Application of Inversion Effect in Construction

Abram Teplitskiy, Ph.D., Scientific Consultant
Roustem Kourmaev, President
Advanced Technologies International, Inc., Richardson, TX
tepl@sbcglobal.net

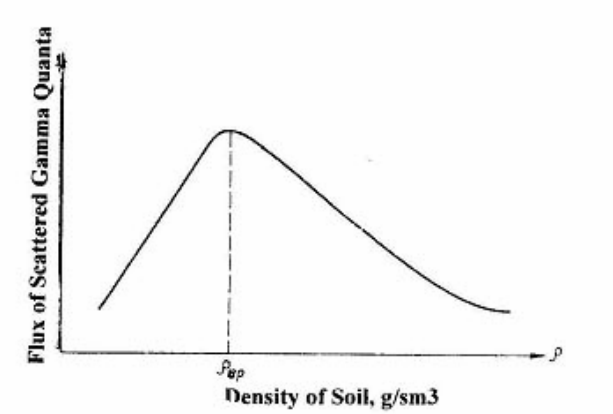
Inversion effect is also known in TRIZ as "The o**ther way around" (1).** We put here main classification of inversion "approach" taken from **July 1997-year issue of TRIZ Journal - Principle 13:**

A. Invert the action(s) used to solve the problem (e.g. instead of cooling an object, heat it).
- *To loosen stuck parts, cool the inner part instead of heating the outer part.*
- *Bring the mountain to Mohammed, instead of bringing Mohammed to the mountain.*

B. Make movable parts (or the external environment) fixed, and fixed parts movable).
- *Rotate the part instead of the tool.*
- *Moving sidewalk with standing people*
- *Treadmill (for walking or running in place)*

C. Turn the object (or process) 'upside down'.
- *Turn an assembly upside down to insert fasteners (especially screws).*
- *Empty grain from containers (ship or railroad) by inverting them.*

Before discussing applications of Inversion approach in construction, we would like to discuss some inversion effects, which were "puzzling" us during our inventing practice. In some cases inversion effect could bring … problems, as it had place during measuring density of Moon's soil with nuclear gauges by Soviet Automatic Station **Moon-16**. By results of these measurements density of Moon's Soil could be **1.6** or **2.3** gram/sm^3. Being professionally connected with nuclear technique, we analyzed this situation. Measurements of the density had been done by scattering of gamma quanta by electrons, which surrounding atoms of Moon soil constituents. When density of soil increases, the amount of scattered quanta also increases, and is registered by a gamma counter located on definite distance from source of gamma radiation. Starting from some density, the energy of gamma "particles" starts reducing due to consequent scattering; and finally soil's constituents absorb them. The changes of scattering gamma quanta flux is shown in **Fig.1** and has **inversion character.**



General Look of Calibration Graph for gamma-gamma densitometer

Fig.1.

As we see in **Fig.1,** to one amount of scattered gamma quanta, by intersection of horizontal line with graph, we are determining two possible values of soil 's density. **In Station Moon-16** case these possible values were **1.6 and 2.3 g/cm^3.** For solving this **ambiguity** we proposed a method based on measuring the amount of scattered gamma radiation on two different distances from source of radiation **(2)**. In **Fig.2** readers could see procedures of finding actual density of Moon's soil.

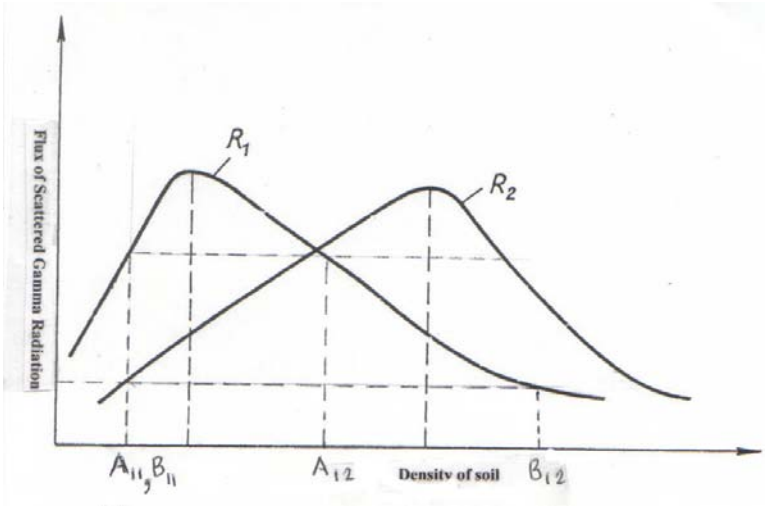


Fig. 2.
Nuclear Density Gauge Calibration Curves for Two Distances Between Source and Sensor of Gamma Radiation

