



USING GEOPHONES ON SURFACE



ARRANGING GEOPHONES AND MICROPHONE

Peace Uses For War Inventions

By Robert H. Moulton



MINING RESCUE GEOPHONE SET LISTENING TO EXPLOSION OF ONE OUNCE OF DYNAMITE 1/2 MILE AWAY

IT WAS a foregone conclusion that many of the inventions born of the needs of war would be turned to peace uses with promise of great benefits. Already the experts of the bureau of mines, who assisted in the war work of perfecting the microphone and geophone to ascertain the exact location of enemy guns, are using these delicate instruments to locate entombed miners, and to make easier and more accurate various mining operations. The principle of the microphone was applied in a general way the location of a ship at sea. Toward the end of the war the device had been so perfected that it was possible for the microphone listening station to calculate the exact position of enemy guns after hearing the shots. The speed with which sound travels, was, of course, known and served as a basis of calculations at different stations. With these instruments electrically connected it was possible to record the exact time at which the sound reached them and then, by a series of rather intricate calculations based on triangulation, to locate the object.

The geophone is based on the same principle as the microphone, excepting that sound waves are recorded from the earth instead of the air, and it has reached such a high state of development under engineers of the bureau of mines that it bids fair to be one of the most useful applications now being made of inventions due to the war.

Geophone Is a Seismograph.
The geophone, though small, is essentially a seismograph, since it works on the same principle as the ponderous apparatus with which earthquake tremors are recorded. It consists of an iron ring about three and a half inches in diameter, within the center of which is suspended a lead disk that is fastened by a single bolt through two mica disks, one of which covers the top and the other the bottom of the ring. There are two brass pieces, the top one having an opening in its center to which is fastened a rubber tube leading to a stethoscopic earpiece. These cap pieces are fastened with bolts to the iron ring and serve also to hold the mica disks in place.

We then have really nothing but a lead weight suspended between two mica disks cutting across a small air-tight box. If the instrument is placed on the ground and anyone is pounding or digging in the vicinity, energy is transmitted as wave motion to the earth, and the earth-waves shake the geophone case. The lead, on account of its weight and because it is suspended between the mica disks, remains comparatively motionless. There then is produced a relative motion between the instrument's case and the lead weight. The result is that a compression and rarefaction of the air in the instrument takes place. Since the rubber tube leading to the stethoscopic earpiece is connected with this space in the geophone, this rarefaction and compression is carried to the eardrum. Usually two instruments are used, one for each ear.

How Direction Is Determined.
When the two instruments are used, it has been found that the sound is apparently louder from the instrument nearer the source of the sound. It is evident then that by moving the instruments properly a point can be found when the sound will be of the same apparent intensity in both ears. The direction of the sound is then on a perpendicular to the line connecting the centers of the two instruments either in front of or behind the observer. Further observation will show which side. Direction is quite accurately determined in this way. The sound is not actually louder in one ear than in the other, but the ear is capable of distinguishing the difference in time at which the sound arrives in the two instruments. Since this is the case, persons who are slightly deaf in one ear are said still to be able to determine direction with the instruments.

During the period of the war, engineers of the mining division of the bureau of mines were engaged in determining the distance that different mining machines could be heard through the clay, shale, coal and the mine cover. Measurements were made also of the energy required in order that they might be heard definite distances through clay, shale and coal, as well as to de-

termine the distances at which the shock waves resulting from the discharge of various explosives could be heard. A brief investigation of the factors influencing the transfer of energy from a mining tool to the clay and coal were also made in order that recommendations could be made as to the type of mining machine which could be used to accomplish the most work with the least noise. In this connection it was found that sounds were transmitted only about half as far in clay as in shale strata and about one-quarter as far in clay as in coal. To give some idea of the sensitivity of the instrument it may be said that pounding with a pick on the bituminous coal can be detected for a distance of 900 feet, and the direction determined, and that pounding with a sledge can be heard as far as 1,150 feet. These measurements were made in the Pittsburgh coal seam in the vicinity of Pittsburgh, where the coal is somewhat harder than in most other bituminous coal beds. The explosion of a one-ounce charge of dynamite was detected a distance of over 2,000 feet through the shale strata.

