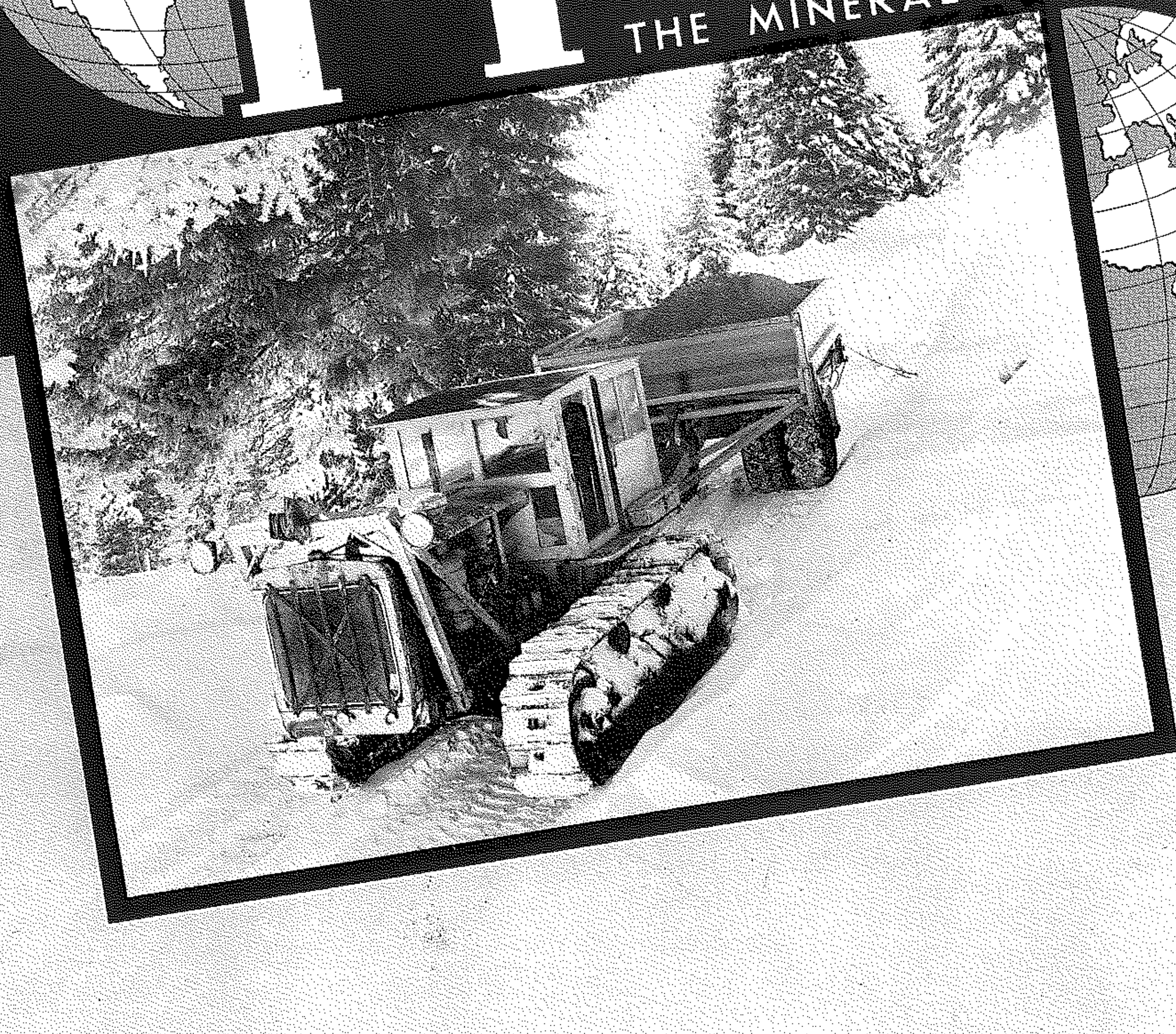
THE MINES MAGAZINE

AROUND THE WORLD WITH THE MINERAL INDUSTRIES



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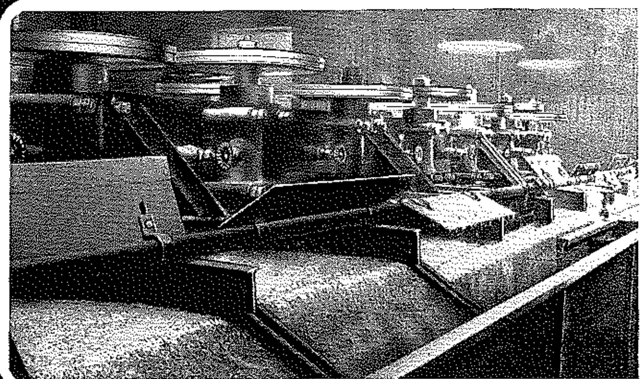

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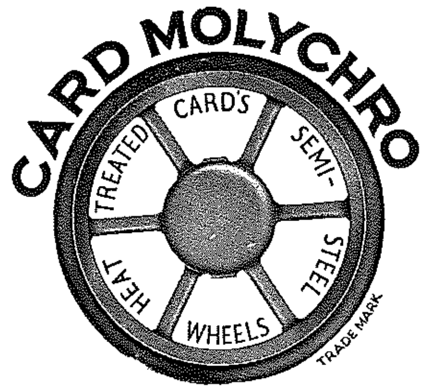

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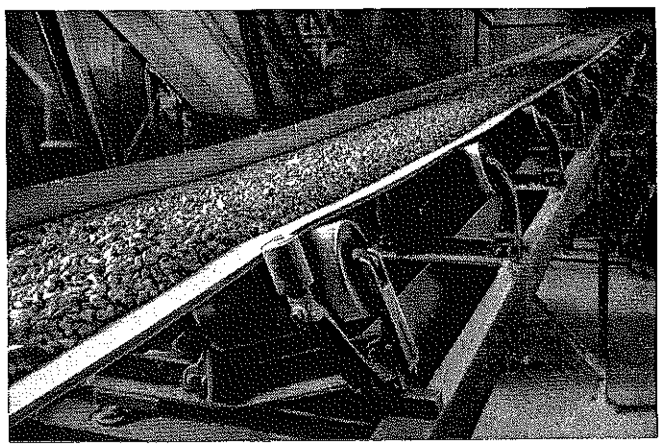

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Letters

MINES SPIRIT

From Clifton W. Livingston

Due to the mere fact that I have accepted a position as instructor in the Mining Department of the Michigan College of Mines, it appears that my copy of *Mines Magazine* has stopped coming. Have no fear, I did not intend to desert the Colorado School of Mines Alumni Association, or the principles, or the intangible thing, called "Mines Spirit."

