Stereo Photography in Brine Wells

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ABSTRACT

In the past year the Laval stereo camera, originally developed for photographic inspection of water wells, has been used very successfully in brine wells. Utilization of this camera makes it possible to obtain sharp, detailed three-dimensional pictures. The camera can be operated at depths or pressures equaling 10,000 feet and in temperatures up to 170 degrees Fahrenheit.

Any number of black and white pictures, to a maximum of 350, can be taken in any one photo run and at whatever intervals that might be required. Photographs are developed and available for viewing within thirty minutes after the camera is removed from the well. Color film is available; however, development must be done at special processing centers and a delay of several days is necessary before film can be viewed.

After development, the film is edited and unusual or significant negatives are mounted in special film holders and inspected in a special stereo viewer. Prints or enlargements can be made from either one of the pair of negatives obtained from each exposure.

The camera can be operated in any borehole six inches in diameter and larger. The unit is operated on 110 volt power and is suspended on 5/16 inch coaxial cable. A combination line meter and weight indicator makes location of each photograph accurate and avoids the accidental lodging of the camera in the well.

Our experience to date indicates that this unit can be a useful tool aiding in the inspection and maintenance of brine wells.

For the past year we have had the very interesting experience of operating the new Laval stereo camera in brine wells. This unusual camera was developed to meet a critical need for the visual inspection and subsequent repair of very deep and expensive water wells in the San Joaquin Valley area of central California.

This area is subject to periodic subsidence and frequently casing damage is very common. The ability to photograph and inspect damaged areas prior to repair has made possible accurate knowledge of underground installations and has virtually eliminated insufficient repair work. More than this, some repair work need not even be attempted, because it is obvious that such work would not be successful.

I want to emphasize here that this unit is not a television camera. Nor is it a duplicate of other conventional cameras available for above fluid work. The Laval camera brings an entirely new concept to borehole photography. Conventional cameras and television cameras provide pictures which are viewed in two dimension. The Laval camera produces pictures with the added dimension of depth.

This is stereo or 3-D photography. Those of you familiar with the three-dimensional cameras which have been on the market for the pleasure photographer know about the detail and clarity

that can be observed by adding depth to a photograph. The Laval camera provides a permanent record that can be examined at the viewer's leisure. No detail is lost in these photographs, as is the case when, for a permanent record, a photo of the T. V. screen is taken.

The camera can be operated either above or below fluid levels. The only requirement for detailed and clear three-dimensional pictures is a fluid that is not turbid and a clear opening of not less than six inches in diameter throughout the entire length of the photo run. This unit can function at combinations of depths and pressures up to 10,000 feet and at temperatures up to 170 degrees Fahrenheit. At higher temperatures the emulsion on the film is affected and tends to become rubbery. Films better able to stand the higher temperatures are presently being developed for use in this camera.

We have used the camera very successfully in the northern Ohio and Lake Erie areas in brine wells, sentinel wells and water wells. The unit has also seen service in brine wells in Texas and Oklahoma. Following are several photographs taken in the areas mentioned above which illustrate the detail and clarity that can be expected with the use of this camera.

When these photos are inspected in the field, they are viewed in three-dimensional stereoscopic pairs that make details very easy to interpret. It is, of course, difficult to reproduce a photo for presentation such as it would actually be seen in the field. Viewing a photo in this manner eliminates the third dimension, that of depth perception. This is the most important difference that makes the Laval pictures superior to any we have seen thus far. In this rather specialized area of photography, depth perception helps immeasurably in the interpretation of the photo.

Figure 1 is a typical photograph of a collar. The square object in the center of the picture is the light source for the camera. This is a sure identification of any picture taken under fluid with the Laval camera. Figure 2 illustrates an example of scale build-up on a section of casing. Figure 3 was taken in a cavity area. Figure 4 shows the trash pile at the bottom of a brine well. All of these pictures were taken under fluid and at depths exceeding 1,000 feet.

The camera is enclosed in a five-inch diameter steel housing. The light source is a 450 volt strobe light which is mounted in the head of the camera for above fluid work and suspended 36 inches ahead of the lenses for below fluid photos. The light source must be mounted ahead of the lenses for below fluid operation to illuminate the full area of focus. If the light were mounted in the head of the unit, the refraction of the light beams would be such that only a small percentage of the focal area would be illuminated. Effective length of focus and radius of focus are 36 inches. With the angle placement of the lenses of 18 degrees, the radius of focus is somewhat greater than 36 inches. In actual practice objects are in focus as much as five feet ahead of the camera lenses. Overall length of the camera for above fluid work is three feet and six feet for below fluid operation.