Sound Tells the Implement.
One interesting feature of the instrument is that the sound transmitted to the ear is characteristic of the implement producing the sound. To illustrate: Twelve mining and carpentering operations were carried out on the coal rib. An engineer of the bureau of mines who had never used the geophone and who did not know what tools were to be operated was able to recognize and name nine of the implements at a distance of several hundred feet through the strata. The other three sounds were accurately described, but the tools were not identified.

Now that the war is over, the bureau has turned to the development of the instruments for peacetime uses. For one thing, it is believed that they will be of great value to mine-rescue crews who may be entering mines for exploration and to locate miners who may have been entombed after a disaster. The tests so far made in the vicinity of Pittsburgh show that a man pounding on the coal rib with a pick, piece of timber or sledge can be detected and located from a point 600 to 1,200 feet distant. This distance depends greatly on the character of coal upon which the man is pounding, and intervening rooms and entries seem to have surprisingly little effect upon the distance or the determination of direction.

Pounding with a sledge can be heard from 200 to 300 feet through the mine cover, depending upon the quietness of the day outside, since any wind greatly interferes with the successful operation of the instruments. It will at once be seen that when mines are not too deep they can be "explored" from the surface and it will thus be possible to find and locate a miner who is pounding. At the experimental mine in Bruceton, Pa., a man has frequently been located through 140 feet of cover within 50 feet of the exact point where he was pounding.

A study is also being made of the distances that pounding on rails and pipes can be heard. Since rails are generally buried in the earth or dust in the entries of a mine, and since this dust dampens the transmission of the sound, the sounds are not transmitted very well. The same is true of pipe lines. However, if the pipe lines are not buried, but are laid on blocks and ties, the pounding can be heard great distances. So far no lines have been found long enough to show the limit of the geophone. It is known, however, that the naked ear can get sounds farther than 2,000 feet.

Used to Guide Tunnel Work.
In metal mines expensive surveys have sometimes to be made in order that the approaching tunnel headings may be brought together accurately. Since direction can be determined so well with the geophones, it is thought that they can be used to guide such work. It would only be necessary to go into each heading and locate the direction from which pounding in the other heading was coming.

Observations made in a metal mine recently showed that direction can be determined much more easily in rock than in coal. This is probably due to the fact that there is some reverberation to the sound from a hammer blow on coal, while on stone the sound is clean cut. It so happened that in this mine a raise was being driven up, about six or eight feet distant from a shaft. Observations were made in the drift of the sound

set up and operated at the survey mark did not break through into the drift, whereas a hole drilled at the point in the drift located by the geophones reached the raise and proved the geophone observation to have been correct within a few inches.

It is also thought the instruments will be of great value in preventing accidents from explosions when breaking through. In this connection an interesting incident happened recently. Observations were being made at a tunnel heading. The pit boss happened along and asked to be allowed to listen. He put the earpieces in his ears and remarked: "Mack is tamping a charge and we'd better move away." He spoke as naturally as he would have done had he been watching Mack, and it is quite evident that he did not realize that the sound was coming through 300 feet of coal, otherwise he would not have given the warning.

Observations were made recently of a mine fire burning from 20 to 40 feet below the surface. A low rumbling noise could be heard as if air were being drawn in along crevices, and occasionally sounds could be heard from the snapping and falling of pieces of coal or rock. As well as can be determined, the fire area was accurately located, but owing to the fact that the fire could not be approached from inside, the data could not be checked absolutely. It is interesting to note that similar sounds could be heard from only one point on the inside of the mine and that point was the one nearest the area as located on the surface.

In addition to the uses enumerated, an engineer of the bureau has discovered that the instruments can be employed advantageously in locating knocks in automobile valves and cylinders. For this purpose it is best to mount the instrument on a short iron rod that can be easily inserted in the machinery. Not only can a troublesome cylinder be located in this manner, but the trouble area in the cylinder also can be found.

APPLE TIME.

