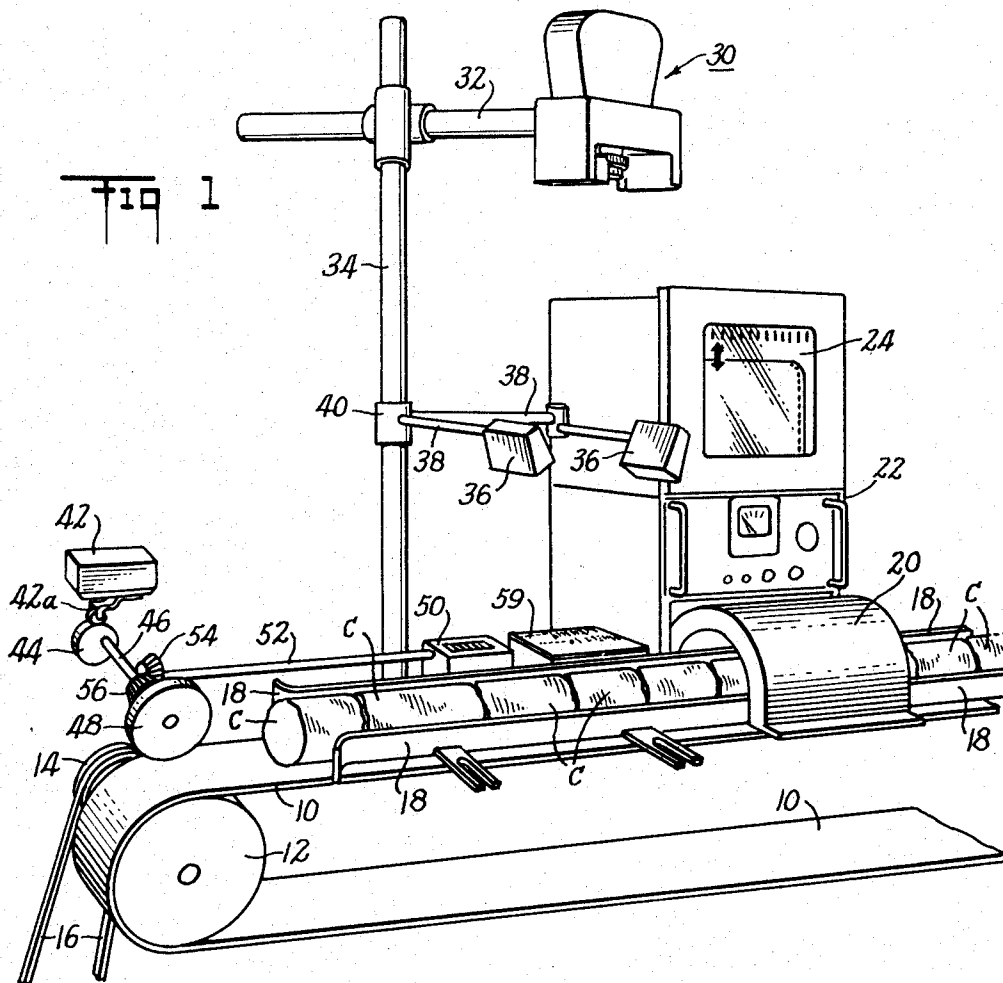
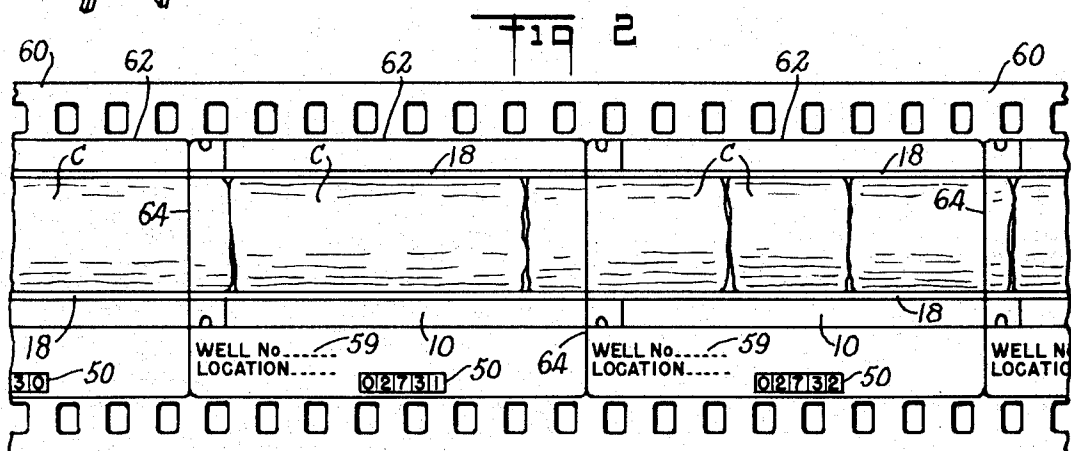
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APPARATUS FOR PHOTOGRAPHING WELL CORE SAMPLES

