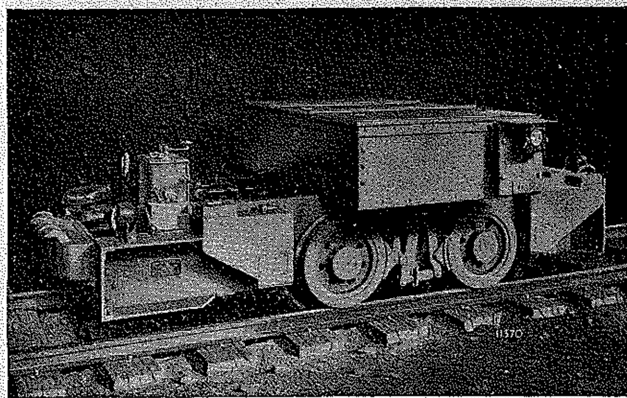
VOL. X OCTOBER, 1920 No. 10

COLORADO SCHOOL OF MINES MAGAZINE

THE COLORADO SCHOOL OF MINES ALUMNI ASSOCIATION, PUBLISHERS, GOLDEN, COLO.

Outside Wheel Type Locomotive with Pivoted Battery Box



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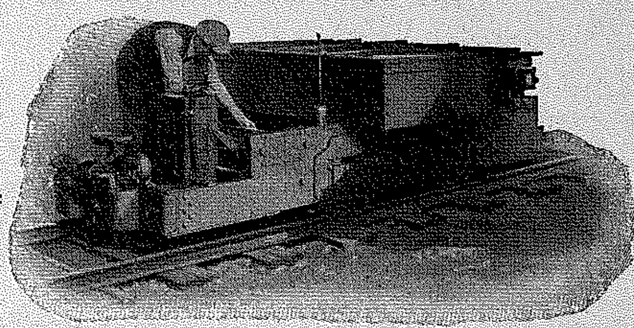

Inside Wheel Type Locomotive with Pivoted Battery Box

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COLORADO SCHOOL OF MINES MAGAZINE

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CONTENTS

THE ALUMNI ASSOCIATION OF THE COLORADO SCHOOL OF MINES HAS A CAPABILITY EXCHANGE which renders efficient Employment Service; if you want a man or a new position wire them.

Analysis of Oil Shale

By C. W. Botkin.*

Introductory.

The amount of oil and ammonia in an oil shale is determined by destructive distillation of the shale. Apparatus and methods vary greatly in different laboratories. Hard glass retorts[1] and distillation flasks have been used, but the charging and cleaning of the glass retort is difficult, and the glass is a poor conductor of heat. Cylindrical retorts made from iron pipe by screwing on caps at the ends[2] are usually free from leaks, but the cap is difficult to remove, the threads soon burn off, unless used in a horizontal position, and then the retort does not readily permit of even distribution of heat. The retort (iron pipe 6 ft. long, 2 in. in diameter, closed at one end) and method[3] used by E. M. Bailey of the Pumpherston Oil Co., Glasgow, Scotland, for available yield of crude oil is not satisfactory for shales containing lighter oils, since it is heated with one end open and has no condenser. The United States Geological Survey[4] and many chemical laboratories in the West have successfully used iron "mercury distillation" retorts. I have used them for two years with students in shale analysis, and in about fifty-five determinations which I have made on Colorado and Wyoming shales and consider this type of retort most satisfactory for both laboratory and field distillations. When this retort is placed vertically and properly heated by one gas burner a uniform distribution and penetration of heat is secured. The oil is driven to the cooler portions at the center and top and finally out at the top without any chance of overheating, and a maximum of oil is produced which is similar in quality to that produced from the same shale by a plant retort. This retort is easily charged and the spent shale readily removed. "Smooth-On" cement prevents leakages, around the cover of the retort. The retort lasts for a large number of distillations, but the cover may warp after ten or twenty distillations where the final temperature reaches a bright red. Bailey's method for determining available ammonia[5] (distilling the shale with steam in an iron tube) is accurate for the total ammonia, but is not well adapted for an accurate determination of oil as the quantity of shale used (30 grams) is too small. The "mercury" retort may be used with considerable saving of time to determine the yield of oil, ammonia and permanent gas by one distillation either with or without steam. For the steam distillation the retort is drilled near the bottom (from one side, horizontally), threaded, and a small pipe for the introduction of steam tightly screwed in. Outside the retort the pipe bends downward, where it connects with a suitable source of steam. This type of retort is suited for control work in plants retorting with steam and for the determination of ammonia under conditions similar to those of plant retorting. This method is not desirable for the determination of the maximum yield of ammonia, since the complete removal of ammonia with steam requires a long time even when small quantities of shale are used, as in Bailey's method. The amounts of oil and especially of ammonia vary considerably with the same shale depending on the method of heating and on the type of apparatus used. It is therefore important that some standard method be adopted for general use. Nothing new or perfect is claimed for the following method, but it is fairly accurate, easy of manipulation, comparatively rapid, and whether the distillation is made with or without steam, the conditions can be easily varied so as to approach those in a plant retort.

Analysis by Dry Distillation.

The apparatus is set up as shown in the accompanying cut. When available, a flow-meter is used instead of the carboy. A weighed sample (241) grams of the shale is placed in a one-half pint "mercury" retort and a paste of "Smooth-On" cement (Engineer's No. 1) quickly placed on the junction surfaces of both the retort and cover, and the cover at once clamped down tightly. The retort is placed in position, covered by an insulation (85 percent magnesia steam-pipe

* Research Chemist, American Shale and Petroleum Co., formerly Associate Professor of Chemistry, Colorado School of Mines.

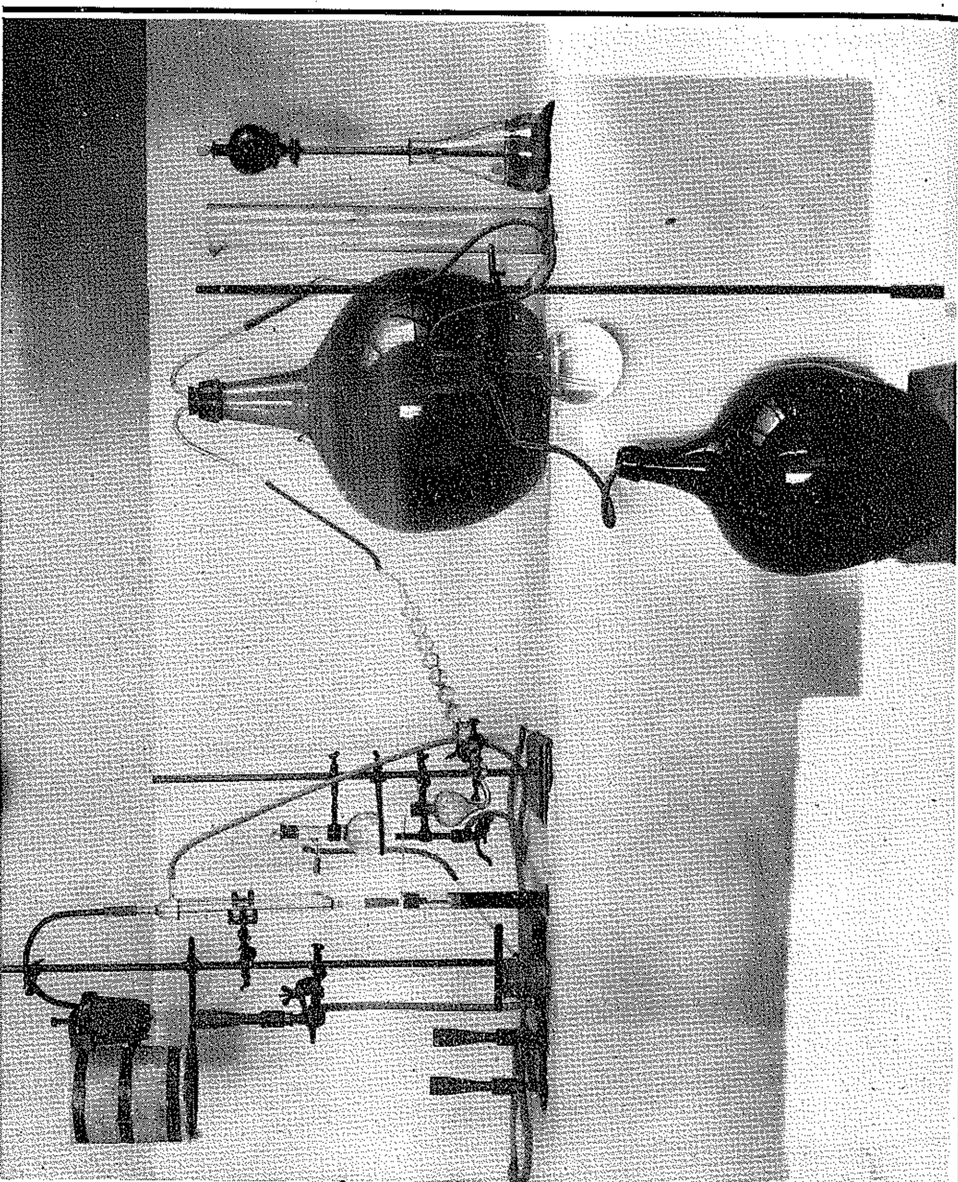
[1] Grafe, Shale Oils and Tars, Scheithauer, p. 148.