The crisp, frosty days of autumn are a sure indication that the apple season is in full swing. Those who can pick the fruit are fortunate, for the apple fresh from the tree, at this time of the year, is unrivaled in flavor and temptingly tart and juicy. But the privilege of gathering apples is no longer limited to those who live in the country, for nowadays many families who own cars avail themselves of the opportunity of motoring to the suburbs, where they may either gather a generous supply from unclaimed trees, or purchase the privilege of picking better varieties from the orchard of some thrifty farmer. After a few of these trips the housewife will find that she has obtained enough apples to supply her family with a variety of preparations for the winter's use. So many things may be done with apples that one becomes enthusiastic at the thought; they may be canned, dried or made into fruit butters and jellies, fruit sirup and fruit leather. Even the pulp which remains may be fed to the cattle, hogs or sheep, so there is no waste whatever in the whole process.—Christian Science Monitor.

NESTED IN TOWER TWENTY YEARS.

There is an old English sparrow that has nested in the eaves at Tower C, at East Somerville (Baltimore and Maryland yards), for the last 20 years.

Fifteen years ago he was caught and marked with a band of silver wire just to see how long he would live.

A new tower is being built at Tower C, and as the new tower is of brick and so constructed there is no nesting place in the eaves, and when the old tower is torn down the old sparrow will be deprived of a home.

Consequently one of the towermen caught the old sparrow (he is very tame), and took him to Wakefield and kept him in the garage several days, thinking he would nest there.

But when he was let out he made a beeline for Tower C at East Somerville, and has been there ever since.

IMPROVED UNIFORM INTERNATIONAL SUNDAY SCHOOL LESSON

(By REV. P. B. FITZWATER, D. D., Teacher of English Bible in the Moody Bible Institute of Chicago.) (Copyright, 1919, Western Newspaper Union)

LESSON FOR NOVEMBER 23

JESUS CORRECTS JOHN'S NARROWNESS.

LESSON TEXT—Luke 9:46-56.
GOLDEN TEXT—Grace be with all them that love our Lord Jesus Christ in sincerity.—Eph. 6:24.
ADDITIONAL MATERIAL—Mat. 18:1-35; Mark 9:33-42; 10:13-16.
PRIMARY TOPIC—Jesus and the Children.
JUNIOR TOPIC—Jesus the Friend of Children.
INTERMEDIATE TOPIC—Hasty and Narrow Judgments.
SENIOR AND ADULT TOPIC—True and False Liberty.

I. Jesus Teaches True Greatness (vv. 46-48).

1. The occasion (v. 46). A contention among the disciples as to who should be the greatest. Jesus had just announced his coming death on the cross, admonishing them to let his sayings sink down into their ears (v. 44). They were disputing among themselves as to who would be the biggest man in the kingdom. The imagination cannot depict a condition where rebuke and teaching were more needed.

2. The method (v. 47). He "took a child and set him by him." Teaching by object is one of the best methods.

In this Jesus showed himself to be the master teacher. Christ was qualified to meet the supreme need of all teaching, namely to know the pupil and to translate knowledge into terms adapted to the comprehension of the pupil. He perceived even the thoughts of the disciples and met their need. When they were conscious of his knowledge of them they were ashamed (Mark 9:34).

3. The teaching (v. 48). (1) "Whoever receiveth this child in my name receiveth me." So completely is Christ identified with those who are childlike in spirit that he regards treatment of them as treatment of himself.

(2) "Whoever receiveth me receiveth him that sent me." Christ and the Father are one, therefore whatsoever attitude one has toward Christ he has toward God. Rejection of Christ is rejection of God. (3) "He that is least among you all, the same shall be great." The one who in self-forgetful service takes the lowest place is truly the great one. This is the supreme law of Christian discipleship. In Jesus we see the one who was incomparably great identifying himself with humanity.

II. Religious Intolerance Rebuked (vv. 49, 50).

1. The case cited (v. 50). The disciples saw one casting out devils in Christ's name, but because he refused to follow them they forbade him. This spirit is liable to seize those who are really zealous for Christ. It often expresses itself against those who do not belong to one's particular church or sect. In determining whom we should admit to fellowship two questions only need be asked: (1) Are devils really being cast out? (2) Are they being cast out in the name of Christ? The plain implication of Christ's words in Matthew 7:22, 23 is that one may even cast out devils and be a stranger to the Lord. There is a supernatural work which is not divine, so unless the mighty works are done "in the name" of Christ a Christian should not fellowship the miracle worker.

2. The principle declared (v. 51). "He that is not against us is for us." This truth is positively stated in Luke 11:23, "He that is not with me is against me." When it comes to man's attitude toward Christ there is no neutrality.