Any number of black and white pictures up to a maximum of 350 pairs can be taken in any one photo run in a well. Pictures can be taken at whatever intervals that might be required. This means that a full 700-foot run could be photographed at two-foot intervals with one magazine of film. The camera is fired manually from a control panel mounted on the service truck which handles the unit. The camera has no shutters. The film is exposed each time the strobe light is fired. Each time the light is fired, the film is automatically spooled two frames forward. Pictures can be pinpointed accurately at any level in a well where trouble is suspected or where information is particularly desired. The control mechanism is arranged in such a manner that it will indicate whether the camera is functioning properly and if the strobe light is firing on every exposure.

Pictures are developed at the job site and are normally available for inspection within thirty minutes after the camera is removed from the well. After development, preliminary inspection is done on a special stereo film editor. Significant or unusual negatives are mounted on special film holders and inspected in a stereo viewer. Prints or enlargements can be made from either of the pair of negatives obtained from each exposure. The negatives can also be mounted for projection in a 35 mm projector.

Color film has recently become available. Because of the thickness of the emulsion on the film only 225 shots are available on any one run. Cost of the film is somewhat higher than that of black and white film. Development of the film must be done at special processing centers. At the

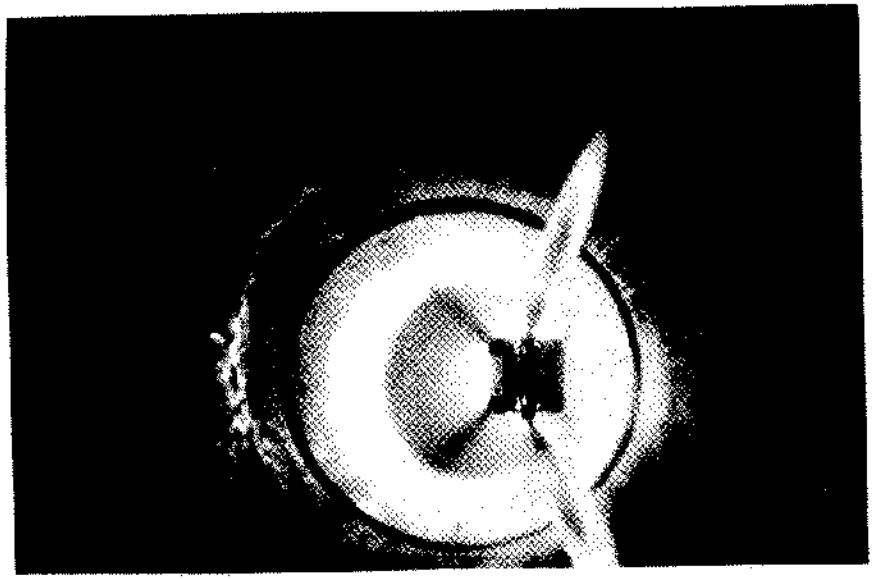

Figure 1

Figure 2

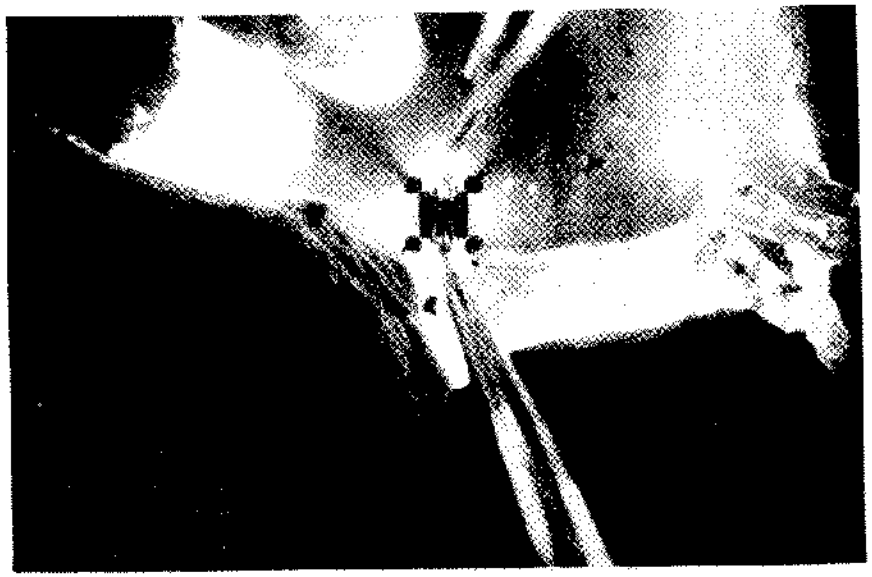

Figure 3

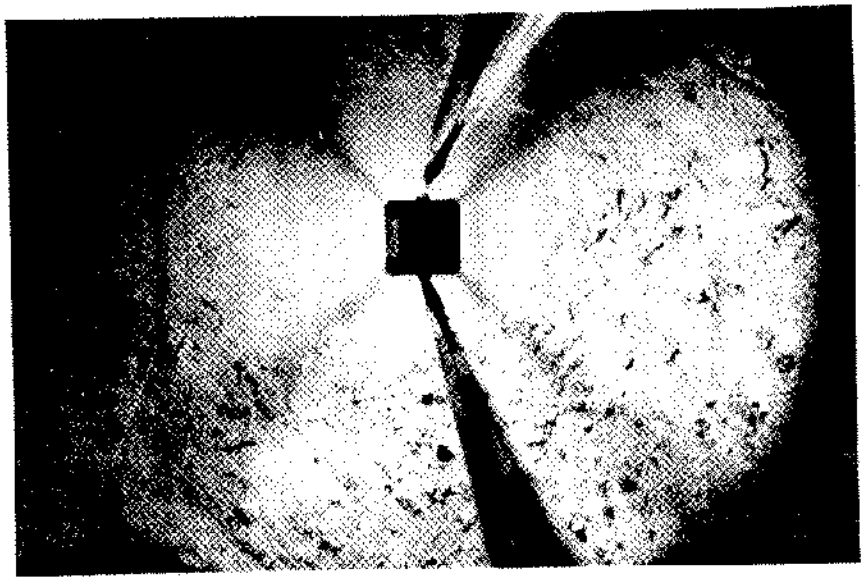

Figure 4

present time the only location that will process the film is on the west coast. The time involved in the transportation of the film to the processor and back means a delay of several days before the film can be inspected. The color photos taken in wells which we have seen, do not indicate that much color can be observed, especially in cased areas. The cavity areas should be a much better place to use the film.

In the very near future a camera assembly that can be used in boreholes as small as three inches in diameter will be available. Because of the size of the unit, the film magazine will contain only enough film for about 100 exposures. The developed film frames will be smaller since the lenses must be located closer together. This unit should be very useful for examination of areas that cannot be penetrated with the larger camera.