[2] Tinkler and Challenger, Chemistry of Petroleum, p. 188.

[3] United States Bureau of Mines, Notes on Oil Shale Industry, 1919. Colorado State Bureau of Mines, Bulletin 8, p. 37.

[4] United States Geological Survey, Bulletin 641, p. 147, 1916.

[5] Blair, Journal Society Chemical Industry, 1911, p. 397. Grissom, Journal Industrial and Engineering Chemistry, February, 1920, p. 172.



Apparatus for Oil Shale Analysis.

insulation, 8 in. long, 4½ in. inside diameter), which also serves as a burner guard, and then allowed to stand at least 15 minutes to give time for the setting of the cement. A small piece of asbestos board is placed over the top of the magnesia insulation so as to cover two-thirds of the retort on the side farthest from the condenser. The condenser is placed in a vertical position in order to secure better drainage, and the water for cooling first run through a small flask, which is heated at the end of the distillation to melt and remove any solid material remaining in the condenser tube. The oil and water distilling from the shale are collected and measured in the graduated cylinder. The ammonia is absorbed from the gases by about 25 cc. of approximately normal sulphuric acid in the Meyer absorption tube. The permanent gases are best measured by a flow-meter, but they may be collected over water and measured by the amount of water displaced. When this last method is used it is necessary to have a large container such as a carboy. A siphon tube leads from the bottom of the carboy into a distilling flask (also containing water), and the pressure in the retort and the tubes leading from it is regulated by adjusting the height of the flask so as to keep the pressure approximately atmospheric throughout the distillation.

When all is ready for the distillation, a number 4 Scimatco burner is adjusted to produce a 4-inch flame and placed with the top 4 inches from the bottom of the retort and with the flame under the center of the retort. The burner is raised one inch at half hour intervals. After about an hour and a half the water to the condenser is shut off and at the end of two hours the burner is placed ½ inch from the bottom of the retort. The retort should reach a low red heat. The oil is usually off at the end of 1½ or 2 hours. Additional burners may be used in case of doubt. The amount of permanent gas and sometimes of ammonia may be doubled by continuing the heating at a higher temperature after the oil has all been removed. Such measurements are not often required and usually only the gas and ammonia accompanying the oil is measured. At the end of the distillation the gas is measured by reading the flow meter or by measuring the water displaced. This volume in liters times 133.7 is equal to the number of cubic feet of gas per ton (2000 lbs.) of shale when 241 grams have been used for the analysis. The water in the small flask connected with the condenser is heated until the steam entering the condenser has melted and removed all the heavy oil. The amounts of oil and water collected in the graduated cylinder are accurately measured. After measuring the oil and water they are transferred to a separatory funnel and the water run into a liter conical flask. The acid is poured from the Meyer tube into the conical flask and the tube rinsed with 50 cc. of hot water. This water is then poured through the inner tube of the condenser into the graduated cylinder so as to rinse out any ammonium compounds. The rinse water is transferred to the separatory funnel, the oil and hot water shaken together, and after separation the water is run into the conical flask. The rinsing in this manner with 50 cc. portions of hot water is repeated three more times adding the rinse water each time to the conical flask. This rinsing is necessary to remove the ammonium compounds from the oil. Usually the rinse water contains more ammonia than the acid in the Meyer tube, and unless the oil is well washed it is impossible to obtain ammonia results which check.

The ammonium sulphate contained in the acid solution and the rinse water in the conical flask is determined by one of two methods. The solution may be boiled to a small volume or an aliquot portion measured and the ammonia determined in the usual manner by a Kjeldahl distillation. When the acid solution is not too deeply colored (which is the rule if the shale is distilled slowly) the following method[5] based on the reaction of formaldehyde with ammonium compounds may be used. It is very rapid and almost as accurate as the Kjeldahl method. The solution is boiled to remove carbon dioxide and sufficient litmus solution or cochineal is added to produce a distinct color. Sodium hydroxide is added from a burette until the solution is exactly neutral. When in doubt about the end-point or the end-point has been passed, a few drops of sulphuric acid are added and the end-point again determined. This may be repeated any number of times until the neutrality of the solution is assured. Often dilution with a large volume of water is an aid in making these end-point colors clearer. With litmus it is most accurate to take the end-point where the color begins to change to a red-violet rather than the final change to deep blue. Ten cubic centimeters of neutral 40 percent formaldehyde are added to the neutral solution and the solution boiled for about one minute. The following reaction takes place:

$$6\,HCHO + 2(NH_4)_2SO_4 = (CH_2)_6N_4 + 2\,H_2SO_4 + 6\,H_2O$$

The solution is cooled to about 60 degrees C, phenolphthalein added, and the sulphuric acid titrated with standard sodium hydroxide. One cubic centimeter of fifth normal base is equivalent to 0.10964 pounds of ammonium sulphate per ton of shale when 241 grams are used in the distillation. The grams of ammonium sulphate from 241 grams of shale times 8.3 is equal to pounds of ammonium sulphate to the ton.

When the amount of spent shale is desired, it is removed from the retort after cooling and weighed. The number of grams of spent shale obtained from 241 grams of shale multiplied by 8.3 equals the number of pounds of spent shale per ton.

Analysis by Steam Distillation.

The apparatus and the method are the same as given above with the following changes. The retort has an iron tube for the introduction of steam, the graduated cylinder is replaced by a liter suction flask, the adapting tube from the condenser extends to the bottom of the flask, a brass or iron condenser tube is preferred, and the small flask for heating the condenser water may be omitted. The shale is heated without steam until it has reached the steam temperature. Then steam is introduced and continued at such rate as to correspond to the amount used in plant retorting, or so that 200 to 300 cc. of condensed steam accompany the oil. After the oil is all out the steam may be continued until 500 cc. of water have collected in the suction flask. Considerable ammonia may still be obtained from the spent shale, but plant operation usually leaves more than 1 percent of the nitrogen in the shale. The heating by means of the Scimatco burner is increased less rapidly than in the distillation without steam. At the end of the distillation the acid solution in the Meyer tube is poured into the suction flask. If the solution is alkaline some more acid is added until it is acid. The oil and water are then separated in the separatory funnel, the oil is measured in the graduated cylinder and the ammonia contained in the water is determined by one of the methods already mentioned.