On the contrary, may I hope to pass it on, at least in a small measure to the young men of this institution, not as *Mines Spirit,* but as the Spirit of the Mining Profession which ties us all together in a fellowship which few industries are so privileged to possess.

So, please see that my copies are forthcoming in the future.
210 East Street, Houghton, Michigan.

COMING TO A WARMER CLIME

From John C. Smith, Ex-'25

Would it be too much trouble for you fellows to note a change of address for the next few months?

Yours truly is heading for the States by plane on December 5. I'm afraid I won't be able to visit with you this time since I have a date with a new car in Detroit and with a steam radiator in New York. Maybe later on I might sneak thru Denver.

Anyhow—the new address: 2230 Vanderveer Place, Brooklyn, N. Y.

Oh, yes—Before it's too late—Merry Xmas and a swell New York. Thanx for an A-1 magazine all the past year. It's a fine job.
U. S. Smelting Refining & Mining Co., Fairbanks, Alaska.

CONGRATULATIONS

From John R. Bruggeman

Allow me to take this opportunity to congratulate you on the excellent manner in which you handled the technical article submitted by Dr. J. H. A. Brahtz and myself.

The general layout was excellent and worthy of highest praise, for as far as I have been able to ascertain there are no errors in the article. Moreover, the equations were neatly set and easily read. The high quality of paper used by your publication also adds much to the value of the article.

I also wish to commend the listing of new publications. I found a number of them interesting and have taken steps to secure copies for my files.

Let me express further the thanks of Dr. Brahtz and myself for giving space to our efforts in the Mines Magazine even though we are not alumni of the school. We will be delighted to hear from any of your readers who have any comments or questions on the article.
U. S. Bureau of Reclamation, Denver.

FOUND PETROLEUM NUMBER INTERESTING

From Robert B. Kennedy, '38

I found the Petroleum Number chock full of interesting articles and think that issues devoted mainly to one industry are of exceptional value to the men in that industry as well as to others outside of that particular line who are interested and appreciate a concise coverage to bring them up-to-date.

It may interest you to know that several of my friends in exploration departments of various oil companies eagerly await my next issue of *Mines Magazine* for the articles concerned with Geophysics. These men, graduates of Texas and Louisiana schools, are duly impressed with an alumni magazine which offers so much of interest and value to all. I can't help but swell with pride to be part (small, but, nevertheless, a part) of an organization so admired by technical men from other institutions.

A feature particularly enjoyed by these exploration and well-logging men is the Patent Service. One man here learned from Mr. Atkins' page that a patent had been issued to him on a well-logging device before he was notified of it by his own employer. That's service!

Keep up the good work on *Mines Magazine* with the knowledge that we all appreciate it and look forward to the next issue with great anticipation. Please feel free to call on me for any assistance I might give to the Association or the Magazine.
1018 Avenue F, Beaumont, Texas.

PERSONAL NOTES

B. F. Amsden, '25, who is doing consulting work in India, is being addressed at No. 10 Middleton Row, Calcutta, India.

P. A. Archibald, '35, Metallurgist in the Testing department, D. & R. G. Railway Company, has moved his residence to 745 Elizabeth Street, Denver.

John Baker, '35, Shift Boss for the Mountain City Copper Company, has joined the Army for a year's duty. He is stationed at present at Fort Belvoir, Virginia, in the Engineers' Reserve school. Mrs. Baker is visiting her parents in Golden.

James Ballard, '25, is now associated with the Seismograph Service Corporation, with headquarters in the Kennedy Building, Tulsa, Okla.

Charles N. Bellm, '34, is Lieutenant in the U. S. Army Armored Force School. His residence is 324 Park Avenue, Elizabethtown, Ky.

Charles Blomberg, '39, has been transferred into the Research department of the Phillips Petroleum Company. He is being addressed at 900 Johnstone Avenue, Bartlesville, Oklahoma.

J. B. Brown, '06, is in Mexico City where his address is in care of the American Club, Apartado 45, Bis., Mexico, D. F.

Robert Cockle, '33, Mine Engineer for the Standard Silver-Lead Mining Company, Wilborn, Montana, has received his call for service in the Army. He and Mrs. Cockle will be in Denver, however, until after the holidays where they are visiting relatives and friends. There address at present is 1235 So. Race Street, Denver.

William S. Cole, Jr., '35, Engineer for the Silver King Coalition Mines Co., Park City, Utah, is another Miner who is serving in the Army. He holds the rank of Lieutenant and is at Fort Belvoir, Virginia.

Frank J. Crane, Ex-'07, is now being addressed at Box 461, Placerville, Calif., where he is engaged in mining.

Allen S. Crowley, '39, Sales Engineer for Gardner-Denver Company, is receiving mail at present at 169 Pearson Drive, Asheville, North Carolina.

Eugene E. Davis, Ex-'29, Engineer for the Mountain States Telephone & Telegraph Co., is stationed at Bozeman, Montana.

Steven S. Dettman, '31, has a new mailing address, 714 23rd Street, Sacramento, California.

Gerrit DeVries, '40, is employed by the U. S. Bureau of Mines as a Junior Engineer. His mailing address is 1006 Elm Street, Rolla, Missouri.

Mark Ehle, '01, who has been Professor of Mining at the University of Arizona for the past 23 years, has been appointed professor emeritus of that department and also mining engineer emeritus of the Arizona Bureau of Mines. Upon his graduation from *Mines* he served four years as city engineer of Arcadia, California. He then became a member of the faculty of South Dakota School of Mines which position he held for 12 years, going from there to the University of Arizona. He receives mail through Box 4753, University Station, Tucson, Arizona.

John B. English, '40, has been transferred from the District laboratory of the American Steel & Wire Company to the Hot Mills, Cuyahoga Works. He is metallurgical apprentice with the company. He resides at 1826 Crawford Road, Cleveland, Ohio.