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APPARATUS FOR PHOTOGRAPHING WELL CORE SAMPLES

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ABSTRACT OF THE DISCLOSURE

Well core samples are photographed by arranging them on a conveyor end-to-end in a string in the same order they occupied prior to removal from the well borehole, moving the conveyor continuously while actuating the shutter of a camera directed at the string by automatic means coupled to the conveyor so that the shutter is actuated at uniform intervals during which the string moves a distance equal to the length of the field of view of the camera, and advancing the film between successive exposures a distance substantially equal to the length of the film exposed on each such actuation to form a continuous strip photograph of the string.

This invention relates to strip photographs of core samples removed from well boreholes and to a method of making such photographs.

In the drilling of oil and gas wells, for example, it is customary practice, when the drilling bit approaches an underground formation which may possibly contain oil or gas, to substitute a core bit and core barrel and take core samples of the strata traversed during the ensuing drilling. These samples are brought to the top of the well and analyzed for such characteristics as lithology, porosity, permeability, and oil and water saturation, which data form the most reliable means for determining whether the formations from which the core samples were taken are capable of producing oil or gas on a commercial basis.

While it is normally desirable to have such core analyses performed as quickly as possible after removal of the cores from the borehole, in order that the data obtained may be utilized in determining whether further drilling is necessary or whether the well may be completed for production at the horizon already reached, it is almost invariably desired to keep the core available for subsequent inspection and analysis, perhaps even years after the drilling of the well. Thus, most companies in the petroleum industry provide extensive storage facilities for maintaining and preserving the cores recovered from wells drilled by or for them. Either the geologists or other company personnel desiring to examine the core samples must go to where the core is, or the core must be brought to them, in either case entailing appreciable time and expense. This also imposes a severe limitation on the amount of core which can be examined by the company's most skilled geologists, and makes it necessary to rely on their less experienced subordinates for examination of much of the core. In many instances, only a visual inspection of the core samples is required, in which case photographs, particularly color photographs, of the core samples would serve as well, thereby obviating the time and expense involved in examination of the core itself, and permitting much more or even all of the core to be examined by the company's top geologists.

In general terms, the present invention supplies this need by providing a strip photograph comprising a series of closely spaced frames portraying successive, substantially contiguous and non-overlapping sections of the string of core samples appearing in the same relative positions which they occupied prior to removal from the

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borehole, so that the photograph is, in practical effect, an elongated, substantially continuous picture of the core. Preferably, but not necessarily, each frame may represent one foot of length of the string of core samples and the frames may show numerals corresponding to the reported depths in feet from which the respective one-foot sections of the core were taken.

According to the method of the present invention, this photograph is made by arranging the core samples end-to-end in the same relative positions which they occupied prior to removal from the well borehole and moving the string of core samples past a fixed camera directed at the core samples while actuating the shutter of the camera to expose the film therein at intervals corresponding to uniform distances of movement of the string, the camera being so spaced from the core samples and its lens having such focal length that the frames thus exposed portray substantially contiguous and non-overlapping sections of the string, and with the film being advanced between such successive exposures by uniform distance approximately equal to the stripwise length of the frames. The optional depth indicia are placed on the film strip by arranging a mechanical counter adjacent said string of core samples in the field of view of said camera, said counter being coupled to the conveyor which moves the string of core samples past the camera, so that the counter is indexed one digit for each foot of movement of the string, with the counter being preset so that when the first section of the string is photographed, the dial of the counter shows numerals corresponding to the reported depth in feet from which this section was taken.