The following are the results obtained by six different distillations of a sample of Colorado shale. The first three distillations were made without steam and the second three with steam. Extreme care was not taken to make the conditions exactly the same and they do not fairly indicate how well the method may be made to produce results which check when samples are run from the same lot of shale.

Retorting Without Steam.

	Sample No. 1	Sample No. 2	Sample No. 3
Water, gallons per ton	1.65	2.2	3.85
Oil, gallons per ton	78.1	77.0	78.0
Gas, cubic feet per ton	4383	4236	3860
Ammonium Sulphate, pounds per ton	10.20	12.05	11.82
Spent Shale, pounds per ton	1130	1112	1123
Gravity of Oil, Be	21.1	21.2	21.5
Saturation of Oil, percent	14.2	15.0	14.0

Retorting with Steam.

	Sample No. 4	Sample No. 5	Sample No. 6
Oil, gallons per ton	78.1	82.5	80.3
Gas, cubic feet per ton	3807	3620	4056
Ammonium Sulphate, pounds per ton	21.9	30.2	32.6
Spent Shale, pounds per ton	1085	1090	1004
Gravity of Oil, Be	20.9	20.2	20.9
Saturation of Oil, percent	12.2	13.0	12.6

PRODUCTION OF ASPHALT IN THE UNITED STATES.

A preliminary estimate of the production and sales of asphalt and native bitumens and allied substances in the United States in 1919, has just been made public by the United States Geological Survey Department of the Interior. The asphalt produced from domestic petroleum amounted to 600,000 short tons, valued at $9,000,000, an apparent increase over 1918, of 72,425 tons, and of $1,564,796, respectively. The asphalt produced from Mexican petroleum amounted to 672,000 short tons, valued at $7,917,000, an increase from 1918 of 21,756 tons, in quantity and a decrease of $2,407,020 in value. About 115,000 short tons of native bitumens and allied substances valued at $1,000,000 was produced in 1919, an apparent increase over 1918 of 54,966 tons and of $219,192.

Observations with the Geophone *

Alan Leighton.

The geophone is an instrument invented by the French during the war to detect, through the earth, the sapping and underground mining operations of the enemy. It was improved by the United States Engineers, and more recently has been further improved by the engineers of the United States Bureau of Mines, and its use in connection with special sounds has been developed.

The instrument, though small, is essentially a seismograph, since it works on the same principle as the ponderous apparatus by which earthquake tremors are recorded. It consists of an iron ring about three and one-half inches in diameter, within the center of which is suspended a lead weight that is fastened by a single bolt through two metal discs (pure nickel discs 0.025 in. thick are used) one of which covers the top and the other the bottom of the ring. There are two brass cap pieces, the top one having an opening in the center to which is fastened a rubber tube leading to a stethoscopic ear-piece. These cap pieces are fastened with bolts to the iron ring and serve also to hold the metal discs in place.

We then have really nothing but a lead weight suspended between two thin discs that extend 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 in wave motion through the earth, and the earth waves shake the geophone case. The lead weight, on account of its mass, and because it is suspended between the discs, remains comparatively motionless. There is thus produced a relative motion between the instrument case and the lead weight. The result is that in the thin space over the disc, a compression and rarification of the air alternately takes place which is magnified at the small outlet. Since the rubber tube leading to the stethoscopic ear-piece is connected with the space in the geophone, the vibrations are transmitted to the ear drum and like other rapid air waves produce sound effects. Usually two instruments are used, one for each ear.

When two instruments are used, it has been found that the sound is apparently louder from the instrument nearer the source of sound, even though the geophones are placed not more than two feet apart. It is evident that by moving the instruments a point can be found where the sound will be of the same apparent intensity in both ears. The direction of the point of origin 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 slight differences in time at which the sounds arrive in the two instruments. Since this is the case persons who are slightly deaf in one ear are able to determine direction with the instruments.

The Bureau of Mines has conducted an investigation to determine the conditions of operation under which the geophone will give the most satisfactory results when used for rescue and survey work in both metal and coal mines.

In coal mines it has been determined that the geophones should rest on a solid shelf of coal or on the floor of a niche cut into the coal. The floor of the mine is likely to be covered with dirt, and is very seldom solid enough to transmit sound well. In metal mines the geophones will, of course, be held against or placed upon the natural rock. If the geophones are held with the hands against the coal, vibrations are set up by the circulation of the blood within the hands that greatly interfere with successful observations. On the other hand the rock appears to withstand these vibrations, and successful results can be obtained by simply holding the instruments in place upon the rock.

If a man is pounding in the hope that he may be located by means of geophones, he should strike heavy slow blows upon the coal or rock. The best results are obtained with a sledge, or heavy stick of timber. This is true even if the man expects to be located by a party operating upon the surface. There is no advantage in pounding upon the mine roof. The sound transmission is not so good, and the process is more fatiguing. It is, of course, known that sounds are transmitted very well along rails and pipe lines. The investigation has shown that while sounds may be transmitted great distances if the rails are laid upon ties or the pipes are sus-

* Monthly Reports of Investigations, Bureau of Mines, Department of the Interior.

pended; on the other hand, if they are buried in loose dirt for a distance as short as fifteen feet the sound vibrations may be completely damped. For this reason a man should never pound on a pipe line or the rails unless he is certain that they are entirely free from any covering. Since the sounds are so well transmitted through the rock or coal, pounding on pipes would seldom be advisable.

In making observations from the surface above a mine, the geophones must be pressed firmly into place upon the earth after the sod has been removed. Experiments were conducted with the geophones placed upon stakes driven into the earth, but this method was found not to possess any advantage.

In regard to the distances that sounds can be detected through the earth, sledge pounding can be heard in a mined-out area of a coal mine at least fifteen hundred feet, through the solid coal two thousand feet, and through solid rock about one-half mile. Blows from a pick, tamping bar, or heavy rock can be detected about two-thirds as far.

The geophone is of great value for rescue work in mines. It frequently happens that after a disaster men barricade themselves in some portion of the mine where the air is still good and await rescue parties. In such a case, if they keep up a continuous pounding, it may easily be possible to locate them by means of the geophones. Otherwise it is possible that the rescue party may come near them without discovering their place of refuge. The same is true of metal mines, where men may be imprisoned behind falls, or even be barricaded in some portion of the mine to which they have retreated in order to protect themselves from the fumes of a fire.

The geophone has also been proved of value for rough survey work in both coal and metal mines, for purposes of checking, positions of headings, winzes or raises, being driven, sunk, or raised to make a connection. It is perhaps of more value under the conditions usually prevailing in metal mines, since direction is more easily determined through rock than through coal.

It is easily seen that geophones are of value when the headings of tunnels difficult to survey are coming together. Direction determinations should be made from each tunnel, and if the results are consistent the operator can be sure of his data. The results may not agree if the strata between the two tunnel heads are not homogeneous, and, of course, in this case little reliance can be placed upon them.