John A. Fagnant, '37, Engineer for Allis-Chalmers Manufacturing Co., has a change of residence address to 1715 South 53rd Street, Milwaukee, Wisconsin.

Arthur E. Falvey, '34, recently accepted a position as Compliance Officer for the U. S. Bituminous Coal Division which calls for traveling quite a bit, his territory being southern and western Wyoming. Idaho Springs, Colorado is his permanent address from where mail will be forwarded.

Thomas G. Foulkes, '22, M.Sc. '23, is the newly elected President of the Engineers' Club of the Lehigh Valley. He became a member of the club in 1929 since which time he has taken an active interest in its affairs. He has served on the Board of Managers, as chairman of the Membership Committee and as Vice-President and also editor of the Club Bulletin.

Mr. Foulkes, a native of Ohio, attended Ohio State University and Miami University before coming to *Mines*. Since his graduation he has been employed by the Bethlehem Steel Company, first in the Open Hearth department, then was transferred to the Metallurgical department, where he is now Assistant to Engineer of Tests. His home is at 531 Linden Street, Bethlehem, Penna.

E. H. Frenzell, '21, Equipment Engineer, Grazing Service, Department of the Interior, who has been located in Washington, D. C., has been transferred to California, where his address is 305 West Olive Avenue, Redlands.

T. E. Giggey, '34, Sales Engineer for Ingersoll-Rand Company, has a new mailing address, Box 1149, Prescott, Arizona.

Merle L. Gilbreath, '33, is also on active duty in the Army and has been sent to Fort Belvoir, Virginia to take the 1st Instructor's course.

Donald W. Gunther, '39, who is in the Training Course of Westinghouse Electric and Manufacturing Co., has recently moved his residence to 427 Rebecca Street, Wilkinsburg, Penna.

Robert N. Hastings, '30, Engineer for Stanolind Oil & Gas Company, formerly of Tulsa, has been transferred to Midwest, Wyoming.

Jack Kelly, '40, underwent an emergency appendectomy at St. Anthony's hospital, Denver, recently from which he is now recovering nicely. Since his graduation he has been employed by the Gates Rubber Company. His mailing address is 472 So. Logan St., Denver.

Karl G. Link, '08, is Mine Superintendent for the U. S. Vanadium Corporation at Bishop, California.

Russell P. Luke, '14, Resident Manager, South American Development Company, Ecuador, is now in the States where he is being addressed North Campo Road, Westport, Conn.

Andrew J. Kizzor, '38, is attending the Boeing School of Aeronautics at the Oakland Airport. The regular course, known as the Airline Technician Course, and lasting for 9 months, is open to graduates of accredited engineering colleges with engineering degrees. The course is designed, primarily, for persons who wish to go into the aeronautical field. Mr. Kizzor is being addressed at 2105 San Antonio, Alameda, Calif.

Charles C. Michaels, '35, is Engineer for the Barber Asphalt Company, at Craig, Colorado.

James H. Munro, '39, in the Seismograph

(Continued on page 658)

PRIZE WINNER

C. O. Reiser, '38, is the second annual prize winner to note the most errors in one issue of *Mines Magazine*. He listed 28 in the October number but only 20 of them could be counted.

This is an easy way to earn $3.00 (one year's subscription to the Magazine free to the person noting the greatest number of errors in any one issue) so the rest of you readers had better get busy and send in your lists.

The Mines Magazine

VOLUME XXX DECEMBER, 1940 NO. 12

Contents

Departments

Front Cover

"Caterpillar" Diesel D-8 tractor operating in high altitude hauling ore from the mine to the mill, a distance of 1½ miles. Average load 14 to 18 tons. 1½ mile haul takes 2 hours round trip. Lumber and supplies are hauled on back trip. 1200 feet difference in elevation. The snow is cleared from the road with a bulldozer when necessary.

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THOMAS B. CROWE

THOMAS BENNETT CROWE, one of the greatest of "Mines Men" passed away the morning of November 13th at the Palo Alto Hospital, after an illness of four weeks. Tom Crowe, as he was known by his friends and schoolmates, was a Mines Man through and through. He glorified in the good old school and was interested in its progress and in the men it graduated.

Tom was a man beloved by everyone who knew him, both young and old. He was great, not only in his accomplishments and success, but also in his capacity to understand people. He was kind and warm and genuine—so generous and thoughtful and humane. As one of the outstanding metallurgical authorities of his day, he was called upon repeatedly to recommend technical men for positions of responsibility in connection with the milling of metalliferous ores. His understanding of human nature was so good and his judgment of a man's ability was so perfect that he usually picked the right man for the job. He took a keen delight in recommending a man for a better position with more responsibility. He was a loyal friend and was always delighted with the success of those with whom he came in contact.

Tom Crowe was born in Emporia, Kansas, September 6, 1876. He was graduated from the Colorado School of Mines in the class of 1900. His first job after graduation was with the Ophelia Tunnel in Cripple Creek, Colorado. Two years later he became assayer and chemist for the Portland Gold Mining Co. The assignment with this company furnished the opportunity for the development of his genius as a cyanide expert. As soon as his ability became apparent he was assigned to metallurgical research, which resulted in marked improvements in the milling practice at the Portland mill of which he became superintendent. His method of crushing and grinding ores brought him recognition among mill men immediately but his great achievement with the Portland was a new method for precipitating gold from cyanide solutions. This method was patented. He extracted the oxygen from the cyanide solution which permitted him to save practically all of the gold even on a very low grade solution. It was said that this invention saved the Portland Gold Mining Company $30,000 a year. Under his management, costs in all departments of the Portland mill were reduced and the efficiency was increased. The Portland was soon recognized as the best operated cyanide plant in the world and Tom Crowe became an authority on cyanidization.

In 1922 he became associated with the Merrill Company of San Francisco and his genius as a cyanide expert and inventor found a larger field for expansion. He made his residence at Palo Alto, California.

He was inventor and co-inventor of many patents in the United States and foreign countries, for metallurgical processes and apparatus. The Crowe Vacuum Process and the Merrill-Crowe precipitation processes are used in cyanide plants throughout the world. His contributions to the advancement of milling metalliferous ores assures him a place in the Metallurgical Hall of Fame. His accomplishments make him one of the greatest of the mining men who have had the honor of graduating from the Colorado School of Mines.