Measuring flux of gamma radiation on distances $\mathbf{R_1}$ and $\mathbf{R_2}$ from source, due to the inversion character of calibration curve, we will get two pairs of possible densities: $\mathbf{A_{11}}$ and $\mathbf{B_{12}}$ for the first sensor, and $\mathbf{A_{21}}$, and $\mathbf{B_{22}}$ for the second sensor. Because soils in the small area of measurements could be considered homogenous, we can conclude that one pair of results should be congruent. In the case shown in the **Fig.2,** congruent results are $\mathbf{D_{11}}$ and $\mathbf{D_{21}}$. So, proposed approach gave the opportunity to solve the density **ambiguity**. Developed principle was realized in a special device, description on which readers could

find in **SU Patent #381,984 (3).** For automatic solving the "**density ambiguity**" problem we proposed a device, a block-scheme of which is shown in the **Fig.3 (3)**. Device contains source of gamma radiation **1** in protective container **2**, sensor of radiation **3** and shield **4** for protection the sensor of direct radiation from source **1**. Electrical impulses generated in sensor by gamma radiation of different energies entered to amplitude discriminators **5** and **6**, which select from the spectrum of gamma radiation scattered by soil, gamma quanta in two energy zones by limiting them by minimum and maximum. Electrical impulses of definite intensity $\mathbf{I_1}$ and $\mathbf{I_2}$ entered amplitude discriminators **5** and **6** representing these two radiation spectrum zones, are entering the block 7, which determines the ratio of above spectral intensities. Device 8 could be graduated directly in density units.

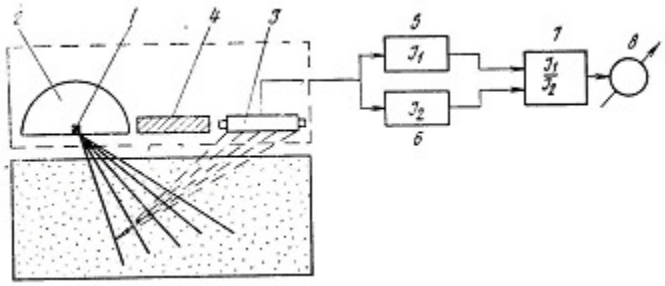


Fig. 3.
Structural Scheme of Nuclear Gauge for Measuring Density of Soils by SU Patent #397,066.

The most known emergence of inversion in construction is **soil standard compaction test**, which was developed by Civil Engineer R.R Proctor for determining optimal amount of water for soils maximum compaction **(1)**. This test often is called as **Proctor Test,** and in **Fig.4** readers could see general look of standard compaction test graph in comparison for different compaction efforts (**2**).

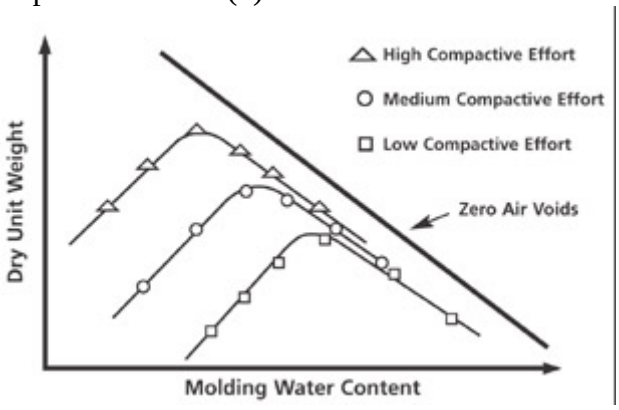


Fig.4.
General look of Soil Standard Compaction Curve

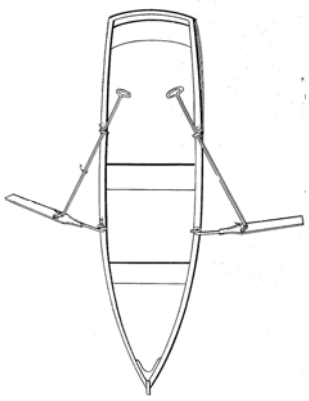
If you would like to compact dry soil, you would get low density. Adding water would reduce friction between soil particles, and a result, provide added higher compaction. But density increasing, due to increasing moisture, would continue up to specific value, called optimal moisture content. If we will increase moisture above this value, water would occupy more and more of porous space between soil particles, and decrease the overall

density of soil **(2).** Inversion effect penetrated all areas of our life. Even in psychology specialists found that dependence between motivation and achieved results is … inversion.