The camera is suspended in a well on 5/16-inch, single conductor, coaxial cable. The service truck is equipped with a winch that can spool up to 6,000 feet of cable. One of the special and unusual features of the camera is the fact that a 110 volt power source supplies all power to operate the unit. The necessary voltage for operating the 450 volt strobe light is built-up and stored in a capacitor until needed. This voltage can be built-up in the capacitor fast enough that two or three exposures can be made per minute. The camera service truck is equipped with a 110 volt portable generator since most work sites are at remote locations where power is not available.

A combination line meter and weight indicator makes the location of each shot accurate within six inches and avoids accidental lodging of the camera in a well or the breaking of the cable. We have also fabricated a lubricator assembly which makes it possible to run the camera in a well under pressure.

It has been our experience that all wells have turbid areas when the fluid in the well is not circulating. This is especially true in cased portions and this condition will seriously affect the quality of the pictures. While this is not generally true in cavity areas because of the circulation from other wells, the best precaution to take to insure good pictures is to circulate the fluid in the well being photographed in some manner. Circulating the fluid either in or out of a well does a very satisfactory job. The use of a lubricator assembly while a well is under pressure in the manner referred to above creates a clear solution throughout the length of a well. Unfortunately, it is not always possible to circulate the fluid, and when this is the case, results, especially, in cased areas are not very satisfactory.

We have not had an opportunity to experiment with any of the flocculants available for settling suspended matter. It appears that the pH of the fluid is a factor in the amount of time necessary to clear a well. A treatment of this sort could involve as much as three days before a well was clear enough to photograph.

The Laval camera represents the most effective method of underground photography yet devised and is a useful addition to the tools that are available for the inspection and maintenance of brine wells. One of the most important benefits of being able to visually inspect underground installations is the elimination of some of the guesswork and difficult interpretation of data that has been necessary until now.