That the instruments are of practical value in this connection can be seen from the following instances: The Bureau of Mines Engineers were present in a metal mine at the time when a drift and a raise had "missed." A few minutes' observation in the drift and of pounding in the raise, showed that the raise had gone up past the drift about six feet in from the face and to the right. Observations made from the raise upon the sounds of the drill operating in the drift showed that the raise extended to a point six feet above the drift, and that the drift was in the direction indicated by the first set of observations. A survey showed these conclusions to be correct. Again, observations were made of another raise which was being driven to the side of a drift, six to eight feet from it. Observations were made of the sounds from the drill, and a point located on the side of the drift behind which the drill in the raise was apparently operating. The survey mark was then ascertained to be from two to three feet to the right of this mark. A drill set up and operated into the survey mark did not hole through into the raise. A hole drilled at the point indicated by the geophones reached the raise, and proved the geophones to be correct within a few inches.

This instance also illustrates another application of the geophone. The surveyors had given the miners the location of the raise with regard to the drift in order to prevent accident in case a blast broke through. The geophone could have located the point easily, and frequent observations, if necessary, would have shown the progress of the work within the raise and before a blast was to be fired.

One of the advantages of the instrument is that it reproduces sound so well. Talking can be understood fairly well through fifty feet of solid coal, and detected one hundred and fifty feet away. The sounds from mining machines are all characteristic. In fact, a bureau engineer through three hundred feet of coal was able to name nine out of ten tools which were being operated upon the coal. In one mine where observations were being made from a tunnel heading, the mine foreman heard the workmen in another tunnel preparing to blast, and ordered the Bureau Engineers to retire until the blast was fired. The sounds were so clear that he did not realize at the time that the tunnel headings were then over three hundred feet apart.

Observations have been made at two mine fires, where it was found that the fire made noise enough to be heard some

distance, either because of the drawing air or the breaking off of bits of coal and slate. At one fire burning about forty feet below the surface all of these sounds could be heard, and an area was located within which they were audible. The fire could not be approached from within the mine, but the one point inside at which similar sounds could be heard was found to be the nearest point to the fire area. Later observations made around the base of a large burning culm pile were of interest because the same kinds of sounds were audible here. At the second fire, which was burning three hundred feet below the surface, only the sounds from dropping rock could be heard.

It is the custom in some localities to put down churn-drill holes from the surface to ventilate blind stopes and to carry pipe lines. These holes often come down in the solid, and much expense is incurred in locating them and driving tunnels to them. Geophones will be of great value here, and there would be no question of faintness of sound since churn-drilling can be detected nearly a mile away.

It is a well-known fact that when the bit of a diamond drill has drilled a considerable distance below the surface, there is no simple method for determining the course it may have taken, although there are survey methods used that give approximate results. Since these bits nearly always drift away from a straight course, it is evident that any instrument making it easily possible to determine their course will be valuable. There is some possibility that the geophone may be useful for this purpose. To date, however, this possible use of the geophone has not been thoroughly studied. Observations have been made upon but two vertical drill holes. These holes, about a quarter of a mile apart, were penetrating strata consisting of alternate layers of gneiss and "black rock," pitching at an angle of approximately forty-five degrees. One hole has reached a depth of approximately 1,000 feet, the other 600 feet. At each hole it was found possible to hear the bits cutting when the geophones were placed upon the rock surface. The observations were somewhat disappointing in that the sound of the bits could be heard within but a limited area, a circle whose radius was approximately one hundred feet, with its center at the drill. Since the area was so small, and presumably directly above the bit, no direction determinations could be made in the usual manner. It is believed, however, that had the bit drifted, this area of audibility would have been directly above the bit and away from the drilling machinery. Observations must be made on inclined holes in order to prove this point. It is certain that should a drill-hole be put down ahead of mine workings there would be no difficulty in locating it from the workings themselves.

Very satisfactory results have also been obtained in attempts made to locate leaks in water mains. The water circulating in the ordinary city main can be heard with the geophones when they are placed on the surface, ten to twelve feet above the pipe. In the business district of Pittsburgh one leak was located within a few minutes, although the water department had been trying to find it for two weeks. The leak could be heard from the surface from any point within a circle sixty feet in diameter, and was located in the joint of a "T" connecting a ten-inch with a fifteen-inch main. The geophones were also used successfully to locate a leak in a one-inch pipe serving a residence.—U. S. Bureau of Mines, Reports of Investigations.

THE RED CROSS OF THE FUTURE AND THE SERVICE MAN.

The primary obligation of the American Red Cross is to the Service Man of the Army and Navy. Five duties still remain:

First—To stay with the Army of Occupation, comprising about 17,000 officers and men.

Second—To continue in the hospitals of the Army, the Navy and the Public Health Service where there are more than 26,000 men, many of whom will be retained there for months and some for years, and carry on recreational and social work.

Third—To keep in touch as an Advisory Organization with the discharged men of the Army and Navy, and be ready —not in the way of financial aid—but what is worth more, to contribute kind advice and friendly assistance.

Fourth—To carry on the work with the families of soldiers and sailors and for the community at large.

Fifth—To care for those blinded in the crash of war, a Service turned over to the Red Cross by the government.

"Am I my Brother's keeper"? is the stammering alibi of sordid selfishness. Answer the call of your Red Cross which holds its Fourth Roll Call November 11-25, and fulfill your obligation to the brother who is still with Uncle Sam.

TECHNICAL REVIEW

GENERAL.

Present Status of the Nebraska Potash Industry. (Ed. C. & M. E., September 22, 1920.)

The potash industry in Nebraska has been suffering for lack of proper support from the fertilizer companies. During the war, when the importation of potash from foreign countries was cut off, the companies mixing fertilizer were dependent upon the home product of potash and were willing to pay high prices for the same. During that time the potash companies prospered. With the signing of the armistice, the fertilizer companies were content to sit back and wait for the lower prices on potash as a result of renewed importations. These importations have failed to meet the needs and the domestic product again has a market, though at much lower prices than formerly. With more willingness on the part of the consumer of potash for fertilizer production, to patronize home production, will come a larger and steadier supply for his needs. R. W. P.

MINING.

Gold Mining in British Guiana. (Eng. and Min. Journal, September 25, 1920.)

With only a few companies still operating, and mining hampered by lack of transportation and by high costs, gold production has been decreasing since 1895, and is now only about one-eighth the maximum recorded. The peak of production was reached in 1893-94, with an output of 138,527 ounces, and since then the industry, not only in Guiana, but also in the other gold-mining locations, has declined. The largest part of the production in Guiana has been from small placer operations, carried on by negroes who are grubstaked by the claim owners, and who go up to the "bush" for a year at a time, dividing their profits on their return. R. W. P.

A Tasmanian Lode Tin Mine. By M. A. Whitford. (C. E. & M. R., July 5, 1920.)

The Royal George Tin Mine operates on a lode of altered granite having well-defined walls. The mill equipment consists of stamps, jigs, grinding pans, Wilfley tables and roasting furnace. Power is supplied by a 220-H. P. gas engine, and water is supplied at the rate of 20,000 gallons per hour by a centrifugal pump. J. A. H.

Designing Mine Signal Systems. By R. H. Bacon. (E. & M. J., August 21, 1920.)

The necessary features of a signal system are safety, reliability, speed of operation, low maintenance cost, and simplicity. The most important consideration of safety recommends the use of electric systems. Low maintenance cost is obtained by the use of rugged equipment. The article ends with a description of the way in which the copper Range Co. selected its circuit layout. J. A. H.

The Copper Ores of Lake Superior. By J. E. Spurr. (E. & M. J., August 21, 1920.)

The copper-bearing formation is a thick series of conglomerates and basic surface lavas. Mineralization occurred in the conglomerate by replacement and impregnation. The greater part of the ore is native copper inter-crystallized with chalcocite, which shows the scarcity of sulphur in the solutions. J. A. H.