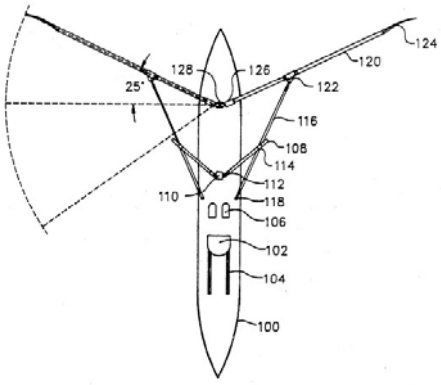
Above we discussed some applications from, we can say, high-tech branch of inversion effect. And can you think about **simple** application of this effect? To **"charge"** readers with some enthusiasm, we present here some examples. Did you face such a problem – what to do with wet umbrella after you enter a department store or pharmacy? If you did, what are you doing with wet umbrella? But some inventive people developed an umbrella, which is hiding its wet parts inside! Look over picture, which we took from Russian Federation Patent **#2,249,421** (**Fig.5**.).

Fig 5.
Umbrella assembled inside with wet side
Public Domain -RU Patent #2,249,421

This umbrella is assembled inside with wet side, which was exposed to rain, so you wouldn't feel any discomfort entering a mall, grocery store or pharmacy in rainy weather. This umbrella could be packed up with wet side inside. This umbrella contains a rod with handle, hoop, and frame, which could be folded, using, we can say, **lever-hinge** mechanism, as shown in the **Fig.5**. Such lever-hinge mechanism is widely used in different application of inversion principle for solving problems in different areas of our life. Being a young person, one of the authors was interested why people while rowing; have to look in direction opposite to direction of rowing? And what he could invent at that time was – install a mirror so the rower could see in back direction as driver in automobile. We can say, it was inversion of direction of seeing using optical tools. Since this time, maybe every year we saw in newspapers, on **BBC** websites, so elsewhere, information about inventions done all over the world for solving this problem. Because application of Inversion effect is a topic of current article, we will discuss some more solution of inversion-rowing problem. We found the first attempts to apply inversion to rowing in the US Patent #, general look of which is shown in the **Fig. 6**



6-a
Oar and Oar Lock
Public Domain-US Patent #49,930



6-b
Oar for rowing with face ahead
Public Domain-RU Patent #2,252,897

In above drawings readers could see two set of equipment designed to provide rowing while seeing where the boat is navigating. Despite these two solutions separated by more than 150 years (**September 12, 1865 and October 28, 2003)**, both of them are based on the same principle – lever-hinge principle. We think that it would an excellent exercise for would-be-inventors to analyze already existing solution of rowing-while-seeing-ahead, and develop own effective solutions. After we discussed the effectiveness of lever-hinge tools for solving above problems we advice readers to analyze unique opportunities, which other simple mechanisms have in solving technical problems. Such exercises would be an excellent lever for advancing readers inventing skills. Now let's analyze one of the most effective application of inversion technique, which is in pipeline construction and repairing. Partially we already did some of such analysis, now we'll diversify these materials. The main idea of inversion technologies in construction is based on inverting flexible hose like shown in the **Fig. 7-a and Fig. 7-b.**

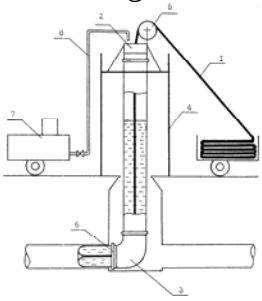


Fig.7 -a
Public Domain – RU Patent # 2,107,216

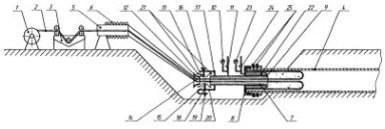


Fig. 7-b
Public Domain - RU Patent # 2,248,497.

Fig.7.
Vertical (9-a) and Horizontal (9-b) options of
Pipeline Repair Inverted Technology

Direct application of inversion effect is technology for making different curvilinear channels in underground space was described in our previous articles in TRIZ Journal. In Fig. 12 we illustrated this technology by example of tools for installing different markers under foundation. Now it sounds symbolically that we named such tools are **inverters**. For **Inverter** details see our article in **July 2005** Issue of **TRIZ** Journal.