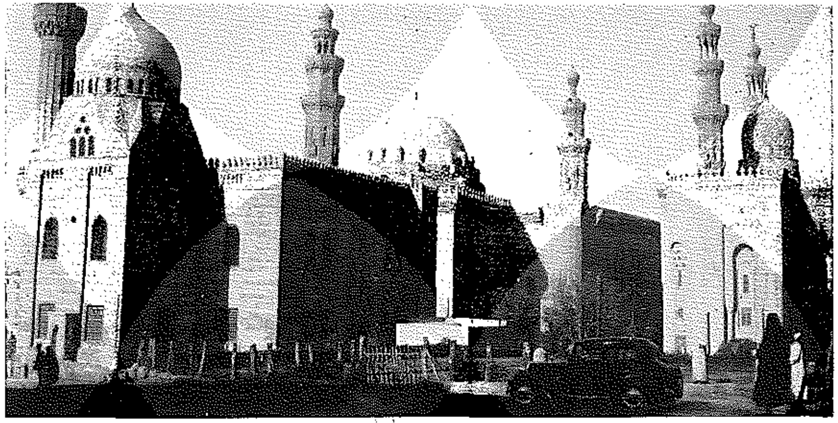
In October 1901 Mr. Crowe was married to Blanche Stonehouse at Cripple Creek, Colorado. This was when he was foreman of the Ophelia Tunnel. He is survived by his widow; a sister, Mrs. Laura Mosley of Colorado Springs, Colorado; a niece, Mrs. Louise S. Zuncich, Palo Alto, California; and a brother, Geo. F. Crowe, Canon City, Colorado. He was a member of the Masonic Lodge at Victor, Colorado, and of the Royal Arch Chapter of Free and Accepted Masons at Cripple Creek, Colorado.

THE LAND OF THE PHARAOHS

By

GEORGE B. SOMERS, D.Sc., '30

Socony-Vacuum Oil Co.
62 Sharia Ibrahim Pasha
Cairo, Egypt



Sultan Hassan and Rifai mosques.

In the first article about this trip called "The Pilgrimage to Egypt,"* I described the voyage from New York, my arrival in Alexandria, the trip to Cairo, and a few of my first impressions. Unlike the series of twelve yarns written about different phases of the sights seen by the first Magnolia Expeditionary Force while doing seismic work in Germany, this series will tell about things as they happen, or are seen without any attempt to keep similar subjects together. The difference in style is due to the fact that the first series was written chiefly after the work was finished whereas this series will be written while the work is progressing.

Selecting a Place to Live

The most important thing to do here first is to find a place to stay. The best hotel, and the one probably thought of when Cairo is mentioned, is Shepherds. Unfortunately with a war on there is practically no tourist trade here and Shepherds just naturally closed down to await the collapse of our trouble making friend Adolf. The gay hotel at present is probably the Continental-Savoy but for that very reason it isn't the best place to stay for more than a few days as it is said to be too noisy and I can well believe it. The company put me up at the Carlton, which is a somewhat smaller, clean, family style hotel that is much quieter than many of the others. Its office is on the first floor of what we would call a nine story building,—European style, they say eight and fail to count the first one. The rooms and dining salon are on the sixth and seventh floors, the remainder of the building being occupied by I know not what.

* *Mines Magazine*, July 1940.

The elevator service tho is very nice,—there are two cages which you ring for and operate yourself. Lights show you whether they are in use or not and which way they are going, and traffic usually isn't so heavy but what one at least is available. Of course the numbers and names on the indicator board are in French but one quickly learns that "Rez de Chaussee" stands for Main Floor even if they never studied Froggy lingo before.

My room was on the sixth floor (seventh to us), and was a very nice one with shower bath and a gadget or two apparently considered by Europeans to be essential to hotel bed rooms,—at least I've seen them in France, Holland, Germany, and Egypt so provided at the best hotels. The windows tho open like doors and have no arrangement for fastening them to make them stay open;—as Cairo is quite windy at times one must concoct a window fastener; why the maker didn't I don't know. The dining room is on the seventh floor and has French cuisine. The head waiter was an Austrian who spoke English with a French accent but he disappeared one day and we heard he had been "concentrated." I know not the nationality of his successor but he might be almost anything. The waiters are Egyptians and wear the fez, white nightshirt, and a red or green belly band or broad belt. The menus are written in French, and the food, tho pretty good runs to a string of rather odd, fancy foods to an American appetite. From a dietetic standpoint the ration is a trifle unbalanced.

For some reason or other I had never heard of, or seen a vegetable called a "Vegetable Marrow" until this trip. I read of it first in an English detective story on the boat, and a few days later got some with my meal. Here in Cairo I've eaten a lot of marrows—they really are all right. Spinach comes on the table served in European style—sort of ground up and hash like—it is much better that way than it is as served in the States and I can really eat it without much trouble tho I still can't say I like it.

The hotel staff is rather international for besides the nationalities already mentioned the head porters are Greek, the telephone girl and chambermaid on my floor are Czech and some more might be anything. The guests that I know of have been English, American, French, Spanish, Swedish, Hungarian, Canadian, and Italian. There have also been some unguessable ones.

After one gets acquainted it is possible to get room and board at a good Pension or sort of boarding house for less than one pays at the hotel, and many live that way altho it has its disadvantages as well as advantages. It is also possible under normal conditions to obtain unfurnished apartments, furnish them, hire a cook and servants and really lead the life of Reilly if you know you are going to stay any length of time. The big problem tho is eating and one must always be very careful. All kinds of stomach and intestinal disorders come from eating fruit that wasn't thoroly washed, raw vegetables, etc. In fact the general rule is to eat no fruit or vegetable raw unless it can be peeled. Usually newcomers do not take this rule seriously at first and as a result suffer from a malady slangily called Egyptian tummy,—it is actually an intestinal trouble.

Our Office

Next comes the office. The main Socony-Vacuum office is at 62 Sharia Ibrahim Pasha but the production department where I work is at 66 on the same street altho all mail is handled at 62. The building (66) is an old converted palace but does very nicely and is quite comfortable. There is one self operating elevator that goes up only, with passengers,—after you

▼ El Azhar University Mosque. Oldest university in the world that is still operating.

get out and close all doors it returns to the first floor and can't be called back,—you walk downstairs. Fortunately we are only on what we call the third floor. Most of the main stems are American, but Hungary, Greece, Italy, Egypt, and possibly other countries are represented by the men, and the stenographers are English, Austrian, Jewish, and Egyptians of Armenian stock. Their typewriters look like American makes but have an English keyboard with £ instead of $ and no # sign.