Danger from Explosive Fumes in Metal Mining. By D. Harrington and B. W. Dyer. (M. & S. P., August 28, 1920.)

Two accidents in May and June in which six men were asphyxiated have aroused interest in the prevention of such deaths. In both cases deaths were caused by carbon monoxide, which was not removed by the air compressor. Other dangerous gases are nitrous oxide, hydrogen sulphide and sulphur dioxide. The remedy is in the use of such ventilating systems as are prescribed by law in coal mines. J. A. H.

Calculation of Unit Smelting Costs and Values. By C. A. Grabiel. (Eng. & Min. Journal, September 25, 1920.)

The question about the value of sulphur in calculating a furnace charge and product is discussed under three heads, according to the three different effects of sulphur, in causing the variation in value. Fuel value, reducing value, and matting value, are the points considered. For the first two it is found that with the addition of from 1 percent to 10 percent of sulphur a good, black copper charge will smelt with a decrease of from 17 percent to 8 percent of coke. From that point the value of sulphur declines until it becomes an expense. The matting value, from an absolute standpoint, is indeterminate. R. W. P.

Liquid Crystals. By Clifford W. Nash. (C. E. & M. R., July 5, 1920.)

In showing many of the attributes of solid crystals, liquid crystals seem to show that the molecules of a solution align themselves before solidification takes place. The more common of these substances are forms of benzine which are solids at ordinary temperature, but which, when melted, give eight different velocities at different directions. The only evidence that molten metals have the same properties is the fact that the crystals of some alloys become larger when remelted. J. A. H.

Ball Tests on Missouri Lead Ore. By Lewis A. Delano and Harold Rabling. (Eng. & Min. Journal, September 18, 1920.)

In crushing tests carried on at the Bonne Terre mill of the St. Joseph Lead Co. in 1916, the capacity of the ball mills and the nature of the product were found to depend upon the following factors: i. e., speed and ball load, size of balls, moisture content in feed, and rate of feed. The speed and ball load determined the power consumed. Variations in either were found to be of minor importance. Upon the size of the balls depended the nature of the product, the highest capacity and lowest slime being obtained with 5-inch balls. The highest rate of feed was obtained in the open-discharged cylindrical mill. R. W. P.

OIL.

The Flow of Oil in Pipes. By Arthur C. Preston. (C. & M. E., September 29, 1920.)

This discussion relates primarily to the flow of mineral oils. The rate of flow of a liquid moving through a pipe under a gravity head is subject to the nature of the liquid—density, viscosity, and inertia being characteristics of the liquid itself, and constituting what is called the internal group of factors affecting flow. The external factors are the diameter, length and roughness of the pipe, and the gravity head. These latter are unimportant as compared to the former. The ordinary hydraulic table is of no value in working out the rate of flow of liquids which have a different density and viscosity than water. An hydraulic table is applicable only to a very special case of liquid flow: i. e., the flow of water, and because of this fact it is readily seen that the internal group of factors constitutes the main issue of the experiments which give some very interesting results. R. W. P.

Prospector's Field Book and Guide. By H. S. Osborn and M. W. von Bernewitz. Ninth edition, 1920, Henry Carey Baird & Co., Inc., New York.

The last edition of Osborn's "Prospector's Field-Book and Guide" was published in 1910. It and the previous seven editions were suitable for those times. The new ninth edition will be found suitable for the present time. While the old-time prospector will always be an important factor, the knowledge of and search for the common and rarer minerals is bringing out men who are trained to some degree. In the field they need a handy and suggestive pocket-book containing hints on prospecting—where to search and how to test—couched in simple terms.

Some idea of the scope of the ninth edition may be gained from the fact that a spirited introduction emphasizes the necessity of prospectors receiving some technical training. The chapter on preliminary instruction covers the fundamentals of a study of the earth's crust. Then follow discussions on practical mineralogy, crystallography, the value of the blowpipe in prospecting, surveying, and chemical tests in the field. Separate chapters are given to the precious and base metals, also to the non-metallic minerals. A general re-arrangement has been made, and the metals or minerals found in association are considered together.

The chapter on the non-ferrous or alloy group of minerals is entirely new, being the best information available. The section on oil has been expanded, while the subject of oil-shale is new. A new and little known, yet successful method of prospecting for gold is included, while superficial indications for copper receive full attention. The chapter on gems in the previous edition has been re-written and condensed on that subject, but to it has been added matters concerning gemstones used for industrial purposes, such as abrasives. A general chapter covers many useful minerals and salts, the old matter being amplified and brought up to date.

An important guide and suggestive aid throughout the new book are the many brief descriptions of ore deposits of all minerals occurring in scattered parts of the world. These have been abstracted carefully, and tell how certain minerals may be expected to be found. Another special feature is the lists of outfits, prices, and manipulation of the apparatus. In the appendix will be found numbers of useful tables, an explanation of the unit system of buying and selling ores, and a complete glossary of mining and mineralogical terms. R. M. K.

FINANCIAL REPORT OF THE COLORADO SCHOOL OF MINES ALUMNI ASSO-ASSOCIATION, BY THE ASSISTANT SECRETARY-TREASURER.

From June 2, 1919, to May 8, 1920.

NOTE: The fiscal year closed on May 8th because the new officers of the Association were elected on that date at the annual banquet.

	Total	Magazine	Alumni Ass'n	Credit Account	Special Fund	Capability Exchange	Salary
Receipts	$5,230.84	$3,226.11‡	$692.90†	$190.71	$353.88	$767.24	
Expenditures	4,522.62	2,128.37	495.16	92.85	404.12	127.12	1,275.00
Total Balance	$ 708.22	$1,097.74	$197.74	$ 97.86	$ 50.24*	$640.12	$1,275.00

‡ This amount includes $1,097.30 received from subscriptions and $2,128.81 from advertisements.

† $130.60 received from back accounts have been credited to the Alumni Association account.

* This loss is due to having Aller's Notes on Rapid Methods of Technical Analysis and Traphagen's Notes on Assaying printed.

$1,097.74	profit operation magazine
640.12	profit operation capability exchange.
$1,737.86	
Less salary $1,275.00	
Balance $ 462.86	Credit magazine account for year 1920-1921, revenue from subscriptions.

	Credit	Debit
Magazine	$462.86	
Alumni Association	197.74	
Credit	97.86	
Special		$50.24
	$758.46	$50.24
	50.24	
Cash on hand	$708.22	

SUMMARY.

Liabilities.		Assets.	
Titsworth Fund	$ 300.00	Liberty Bond	$ 500.00
Credit Account	97.86	Notes Outstanding, Titsworth Fund	40.00
Magazine Subscriptions	462.86	Cash Balance	708.22
Special Fund	50.24		
Alumni Association Balance	337.26		
	$1,248.22		$1,248.22

Respectfully submitted,

C. ERB WUENSCH,
Assistant Secretary-Treasurer.

Approved:
MAX W. BALL,
Treasurer.

PERSONALS

'83.

In the September issue we published a personal announcing the death of Wm. B. Milliken at Ipoh Perak, Federated Malay States. This should have read Wm. B. Middleton. Wm. B. Milliken, '93, is still very much alive. He has offices in the Mining Exchange Bldg., Denver, Colo. His son, Carl S. Milliken, was just elected Secretary of State in Colorado on the Republican ticket.

'95

Charles T. DuRell has moved from 4112 Ingomar Street, N. W., Washington, D. C., to 1740 Euclid Street, N. W., Washington, D. C.

'99.

Lester Grant, Professor of Mining at the Colorado School of Mines, has returned to Golden after a short professional trip to Flat River, Missouri.

'00.