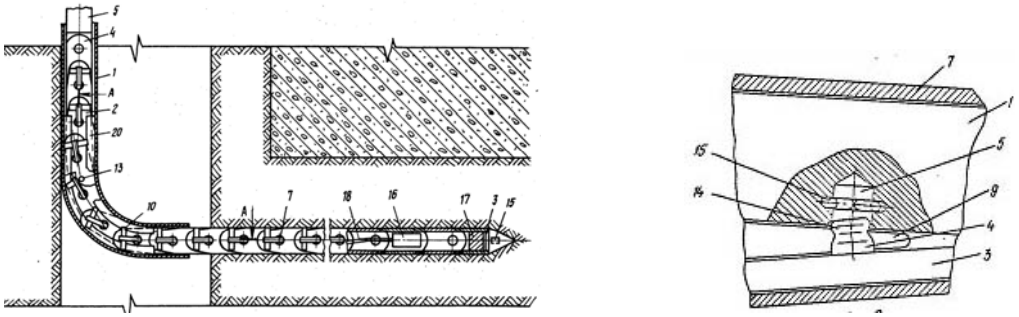


Fig. 8.
Inverter Principle Illustration
Public Domain - SU Patent #809,974

Our experience shows that Inversion Effect could be applied to any technology and technological situation. Everybody used that road concrete paving usually is made from monolithic material, which was accompanied by special drainage ditches. Such systems are enough complicated structures, and, moreover, consuming special service time. In this case, inversion technology is enough obvious - make concrete paving not from monolithic concrete but from …porous concrete. In this case, concrete **by itself** would drain storm water, and move it to underground channel. Pavement made from porous concrete is shown in **Fig.9,** and is formed with a number of aqueduct channels located underneath the pavement surface, so that water can percolate downward into the pavement and enter the channels.

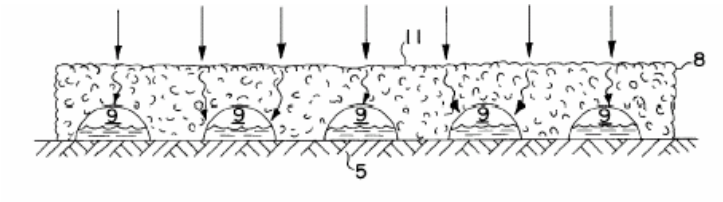


Fig. 9.
Porous Concrete Pavement Structure
Public Domain – US Patent #6,206,607

In Europe specialists inverted roofs structure, and made them instead monolithic concrete with … holes - from porous concrete. Such roofs would transmit water from the roof surface to the "under-roof" water collection system, which direct rainwater to pipes, and by this pipes rainwater will get in storm water drainage.

We found other way around for advancing underground drainage pipelines. For combining underground drainage by put together storm water and drain water, it was proposed to use combined pipes, which are monolithic from the bottom and porous from the top. It shows its effectiveness during exploration, but it was time and labor consuming to install such asymmetric pipes in a right way – with porous side on the top. To solve this problem we used once more "**Other Way Round**" method. We proposed to mount

porous pipes on the bottom of the trench, and then cover the bottom part of these pipes from inside with water-protective materials, using special spraying gun moving inside drainage pipeline.

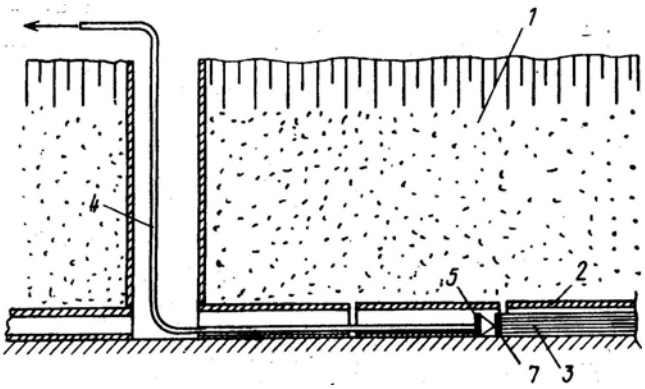


Fig. 10.
Technology of Installing Underground Drainage from Porous Concrete with Mudding the Bottom part of Drainage by Spraying
Public Domain – RU Patent #2024687

We hope that materials of this article about Inversion Effect Applications with examples from construction technology would be helpful to inventing practitioners.

References

1. **Roustem Kourmaev and Abram Teplitskiy, Application of 40 invention Tricks in Construction, TRIZ Journal, May 2005.**
2. **Abram Teplitskiy, "Technology of Soil Compaction Quality Control", Kiev, Publishing House Budivelnik, Kiev, 1985, 75 pages (In Russian).**
3. **Abram Teplitskiy et al., , Device for Measuring Density and Moisture Content of Soils, SU Patent # 364,883.**
4. **Abram Teplitskiy et al., Device for measuring Density and Moisture Content of Soils, SU Patent #381,984.**
5. **Abram Teplitskiy et al., Method for Measuring Density of Soils, SU Patent #397,066.**