Office hours in winter are from 8:30 A.M. to 1:00 P.M. for six days, and also from 4:00 to 6:00 P.M. every day but Saturday. In summer they work straight thru until 2:00 P.M. and then take off. It is an old Egyptian custom but gives plenty of time for lunch and a nap, as everything closes and you can't do much during the interval.

Supper doesn't come until 7:30 P.M. so there is time to clean up,—or else you can go to a six-thirty movie and eat later.

Cairo a Cosmopolitan City

Cairo is said to be one of the most cosmopolitan cities in the world and I can well believe it as sooner or later you run into every race or nationality or mixtures thereof. There is a large Italian colony, many Greeks, some French, a lot of Jews, quite a few Hindus, a host of Arabs and Egyptians, Turks, Persians, Sudanese, Nubians, etc. There are many more English than Americans without counting the swarms of Tommies, Kilties, Sikhs, New Zealanders, R. A. F. men, etc. Most of the Germans and Austrians have been chased off or temporarily laid on the shelf. As a sample of the mixture here I have already told of the office force and hotel staff. Another illustration is the Kodak store where I have my films developed. The manager is a Russian, born in Egypt; his assistant is a French girl, born in Algeria; and the roustabout is an Egyptian with a strong trace of Nubian.

The next thing to do is get a guide book and map of Cairo, in addition to which I also bought a History of Egypt and a book describing the chief antiquities to see and where to find them. As a stranger you'll be hounded at every turn by native guides or Dragomen all of whom speak a little English. They are a big help at first, if you get a good one, but they have lots of petty grafts as I'll relate later, and after a few trips you learn to do without them.

Egyptian Museum

My first trip was to the Egyptian Museum and it was all over entirely too soon,—expect to go back for a few more looks after I've soaked up some of the other principal sights. It occupies a huge building with two floors devoted to exhibits of ancient Egypt. They being with the pre-Dynastic times when Egypt went thru the old and new stone ages like all other countries and end up, I think, about the time of the last Dynasty. Their civilization blossomed almost overnight with the arrival of what we called for convenience the First Dynasty, and reached its peak about the eighteenth thru the twentieth, I believe. Unfortunately, the Rosetta stone which proved to be the key to the hieroglyphics is in the London Museum and only a reproduction is here but it is an interesting sight for all that.

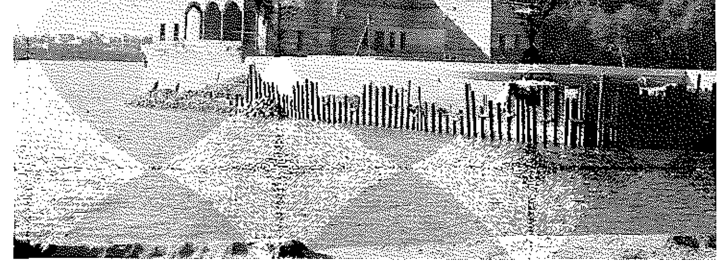
The first exhibit is a beautiful silver sarcophagus found less than a year ago, and the only large silver one ever found—it sure is a beauty. Then come huge statues, sarcophagi, pillars, samples of tombs, etc.,—it would take an enormous volume to begin to describe them. Finally one climbs the stairs leading to the second floor, stops to examine samples of papyrus that are beautifully preserved, and suddenly bursts upon the Tutankhamen exhibit. King Tut himself is back at Luxor in his own tomb in the Valley of the Kings but his golden casket and outer boxes (there must have been from five to seven all told) are here. Wonderful jewelry, chariots, beds, boxes, etc., abound. Eventually you will get thru and go to the jewel room where ornaments from all dynasties are on display. Of course these ornaments are far different from modern ones as they depended on color and design in those days rather than on glitter as we do now but the old boys knew their stuff.

Then you wander and wander and see caskets and sarcophagi or whatever they are of all kinds, ages, sorts, and descriptions, large and small statues made of different materials, and innumerable sets of four bottles or jugs containing the heart, viscera, etc., of the mummies. There is also pottery, old cloth, toys, food, grains, etc., but all mummies themselves are wrapped so you can't see them. I wanted to see one to find out just how good a job they did of mummifying but all mummies were hidden away from tourists' eyes quite a few years ago so I will have to rely on memory as to how one looked I saw in a museum in my prehistoric youth. Four hours at a time is about all you can absorb of Egyptology and that is just time enough for one good gallop thru the museum. Now that I know where to find things I'll go back later and do the place more thoroly in sections.

The Pyramids

The usual trip from Cairo is to the pyramids of Gizeh and it is a grand trip to take. It is about ten kilometers from Cairo and you can go there by auto, hack, or street car, depending on your haste or pocketbook,—I was taken once by auto and went once by street car,—will probably go by street car the third time. Eventually you land near the pyramids and from there you can either walk or ride a camel or jackass,—I chose the camel but will walk next time as it isn't far. If I were a camel I'd either stay up or down,—getting up and down the way they do is too much of a good thing. Am not sure but believe the hind end starts up and gets part way,—then the front end goes up and finally the back end gets where it belongs. Maybe it is just the other way around for I was too busy snapping back and forth and holding on to be sure but believe I have it right. They also go down in three stages and it is always a question of whether to go down with them or take a short cut. My dragoman rode a jack but I had ridden lots of jacks in Colombia, Honduras and western United States and hadn't ridden a camel since I was a tiny youngster and rode one at a zoo,—so I chose the camel.

We passed right by the pyramids and went on to the sphinx. The funny thing about the pyramids is that they don't impress you until you get close to them for they are backed only by the skyline and you have nothing to compare their size with. Once there by them tho they appear enormous—Cheops is roughly two and a half ordinary city blocks long at the base a fine grained beautiful limestone or marble but most of it has been removed to be used elsewhere and only big rough blocks of limestone and some granite remain. The pyramids have, therefore, shrunk a little in size since they were first made, with Cheops for example some thirty or thirty-five feet lower than it was originally. There is enough rock left tho to build a good sized town.