Daniel Harrington, of the U. S. Bureau of Mines, Golden, Colo., has offices at 500 Custom House Bldg., Denver, Colo.

'04.

Hugh J. Carney has removed from Ouray to 817 N. Mesa Avenue, Montrose, Colo.

'05.

Robert McCart, Jr., of El Paso, Texas, was a visitor in Golden recently. He has been in Denver purchasing mining machinery.

'06.

George Heitz has moved from Leadville, Colo., to Los Angeles, Calif. Address Box 1197.

'07.

A. C. Norton's present address is 2544 High Street, Denver, Colo.

'08.

Maynard J. Trott has moved from Colorado Springs to 1014 Mechanic Bldg., Emporia, Kansas.

Samuel C. Sandusky has resigned his position with the Zuma Mining Co., Eureka, Utah. His present address is Salida, Colo.

'09.

Wm. J. Hamilton has resigned from the Granby Con. M., S. & Power Co., Ltd., Anyox, B. C. He is residing at 518 E. Sola Street, Santa Barbara, Calif.

'11.

Arthur L. May is with the Crichton-Curl Enamel Co., Ellwood City, Pa.

'12.

E. T. Hager, of San Luis Obispo, Calif., has moved to 807 Baker-Detweiler, Los Angeles, Calif.

Mr. and Mrs. Charles L. Harrington, of 1559 Franklin Street, Denver, Colo., announce the birth of a daughter, Virginia Lee, on October 5th.

Mr. and Mrs. Albert L. Toenges announce the arrival of Benjamin Harry on September 21st at Pittsburg, Kansas.

Donald Dyrenforth, formerly general superintendent Akron Mines, Whitepine, Colo., is now with the Dorr Co., Denver.

'13.

Harvey Matthews has gone to Red River, New Mexico, on an extensive mine examination trip.

Philip E. Noland's address is care Cla del Minerales y Metales, S. A., Monterrey, N. L., Mexico.

'14.

Lionel Brooke is superintendent of the Eureka Holly Mining Co. and the Bullwhacker Cons. Mines Co. of Eureka, Nevada.

E. A. Strong's address is 1213 Hobart Bldg., San Francisco, Calif. He is metallurgist for the Metals Exploration Co.

We have just learned the sad news that Ralph W. Smith lost his wife on October 12th at Scottsbluff, Nebraska. Mrs. Smith was only ill one week. She leaves a two-and-one-half-year-old daughter, Barbara Jane.

E. V. Graybeal is located at Miami, Ariz.

'15.

Monroe O. Carlson and Miss Hazel Eliza Curtis were married at Gunnison, Colorado, on September 22nd. They will reside at Somerset, Colorado, where Mr. Carlson is engaged in the coal mining business.

Ben C. Essig has resigned his position of field engineer with the U. S. Bureau of Mines to become superintendent of the Big Indian Copper Mine near Moab, Utah.

'16.

Jay J. Burns recently resigned from the Butte & Superior Mining Co. He is now with the Champion Mining Co., Race Track, Montana.

'17.

Lisle R. Van Burgh has been transferred from Minnett, Mont., to the Denver offices of the Frantz Corporation, 306 First National Bank Bldg. Mr. and Mrs. Van Burgh are rejoicing over the recent arrival of a baby boy.

Robert A. Thurston is at the Kirk Mine of the 4-C Co. at Cananea, Sonora, Mexica.

'18.

Roger F. White and Miss Esther L. Plimpton, of Modesto, Calif., were married in Washington, D. C., on September 30th. They will reside at 3612 McKinley Street, Chevy Chase, D. C.

'20.

Antonio D. Alvir is now at No. 5558 Drexel Avenue, Chicago, Ill.

Fred L. Serviss is with the Colorado Fuel & Iron Co. at Trinidad, Colo.

EX-MINES NOTES.

'17.

Mr. and Mrs. Chas. M. Beyrle announce the recent arrival of Beverly Ann, at Christmas, Ariz.

OBITUARY.

'07.

Thos. P. Ellis died at Alameda, Calif., on September 27th. He had been ill for a month. The end came very unexpectedly, as he was convalescing when pneumonia set in. He leaves a wife and three children. Mrs. Ellis will reside at R. F. D. 3, Box 12 G, San Diego, Calif.

SCHOOL NEWS.

Harold Crooks, Associate Professor of Geology, resigned his position on November 1st to accept a position on the geological staff of the Standard Oil Co. for services in Venezuela, South America.

He will be succeeded by James J. Lillie of Frisco, Utah, a mining geologist and graduate of the University of Utah.

Prof A. E. Bellis, recently organized a brass band amongst the School of Mines students. About twenty-five men have reported for rehearsals. The new organization gives promise of being an excellent one.

Major G. C. Dobson, who has been commander of the School of Mines reserve officers' training corps since it was organized, is leaving the army. His place here will be taken by Captain S. R. Irwin. Major Dobson will go back to civilian life to follow his old profession as a civil engineer. Captain Irwin is a graduate of West Point. During the war he served overseas with the second regiment of engineers, second division. He was badly wounded in the Chateau Thierry engagement.

Electrical Testing Facilities at the School.

The Department of Electrical Engineering of the Colorado School of Mines, in conjunction with other departments of the school, has equipment for carrying out the following tests of electrical apparatus and equipment for use in mines and mills.

1. Wires and cables: dimensions of conductor and insulation; specific resistance of conductor material; dielectric strength of insulation; continuity of insulation; effect of temperature, moisture, oils, chemicals or gases on the insulation.
2. Insulating materials: specific resistance and dielectric strength; effect of temperature, moisture, oils, chemicals, or gases on the insulating qualities of the samples.
3. Line insulators: insulation resistance; wet and dry flash-over voltages.
4. Resistors: watt capacity; current capacity; resistance; temperature coefficient of resistance.
5. (a) Primary batteries: watt and current capacities at various rates of discharge; voltage characteristics; polarization, local action, recuperation. (b) Dry cells: tests in accordance with the American Electro-chemical Society specifications for telephone service, ignition service, and intermittent lighting service.
6. Storage batteries: efficiencies at various rates of charge and discharge; weight efficiency per ampere-hour and watt-hour; voltage curves on charge and discharge; ampere-hour and watt-hour capacity; loss of charge due to standing; life of battery under specified conditions of service; recuperation after high discharge rates; internal resistance; effect of temperature on capacity and efficiency.
7. Circuit closing devices: durability; heating; current capacity; safety when operated in an atmosphere of explosive gas; effect of moisture.
8. Safety fuses; current capacity; reliability in operation; safety when used in an atmosphere of explosive gas; effect of moisture.
9. Telephones and signaling devices: electrical characteristics; reliability; effect of moisture on operation; safety when operated in an atmosphere of explosive gas.
10. Generators and motors: efficiency; regulation; resistances; rating; temperature rise; effect of moisture on insulation resistance.

Equipment.

The following equipment is available in the various departments of the school:

- Potentiometers for accurate determination of current and voltage.
- Standard cells.
- Standard resistances.
- Standards of inductance and capacity.
- A number of sensitive galvanometers.
- A wide range of voltmeters, ammeters, and wattmeters of commercial accuracy.
- 100 kva., 2300 volt 60 cycle 3-phase alternator.
- 75 kw., 230 volt 3-wire direct current generator.
- 75 kw., 120 volt twin unit direct current generator.
- 30 kva., 1100 volt 125 cycle single phase alternator.
- 5 volt, 600 ampere continuous current generator for the electrodeposition of metals.
- Transformers up to 25000 volts.
- Seventy series, shunt, compound and a. c. motors and generators of capacities 15 kw. and under.