Advantageously, but not necessarily, the core samples may be conveyed by the apparatus disclosed in U.S. Patent No. 3,025,398, and thus photographed at the time of making the radiation log disclosed in that patent, thereby obviating the need for additional handling of the core.

The film may be viewed, for example, by the use of a compact strip-film projector, which projects images against either a screen or a blank wall, with the film being advanced manually so that the image of any selected interval of core may be viewed for as long as desired. The considerable enlargement of the image produced by projection affords some of the advantages of a microscopic examination of the core, while permitting the entire width of the core to be examined simultaneously and to be compared with adjacent sections of the core.

In the drawings:

FIGURE 1 is a somewhat diagrammatic perspective view showing a method of photographing core samples within the scope of the present invention.

FIGURE 2 is an enlarged, fragmentary plan view of film strip embodying features of the present invention.

The aforementioned U.S. Patent No. 3,025,398 discloses a method of determining the wireline-measured depth of the formation from which core samples were taken from a well borehole which includes the steps of placing the core samples in line in the same sequence as the relative positions they occupied prior to removal from the borehole and moving this string of core samples relatively to a radiation sensitive device, while making a graphic record of the intensity of radiation detected by the device, and correlating this record with a conventional downhole radioactivity log made with a wireline-supported sonde.

Said patent discloses an apparatus for making the surface radiation log of the core samples which includes an endless belt on which the string of core samples is supported and which is motor-driven to move the string of core samples continuously past a stationary radiation detector, such as a scintillator. The process of that patent

has gone into widespread commercial use, particularly in what is known as "hard rock" country, such as the Permian Basin. Thus, the apparatus is already available in many areas.

In FIGURE 1, the string of core samples C are shown supported upon the endless belt 10 of such an apparatus, which is more fully described in said U.S. Patent No. 3,025,398. The belt 10 is supported at each end upon drums, one of which is shown at 12 and which is driven by a pulley 14 through a belt 16, which in turn is driven by an electric motor (not shown). The core samples C, supported upon the upper span of the belt 10, are guided laterally between adjustable side rails 18, and are moved continuously through a lead-shielded tunnel 20 containing a scintillation detector which, through appropriate electrical circuits in the cabinet 22, drives a strip recorder 24 to plot a graph of the level of radiation detected by the scintillator.

Mounted directly above the conveyor belt 10 in position to photograph the core samples after they emerge from the tunnel 20 is a camera generally designated 30, adjustably supported on a crossarm 32 secured at the upper end of a vertical post 34. Also supported on the vertical post 34 are a pair of stroboscopic lights 36 secured at the ends of adjustable horizontal arms 38 projecting from a collar 40 encircling the post 34. The stroboscopic lights 36 are arranged to illuminate the section of core being photographed by the camera 30 for a brief instant during the interval the shutter of the camera 30 is open. The speed of the film and the *f* number of the lens and shutter of the camera 30 are such that, in ordinary room lighting, no appreciable exposure of the film takes place during the brief interval the shutter is open except during that instant when the stroboscopic lights 36 are flashed. The duration of the flash is so brief that the movement of the core samples C on the continuously driven conveyor belt 10 is effectively stopped, so that the image of the core on the film in the camera 30 is substantially free of blurring.

The camera 30 is of the electrically operated type wherein electrical impulses cause opening of the shutter to expose the film, followed automatically by motor-driven advance of the film preparatory for the next exposure. The camera 30 is controlled by means of an electrical switch 42 whose plunger 42a is actuated by a cam 44 fixed at the end of a shaft 46 driven by a wheel 48 which frictionally engages the upper surface of the conveyor belt 10 at a point directly above the highest point of the drum 12. The wheel 48 has a circumference, for example, of exactly 1 foot so that it and the cam 44 make one revolution for each foot of linear travel of the conveyor belt 10, bringing the high point of the cam 44 opposite the switch 42 and causing the camera 30 to be actuated to take one photograph for each foot of core sample.

The spacing of the camera 30 from the string of core samples C and the focal length of its lens are such that each frame exposed on the film consists of the image of a section of the string of core samples having a length exactly equal to the circumference of the cam 44, for example, one foot. The film is advanced between adjacent exposures by a distance such that the adjacent exposed frames do not overlap, but either just touch the adjacent frames or leave a very narrow line of unexposed film between adjacent frames.