▼Island (Roda) where Moses was found in the bullrushes. The Nilometer is in the foreground but doesn't show.

The sphinx has been uncovered so that paws and all show but they claim it was more impressive covered up. It isn't as large as pictures of it indicate for it is usually photographed with the pyramids for a background and perspective and the camera does the rest. We then went thru the rather recently discovered Temple of the Sphinx and saw huge granite blocks up to eighteen or twenty feet in length by four by six feet in width and height, fitted perfectly together,—getting them like that was a job. They are still digging and excavating all around here and may dig up something new any day.

Then I went to Cheops and made the trip thru it. One enters by a new opening made by vandals and climbs up a few steps to the old entrance level, then thru a low steeply inclined passageway to a high, also steeply inclined hall or room. Here you can see how the casket was pulled and pushed up a ramp until it finally reached the burial chamber. Cheops' old stone sarcophagus, not quite finished, is there so he may have been buried elsewhere as his mummy wasn't found here by the last to enter recently,—either that or he was stolen by some one who entered long ago. At the base of the big inclined gallery a passageway leads back to the Queens chamber. There is also a small passageway near the entrance that leads downward but it is closed at present, —there are also five rooms above the Kings chamber to relieve the weight, that no one climbs up to unless they have to. It is a lot of fun tho to go thru the pyramid,—maybe some day I'll try climbing outside to the top.

Near the pyramids is the Mena House or place where you can live or get fine meals that I understand cost plenty. I was invited to a champagne breakfast there Xmas morning and enjoyed the novelty very much.

Here would be a good place to give the low down on the dragomen or guides who naturally are out to make all they can. First they have a fee which can be cut a little by bargaining altho they show you an official book with scale of prices first. They also expect a small tip or "backsheesh" as it is called here. If you go by auto or gharry (horse drawn hack) they'll arrange that and pay the bill as you can't speak Arabic. Naturally, they get it for less than they charge you. Then my dragoman paid the bills as we went along but his mathematics was poor altho always in his favor for a couple of piasters when it came to settling up,—he could also think of places where he had paid out something altho I hadn't seen him do so. Then sooner or later he will take you to a bazaar and want you to buy. The prices asked there are enormous and they expect to knock off fifty per cent to make a sale so you will think you are getting a bargain. The dragoman tho gets you outside and tells you he can get it for you for sixty per cent of what they ask so that gives him a nice cut. I got my dragoman to buy me some big oranges one day and he got me seven for five piasters. I went by myself and got ten so he made a little there. I understand our expression "got gypped" came from here as an "e" in front and a "t" for the final "p" makes it fit the bill. Even then prices will seem cheap to you.

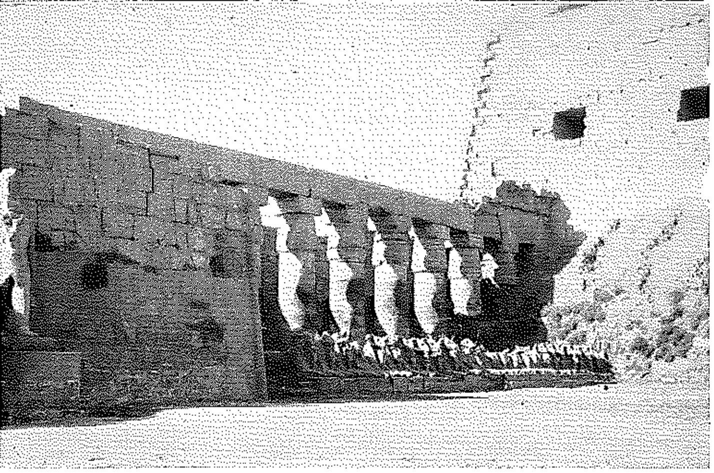
Citadel Trip

The Citadel trip is one of the usual things to do and, to say the least, it is very interesting. It really takes all day if you take in the Tomb of the Khedive, Tombs of the Mamelukes, City of the Dead, etc., but I left that part of it for a future excursion. We, my dragoman and I, took a gharry and before long were at the Sultan Hassan mosque. Across the street is the Rifai mosque, also called the Coronation mosque, which is quite new and fine but it takes a permit to enter there and I didn't have one.

The Sultan Hassan mosque is supposed to be the finer of the two and I must admit it is an impressive place. When entering a mosque you must either go in bare footed, in stocking feet, or rent a special pair of slippers to go on over your shoes,—I rented slippers one of which came off as I walked around and caused much consternation. Fortunately I managed to stand on one leg like a stork until the damage could be repaired so that no harm was done. I haven't been able to find out exactly the reason for the removal of all shoes but it is done partly at least for protection and cleanliness of the floors and fine rugs thereon tho it may also have some religious significance. I've been in two mosques since that had dirt floors where I could keep my shoes as were but one of these mosques was undergoing repairs, and the other is used only once a year, so again nothing is proven.

After being "resoled" we passed thru a corridor into a central open patio in the middle of which is the washing font where they wash before they pray. Opening out from this patio are four covered wings in one of which is the platform for the Koran reader. Behind it is the pulpit or Minbar and to the left of the Minbar is the Kibla or niche, which by the way is always on the side toward Mecca. All the faithful have to do when ready to pray is to head in the direction of the Kibla, kneel and they are all set,—for they must head right. Mosques of course differ from churches in having a minaret where a man called the muezzin calls the Moslems to prayer about five times daily. In this mosque numerous chains hang from the roof in each of the four wings to support lights of former days. I walked thru a gap under the pulpit, starting with the right foot, and said "Good Luck" with each of the first three steps. This brought me out to the niche or Kibla and from there we went to another room where the tomb of Sultan Hassan is located. Some think he isn't there as he was pretty mean and it is claimed by some he was tortured to death and his body done away with. The inside of the mosque is nicely fixed up and there are fine rugs on the floors.

Next we drove to the Citadel which was an old fort built by Saladin that is now used as a barracks for troops. Here we went first to visit the Mohammed Ali mosque and palace. The former is known as the Alabaster mosque as it is built of white alabaster inside and out and is certainly a beauty. Inside there is the courtyard with the washing fountain and from it one enters the mosque proper. The



▼ Temple of Karnak near Luxor.

windows are of beautiful colored glass and fine large rugs cover the entire floor. The space above ones head is filled with what at first looks to be a myriad of goldfish bowls but which turn out to be covers for the electric lights hanging by chains from the roof. When the lights are all turned on it is said to be a wonderful sight which I missed as they are not turned on very often.