Electrical Testing Arrangements.

Two different proposals for the use of the equipment are offered:

A. Any responsible person or organization may, with the consent of the President of the Colorado School of Mines, use the equipment by paying for the actual material, labor, power, water, expert assistance used, and depreciation. In this case the person using the plant will be responsible for the accuracy of the results obtained.

B. The professor of electrical engineering will run a test, in which case a charge equal to the cost of similar work done by a commercial testing laboratory, or by a consulting engineer, will be made.

If desired, an estimate will be made of the cost of the test previous to starting the work, but this will not be used in billing the actual charges. The department of electrical engineering will be responsible for the accuracy of the results, and will make a report to the person authorizing the test.

Material and apparatus may be shipped by express or freight directly to Golden, Colorado, all charges prepaid. Freight sent via the Colorado & Southern Railway or via the Denver & Intermountain Railway must be hauled from the railway yards to the electrical engineering laboratory at the expense of the shipper.

All details as to the responsibility of the shipper, suitable modes of making payments, handling of the shipments, nature of the test work to be carried on, the persons to whom reports are to be made, and other necessary business matters should be clearly understood as a result of correspondence or a conference before consignments of apparatus or material will be authorized.

ARLINGTON P. LITTLE,
Professor of Electrical Engineering,

METRIC SYSTEM EXPLAINED IN ONE MINUTE

A member of World Trade Club holds the world record for rapid explanation of the Metric weight measurements and the way in which they ought to be used. He does this in one minute. An objector who had never looked the matter up declared that the metric system was complex and that it would take a long time to learn it. It was then that the member of World Trade Club first undertook to explain, in one minute, all that needed to be known of metric units. He did it to the satisfaction of eminent auditors. Here is how he did it:

"Learn only the units, dollar, meter, liter, gram—dollar, the measurer of value; meter, the measure of length; liter, measure of bulk; gram, for weight. You know all about the American dollar. The metric units, meter, liter, gram, are just like dollar, divided decimally and multiplied decimally. If you want to compare metric units with present units, the meter is 10 per cent more than the yard; 500 grams is about 10 per cent more than the pound avoirdupois, the liter is 5 per cent less than the U. S. liquid quart (13 per cent less than the British liquid quart)—that is all 90 per cent need to use the metric standards."

"ACCIDENTS WILL HAPPEN."

The progress of an American Red Cross relief train was recently somewhat impeded while passing through the Balkan states by frequent collisions with cattle, which appeared to be wandering aimlessly about near the railroad track. After being awakened several times during one night the official in charge of the relief train started out on a tour of investigation, bent upon discovering if all the cows in Roumania were sleeping on the track.

Upon emerging from the train he found the carcass of a young bull lying by the track with tether ropes attached to his fore and hind legs and a peasant and the station master preparing to skin him.

The Red Cross worker called his Roumanian interpreter and demanded an explanation of the strange proceedings. He learned that the Roumanian government had passed an edict forbidding the slaughter of live stock for one year. Since there was nothing in the ukase regarding accidental slaughter, these "accidents" were common occurrence in the country.

THE PUBLIC HEALTH CRUSADE.

Acting on the principle that a large percentage of the disease of the world is preventable, a nation-wide movement is about to be inaugurated in the United States for the promotion of public health. Information will be spread by lectures given by Red Cross nurses on Chautauqua circuits, which will be followed up in the smaller communities by nursing States for the promotion of public health. Information will be spread by lectures sired, where such committees have already been established. Every assistance will be given to communities in organizing and maintaining this service.

ATHLETICS

By Ralph C. Maxwell.

Mines 3; Utah Aggies 27.

On October 16th the team played the Utah farmers at Logan, Utah, and although they were beaten by a score of 27 to 3, the trouncing was not as bad as the score would seem to indicate. The Mines clearly outplayed and outfought the lighter Utah team. The first score came about when the head linesman blew his whistle to announce off-side for both teams. The signal was given before the ball was snapped. The ball was then snapped, both teams standing upright meanwhile; the Utah half-back took the ball and ran 95 yards for a touchdown. The head linesman was evidently influenced by the presence of many Utah rooters, he reversed his decision declaring the Mines off-side and allowed the touchdown. Two of the other three scores were made by recovering fumbles, while the third was made on the recovery of a blocked punt.

Mines 0; Colorado Aggies 27.

Colorado Aggies defeated Mines 27 to 0 in a clean and well-played game before about 3,500 spectators. During the first period the Farmers had everything their way, going through the Mines' line and around their ends at will. Before the Ore Diggers could get started the Aggies had made three touchdowns, all in the first quarter. D. Hartshorn made all of them on straight line bucks. Ratekin made two of the three attempts at goal, the score standing 20 to 0 in favor of the Aggies.

The Mines held during the second quarter and kept the Aggies back from the goal. During the first half the Aggies made eight first downs to the Mines' four. Penalties were numerous, off-side plays being especially frequent. Frequent punting was resorted to by both teams during the second period. All attempts at forward passing during the first half failed.

The Aggies scored again in the third period after D. Hartshorn had intercepted a pass and carried it back twelve yards. Another pass, Scott to Bresnahan, netted ten more, and then Schultz, who had replaced D. Hartshorn, carried the ball over for a touchdown on a cross tackle buck. Ratekin kicked the goal. This ended the scoring for the game.

Later, in the third quarter, Bresnahan received a pass from Scott and carried the ball over, but it was not allowed because the Aggies were off side on the play. At this point many substitutions were made and the rest of the game was a see-saw affair. Joe Haskins caused a thrill in the last period by catching a fumbled punt and getting away for 35 yards. But two fumbles marred the game, both being made by the Aggies. The Farmers tried their Million-Dollar play but once, and it proved to be a miserable failure mainly because of the superb defense against this play. Fahey did the punting for the Mines. Linderholm, Haskins, Fahey and Robertson starred for Mines. "Big" Litheredge, who got in the game for a few minutes during the third quarter, also showed to good advantage. The absence of both Bunte and Jordan, through injuries, was keenly felt. Clark, playing half, broke his ankle in the second period and was supplanted by Robertson.

Between halves a demonstration was staged in favor of the Educational Amendment.

The lineup:

MINES		AGGIES
Linderholm	R. E.	Bresnahan
Gibbons	R. T.	Nicholls
Clough	R. G.	Bain
Hyland	C.	Meyers
Houssels	L. G.	McMichael
McGlone	L. T.	Dotson
Mitchell	L. E.	Ratekin
Poulin	Q. B.	Donaldson
Clark	L. H.	D. Hartshorn
Fahey	R. H.	F. Hartshorn
Haskins	F. B.	Scott

Mines 7; Wyoming 14.

It seems as though the jinx that has been following the Mines team all season followed them to Broadway Park on October 30th, and although the team played better football than the Wyoming contingent, they were defeated 14-7. There was a light snow falling throughout the game and the field became rather heavy towards the close of the same. The story of the game is one of all kinds of football, good, bad and indifferent. Both teams played better in the first half, but as the game neared completion some pretty poor football crept in, both teams offending about equally.

Both teams had a first-class defense against regular football, and neither team showed very much on the offense. Wyoming's first touchdown was the result of a forward pass which brought the ball to the two-yard line, where it was pushed over in two plays. The score made by the Mines was the direct result of two passes, Poulin to Jordan. Wyoming's second score was made by Layman, who caught the ball on a punt and ran through the whole Mines team for a touchdown. Both of the Wyoming scores would have been stopped had the tackling been up to standard. Linderholm, Jordan, Mitchell and Robertson played the stellar roles for the Mines team.