III. Resentment Rebuked (vv. 51-56).

1. Farewell to Galilee (v. 51). As the time had come for him to be received up he set his face to go to Jerusalem. The time of his sacrifice was come and Jerusalem was the place where it was to be accomplished.

2. The Samaritans refused to receive him (vv. 52, 53). This refusal was due to the impression that he was going to Jerusalem. Their national prejudices were so strong that they regarded his action as a national insult, therefore refused hospitality to him.

3. James and John vehemently resent this action of the Samaritans (v. 54). They regarded it as an insult to their Lord. Their love was so vital that an affront to the object of their affection was most bitterly resented.

4. The Lord's rebuke (vv. 55, 56). (1) "Ye know not what manner of spirit ye are of." He did not minimize the insult or question their motive. He who knew their hearts was aware that they were moved by love for him. He told them, however, that such insults were not to be met by violence. Religious persecutions are always wrong. The spread of truth is not to be by means of material weapons. (2) "For the Son of Man is not come to destroy men's lives, but to save them."

A Fiction.

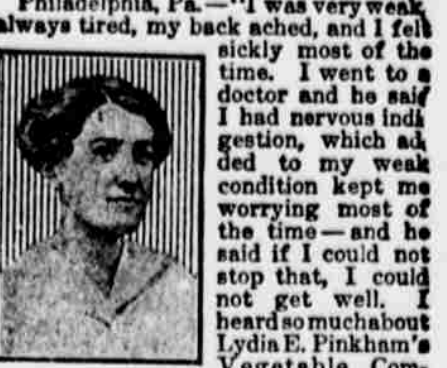
That God being good is the author of evil to anyone, that is to be strenuously denied, and not allowed to be sung or said in any well-ordered commonwealth by old or young. Such a fiction is suicidal, ruinous, impious.—Socrates, in Plato's "Republic."

The Law of God.

Wealth is a weak anchor, and glory cannot support a man; this is the law of God, that virtue only is firm, and cannot be shaken by a tempest.—Pythagoras.

THIS WEEK, NERVOUS MOTHER

Tells How Lydia E. Pinkham's Vegetable Compound Restored Her Health.



Philadelphia, Pa.—"I was very weak, always tired, my back ached, and I felt sickly most of the time. I went to a doctor and he said I had nervous indigestion, which added to my weak condition kept me worrying most of the time—and he said if I could not stop that, I could not get well. I heard so much about Lydia E. Pinkham's Vegetable Compound my husband wanted me to try it. I took it for a week and felt a little better. I kept it up for three months, and I feel fine and can eat anything now without distress or nervousness."—Mrs. J. WORTHLINE, 2842 North Taylor St., Philadelphia Pa.

The majority of mothers nowadays overdo, there are so many demands upon their time and strength; the result is invariably a weakened, run-down, nervous condition with headaches, back-ache, irritability and depression—and soon more serious ailments develop. It is at such periods in life that Lydia E. Pinkham's Vegetable Compound will restore a normal healthy condition, as it did to Mrs. Worthline.

INDIGESTION Caused by Acid-Stomach

Millions of people—in fact about 9 out of 10—suffer more or less from indigestion, acute or chronic. Nearly every case is caused by Acid-Stomach.

There are other stomach disorders which also are sure signs of Acid-Stomach—belching, heartburn, bloating after eating, food repeating, sour, gassy stomach. There are many ailments which, while they do not cause much distress in the stomach itself, are, nevertheless, traceable to an acid stomach. Among these are nervousness, biliousness, dizziness of the liver, rheumatism, impoverished blood, weakness, insomnia, melancholia and a long train of physical and mental miseries that keep the victims in miserable health year after year. The right thing to do is to attack these ailments at their source—get rid of the acid stomach. A wonderful modern remedy called EATONIC now makes it easy to do this.

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PATENTS

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The Poor Fish.
First Flatter—I'm sure in a dickens of a fix now.
Second Flatter—Can I help you out?
First Flatter—No; you see while my wife was away I let the goldfish die and in order to make up for it I bought a fish and put it in the bowl, but she found out it was a salmon.

A woman never thinks that a man thinks she talks too much.

If you would be happy let the other fellow do the worrying.

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