We then went outside and saw where the Mamelukes were slaughtered between two walls, and also went thru Mohammed Ali's old palace which is in a bad state of repair now but which must have been a lulu in its time. From here we could see the City of the Dead which is a cemetery built like a town where the relatives come several times a year and eat and sleep with their dead. It was near here that Amin Bey made his fabled escape by jumping his horse over the wall. My guide book says if you have imagination enough you can see where the horses hoofs were driven into the rock below when he landed but I didn't have that much imagination especially so as it also said that Amin Bey wasn't there at all but had heard of the coming massacre of the Mamelukes and fled to safety in Syria. You can pay your money and take your choice.

It was here also that the Holy Man (Arabian) of the mosque insisted on telling my fortune (for a price). First I had to give him a silver coin which he buried in the sand. Next came a rigamarole of measuring my hand and laying these measurements out geometrically above the buried coin. Little by little came the fortune—he had a good gift of gab and a hot line but I'm not supposed to tell it or else it will come out contrarywise. It wasn't such a bad racket he had at that only at present there are not many suckers around.

The "Old" mosque close by was undergoing repairs but we stopped in to see what it looked like. It ought to look better when it gets fixed up.

From here (still in the Citadel) we went to Joseph's well which is supposed to refer to Saladin whose name was Yusef (Joseph) rather than to the biblical Joseph. It is quite a sight for it is a hundred and twenty-five feet down to the water, and one goes down by a ramp which is built in the rock around a large main open shaft. On the shaft side are windows cut in the rock but you carry a candle to be sure of enough light. I saw traces of stairs but they were so filled with dirt that they resembled a plain incline. The water is supposed to come from the Nile and the well could furnish water in the old days to the besieged if necessary.

Then our gharry drove us thru some old narrow, winding, smelly streets lined with small shops, and everywhere a swarm of humanity milling around, to an old section of the city wall with a large gate in it. Only sections of the wall remain here and there but it is an interesting sight to see. From here we went to the "Blue Tile" mosque, so named because as the name implies the inside is lined with blue tiles about the size of those I brought back from Delft in Holland. In the patio in the center is a large palm tree and some other shrubs,—it is the only sort of garden I ever saw in a mosque. Naturally before getting home my dragoman had to take me to the bazaar called "Khan el Khalil" or "Mousky" and in so doing went by the El Azhar mosque and University which is the oldest one in existence. Work was started on it in 970 and finished in 973. Today it is the center of Islamic teaching and literature altho much smaller than it was in 1912 when at its peak due to six other institutions having opened up in Egypt. When at its peak it had 15,000 students and 600 teachers.

The Khan el Khalil is the famous bazaar of Cairo and is certainly an interesting place to wander thru. I wasn't sucker enough to bargain against the combination of dragoman and Jewish owner so I just looked around and promised to return,—it is a wonderful place to buy souvenirs. Situated in an old part of Cairo it consists of a host of little rabbit warrens lined with shops. The owners stand in front like ghouls and literally grab you as you go by imploring you to just go in for one look. You can get rugs, ancient and modern jewelry, gold, silver, and brass work, bracelets, perfume, and millions of other things. You are always invited to drink coffee and then if you want to buy the haggling begins. They expect to end up getting fifty per cent of the original asking price so stay with them and hang on. I don't like the method but it is a good place to learn to bargain.

Old Cairo

Another interesting trip is to go to Old Cairo but here my dragoman fell down badly on me for he didn't begin to show me all the places. Nevertheless we took a street car and finally reached our destination which was by the Nile near an island where Moses was "found" in the bullrushes,—at least that was the story the princess told and actually got away with. There are no bullrushes now as they didn't want it to happen again, but instead there is a Nilometer or gauge for registering the water in flood time. From here we went to visit an old Coptic church either 800 years old or built in 800. Inside were twelve pillars each of which had an apostle's picture painted on it but the paintings were beginning to show their age. Eleven of the pillars were alike and quite ornate but the twelfth representing Judas was rough and crude and looked as tho it had been stuck there until they could get a better one. There was a lot of ancient fancy wood carving on a partition or screen, and also an old crypt in the basement they claimed was an old building or site of an old building where Mary and family or maybe Jesus were supposed to have taken refuge for three months. This crypt gets flooded by the Nile every year, and shows the water marks around the walls and on the pillars.

My dragoman then took me to an old synagog built on a spot Moses had visited. Here I found that in order to show respect I had to leave my hat on which was a new wrinkle to me but I'm not too old yet to learn. Here they had a lot of old relics but the interesting sight was rolls of deerskin covered with Hebrew characters one of which was said to be the oldest extant story of Esther. The guide from the synagog informed me that there were three unsolved mysteries about these rolls or books: first, what material was used for the ink to make it last and remain so perfect looking; second, what was used to color it; and third, how were the characters so perfectly made when the art of printing was unknown.

Next we wandered down to the mosque of Amr (built in 643) which is the oldest one in Cairo, and except pers or bare feet were not required as the inner court is paved only by the ground itself. Services are held here once a year. Near the entrance door are two posts quite close together called "The Needles Eye." Legend says that if a man proclaims his truthfulness and wants to prove it he can try to pass between the posts but that if he fails to do so he is branded forever as a liar. I didn't try the test for P. T. Barnum's human skeleton could not have gone between them so what chance had I. There is also a stone post here with marks on it supposedly put there with a whip when the post refused to leave Mecca to go to Cairo, and had to be lashed to make it change its mind. I'm telling these stories for what they are worth and as I heard them without vouching for their authenticity or truthfulness.

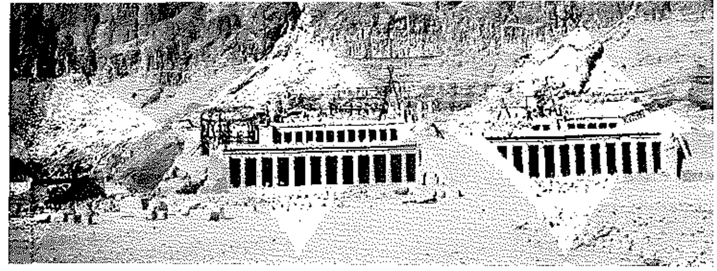
And that was all I saw in the vicinity. There are two more Coptic churches and the Coptic museum, also an old Greek church so I'll have to go back,—but without the dragoman.