It seemed to many of the Mines adherents that the team got the worst of many decisions, but then all this must be considered in with the general run of the game. Mines played better football, but Wyoming got the breaks of the game.

The line-up follows:

MINES		WYOMING
Mitchell	L. E.	Hegewald
McGlone	L. T.	Neff
Hyland	L. G.	Tucker
Black	C.	Long
Gibbons	R. G.	Alers
Crawford	R. T.	Buchanan
Linderholm	R. E.	Thompson
Poulin	Q. B.	Wilson
Robertson	L. H.	Simpson
Bunte	F. B.	Fitzke
Jordan	R. H.	Layman

Officials—Crowley, referee; Bansbach, Umpire; Shafer, Head Linesman.

AGE OF WATER POWER DEVELOPMENT NEAR.

Many Developments Already Completed—The Power of Water Analyzed.

Those who look into the future with prophetic eyes predict that an age of water power is dawning. They point wisely towards the great water power developments already completed or in course of construction all over the world, from the rivers of Maine to the canyons of California; from Alaska to Argentine, and from the Kashmir Valley in India to the outlet of Victoria Nyanza in Africa. And they back up their arguments with the statement that coal will be exhausted early in the next century and that mineral oil and natural gas will vanish with the coal.

Amid all this prognosticating and arguing arises a host of questions about this water power which is to keep us from freezing in the next century, to turn the wheels of our industries, to prepare the food and to run our vehicles.

Every stream of running water, from the trout brook sporting through the farm meadows to the largest rivers, is capable of producing more or less power. A hundred years ago, when steam power was still in its infancy, water power was quite extensively developed in this country, but the steam engine, with cheap wood and coal fuel, quickly reached the practical stage, and the old "over-shot" and "under-shot" water wheels were abandoned. Up to a few years ago it was not practical to develop most water power because this power had to be utilized on the spot and very naturally the very best water falls were located in the wilderness, scores of miles away from the seaports, the railroads and the cities which needed it. But the development of the electric transformer changed all this and made it possible to transmit this energy for hundreds of miles without serious loss.

The power of water is greater than any one without experience can imagine. For many of us have, when in swimming, struck the water a sharp blow with the flat of the hand, or, when learning to dive, struck the water flat instead of head first, only to learn that the liquid offered considerable resistance.

A stream from a fireman's hose will knock a man down. The jet from a nozzle in placer mining in the west eats away a large piece of land in a day, and toys with great boulders as if they were pebbles.

Water power represents heat energy. The water is drawn up into the clouds by the heat of the sun and deposited on the distant mountains in the form of rain. This water spends this acquired energy in racing downhill, back to the sea. Water wheels are but devices to catch and utilize this energy which ordinarily is wasted on the unmoving rocks and stones. Water acts as a moving power either by its weight, which is over sixty-two pounds to the cube foot, or by its pressure or impact. The power of a fall of water is equal to the weight of its volume and the vertical height of its fall. To compute the power of falling water it is necessary to multiply the volume of flowing water in cube feet per minute by its weight, 62.5 pounds, and this product by the vertical height of the fall in feet. Thus a stream of water when flowing over a weir five feet in width by one foot in depth and having a fall of twenty feet develops 37.91 horse power.

So important is the development of water power in this country that the General Electric Company and other large electrical concerns maintain a large staff of engineers whose duties are to examine prospective water power developments for enterprising men who plan to harness the rivers and streams.

PROFESSIONAL CARDS

BEELER, HENRY C.
Mining Engineer.
229 Coronado Bldg.,
Denver, Colo.

BURLINGAME, WALTER E.
Chemist and Assayer.
1736-38 Lawrence Street,
Denver, Colo.

BUTLER, G. MONTAGUE
Mining and Geological Engineer.
Dean College of Mines and Engineering, University of Arizona, Tucson.
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CORRY, ARTHUR V.
Member Harper, Macdonald & Co.,
Mining Engineers, Butte, Mont.

DUGAN, WILLIAM F.
General Agent for Southern California.
Columbian National Life Insurance Company.
Old Line, Low Cost Life Insurance, Accident and Health Insurance.
716-718 Trust & Savings Bldg.,
Los Angeles, California.

HAMMOND, JOHN HAYS
Mining Engineer.
71 Broadway,
New York.

MILLIKEN, WILLIAM B.
Mining Engineer and Metallurgist.
709-10 Mining Exchange Bldg.,
Denver, Colo.

MONTANA LABORATORY CO.
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743 Conway Bldg., Chicago, Ill.

TAYLOR, FRANK B.
Geologist and Oil Expert.
Reports and Investigations.
Box 325, Casper, Wyo.

WALTMAN, W. D.
1215 First National Bank Bldg.,
Denver, Colo.
Phone Champa 5236.

WOLF, HARRY J.
Mining Engineer.
42 Broadway,
New York.

Office and Residence, Cor. 15th and Ford Streets
DR. PAUL MEYER
Physician
Phone Golden 21 Golden, Colorado

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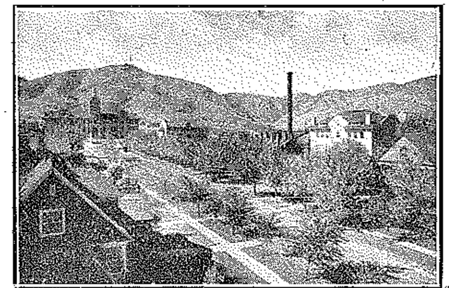

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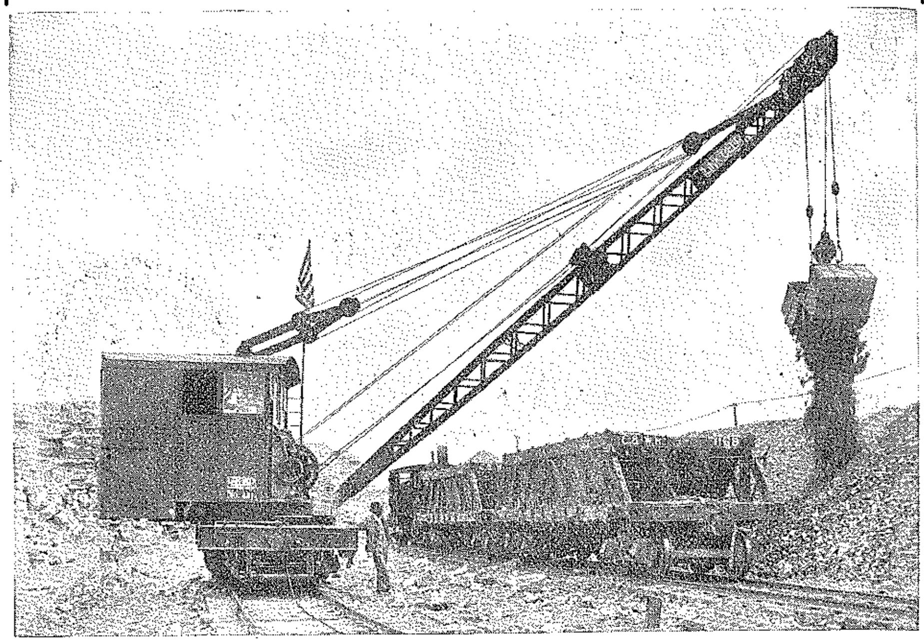

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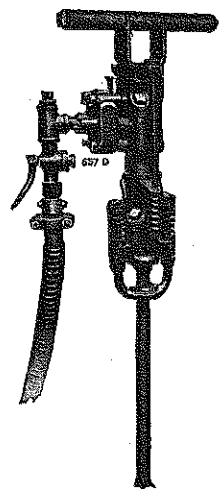

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