Thus, as shown in FIGURE 2, the film strip 60 consists of a series of successive frames 62 separated by thin spaces 64, with the respective frames each portraying substantially contiguous and non-overlapping sections of the string of core samples C, so that the film consists essentially of an elongated, continuous picture of the string of core samples.

As shown in FIGURE 1, there may be mounted alongside the string of core samples C on the conveyor belt 10, within the field of view of the camera 30, a mechanical counter 50 having its dial facing the camera. The counter

50 is actuated through a rotary shaft 52 having fixed at its outer end a miter gear 54 which meshes with another miter gear 56 on the aforementioned shaft 46. Thus, the shaft 52 makes one revolution for each foot of movement of the conveyor belt and this causes the dial of the counter 50 to be indexed one digit. The counter 50 is preset so that its dial indicates numerals corresponding to the driller's reported depth of the formation from which the first foot of core samples photographed were taken. Thus, as the conveyor belt 10 conducts the string of core samples beneath the camera 30, the dial of the indicator 50 is automatically indexed so that, as shown in FIGURE 2, the successive frames of the film will show numerals corresponding to the reported source depths of the respective sections of core portrayed.

There may be also mounted alongside the string of core samples, within the field of view of the camera 30, a card 59 marked with the well number and location so that each frame of the film will also show this information.

It will therefore be appreciated that the aforementioned and other desirable objectives have been achieved. However, it should be emphasized that the particular illustrative embodiments of the invention which are described herein and shown in the accompanying drawings are intended as merely illustrative of the principles of the invention rather than as restrictive of the scope thereof, which is defined only by the appended claims.

We claim:

1. Apparatus for photographing well core samples comprising an endless conveyor adapted to support a string of core samples arranged end-to-end in the same order as the relative positions they occupied in the well bore, means to drive said conveyor continuously in one direction, a photographic camera arranged above said conveyor and directed downwardly at said string, the lens of said camera being so spaced from said string and having such focal length as to expose a predetermined stripwise length of the film of said camera to the image of a predetermined interval of the length of said string upon each actuation of the shutter of said camera, shutter actuating means for actuating the shutter of said camera, said shutter actuating means being coupled to said conveyor to actuate said shutter each time said conveyor and said string move a distance equal to said predetermined interval, and film transport means in said camera for moving said film a distance approximately equal to said predetermined stripwise length of said film upon each actuation of said shutter, whereby to form a substantially continuous strip photograph of said string.

2. Apparatus for photographing well core samples comprising an endless conveyor adapted to support a string of core samples arranged end-to-end in the same order as the relative positions they occupied in the well bore, means to drive said conveyor continuously in one direction, a photographic camera arranged above said conveyor and downwardly directed at said string, the lens of said camera being so spaced from said string and having such focal length as to expose a predetermined stripwise length of the film of said camera to the image of a predetermined interval of the length of said string upon each actuation of the shutter of said camera, shutter actuating means for actuating the shutter of said camera, said shutter actuating means being coupled to said conveyor to actuate said shutter each time said conveyor and said string move a distance equal to said predetermined interval, stroboscopic light means arranged to illuminate the portion of said string in the field of view of said camera and light energizing means coupled to said conveyor to flash said stroboscopic light means during the interval when said shutter is open.

3. Apparatus for photographing well core samples comprising an endless conveyor adapted to support a string of core samples arranged end-to-end in the same order as the relative positions they occupied in the well

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bore, means to drive said conveyor continuously in one direction, a photographic camera arranged above said conveyor and directed downwardly at said string, the lens of said camera being so spaced from said string and having such focal length as to expose a predetermined stripwise length of the film of said camera to the image an interval of said string one foot in length upon each actuation of the shutter of said camera, shutter actuating means for actuating the shutter of said camera, said shutter actuating means being coupled to said conveyor to actuate said shutter each time said conveyor and said string move a distance of one foot, a mechanical counter positioned in the field of view of said camera with its dial generally facing said camera, said counter being coupled to said conveyor so that it is actuated to index one digit for each foot of movement of said conveyor and said string, and film transport means in said camera for moving said film a distance approximately equal to

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said predetermined stripwise length of said film upon each actuation of said shutter, whereby to expose said film to form a series of substantially contiguous frames together representing a strip photograph of said string, with the successive frames showing numerals corresponding to the depths in feet from which the core samples were respectively taken from said well bore.

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