Geological Museum and Wax Museum of Egyptian History

Much to my guide's disgust I went alone on my next trip which sounded minor to him but which was very enjoyable to me. I started out on foot and went to the Geological Museum where I saw collections of Egyptian fossils, rocks and ores. Picked up a number of ideas, particularly on desert geology and vertebrate paleontology, and saw some interesting sights. Then I wandered on until I came to a Wax museum of Egyptian history and went thru it. Have found no one since then who knew there was such a place in Cairo. There were very life-like exhibits of a ship showing the landing of some French including the Empress Eugenie, a wedding scene, a fortune teller in a bazaar, an Egyptian bathroom, a street group eating, a harem, the present king and his father, Solomon ordering the baby cut in two so as to find out which woman was its mother, the finding of Moses, a dope fiends dream (it was a honey), an ancient scene with Tutankhamen, Cleo calling for her asp, and a poor starving woman's cottage. Afterward I wandered past the various government buildings, and finally reached the Royal Palace or Abdin Palace as my map calls it. It covers a lot of ground and makes a good eyeful from the outside,—the guards wore black uniforms with lots of bright red trimming.

Incidental Trips

Before taking up any more tours I'll ramble along about some stray odds and ends while they are still on my mind. There are a lot of autos here and most of them are large ones altho gasoline is around thirty cents a gallon. Practically all of the cars are of American makes with Fords, Chevys, Buicks, Packards, Lincoln Zephyrs and some Studebakers apparently in the lead. I've seen a few small English flit-abouts (Morrises, Austins, etc.) and a Rolls-Royce as well as quite a few diminutive Italian Fiats, also an occasional German car and a French Renault. They tell me you can get pretty fair service on them but that desert work is hard on cars and the sand soon cuts them badly. A Swede working for Socony-Vacuum came from the field one day in a sandstorm and it cost him between sixty and seventy dollars to put his car back in shape (externally). The paint was gone and windshield so badly scratched up by the sand blast it had to be replaced as he couldn't see well thru it. Traffic tho is a problem and chronic horn blowers would find this place a veritable Heaven as you can't go far in town without constant horn blowing. The natives are not traffic minded so walk anywhere, streets or sidewalks, jaywalk when they want to, do not apparently know their left hand from their right or at least even when walking they are as apt to pass on one side as the other, and make little or no attempt to get out of a car's way,—in fact they deliberately step in front of them and cars have to stop or have an accident. So far as can be seen they are not traffic conscious and driving must be a nightmare—to date I haven't tried it. Thus far I have gone chiefly shanks mare and that is bad enough for I feel sometimes the filling up of sidewalk space and dodging left and right is a deliberate attempt to annoy foreigners. Have had a lot of fun tho while walking, by just lowering a shoulder and continuing in my proper place,—my bulk generally holds the road and they dodge—two can play at that game of road hog.



▼Deir-el-Bahari near Thebes (now known as Luxor).

The streets are narrow and winding and seldom go where you expect them to,—they are also pretty well congested with pushcarts, horse drawn vehicles, bicycles, pedestrians, a few autos, goats and what have you. Sidewalk cafes are fairly numerous and if business is flourishing pedestrians must take to the streets. I remember one cafe in particular that had a row of tables along the wall and another row by the curb, (it was a fairly broad walk for a change), which left just a narrow one-man passageway for traffic in between. In that narrow space, right near the corner, sat three men who blocked it entirely and it was a case of take to the street or else. I hope they were enjoying themselves.

Cairo has a flock of Midans or circles where a number of streets meet. After you learn the names of the different ones it is easy for someone to tell you how to go somewhere—also people who drive here say they are convenient when you are going some place. I've seen many circles before but one always had to circle them to get anywhere. Have watched them here and they plow right across, turn left or right, press on the horn button and hope they don't hit or get hit.

Street cars are prevalent and run at frequent intervals. Usually there is a car and trailer the former being part first class and part second class,—the trailer is always second class or half price. I can't see much difference and have traveled both ways, but "face" means a lot here in the East and many who ride second class will go out of their way to go thru the first class part to get off so if any friend sees them he'll think they are traveling in style. The fare in town is roughly four cents for first class and two for second altho it varies with the distance you travel. You get a ticket showing what you paid and where it is good to and inspectors board the car every so often to check up. The signs with numbers showing where the cars go are in both English and Arabic so that one can quickly learn the Arabic numerals.

There are two English newspapers published here, the Gazette and Egyptian Mail. Englishmen prefer the former, Americans the latter altho they must read the Gazette Monday because the Mail is a six day paper. Most of the news is for English consumption and at present pretty much censored propaganda so I've subscribed

▼Colossi of Memnon near Luxor.

for the Paris edition of the Herald Tribune (which is also censored at present but which does have some American news),—it usually arrives about two weeks late but so far hasn't appeared at all. We also have a French newspaper, "The Bourse" and some Arabic, Greek, and Italian papers as well as others.

Movie Theaters

There are a lot of movie theaters which give American, English, French and Arabic productions with American way in the lead and probably Arabian second. They average about four months behind their showings at home which isn't so bad. Performances come at 3:15, 6:30, and 9:30 P.M. with one at 10:30 A.M. on holidays. You go for your particular show, get a reserved seat and either get there on time or miss part of the show. The dialog of American pictures is given at the bottom or off to the sides in writing in Arabic, French, and sometimes Greek, or English if the newsreel is in French. Those who can't understand the spoken language and must read usually carry on a continuous conversation in their own speech which is a trifle annoying. This feature isn't as prevalent in the more expensive seats which is an added incentive to get them. The English soldiers usually listen quietly but older Englishmen may bring a wife or lady friend and apparently are afraid they'll die without having said all the bright remarks they intended to. Prices vary for seats with location and performance from three to eight piasters which at present exchange is from twelve to thirty-two cents. I figure on about five and a half piasters or twenty-two cents. Box or loge seats are the highest, then balcony, rear, middle, and front downstairs. Generally you slip the usher a half piaster for finding your seat as it is indicated by a number scribbled on the back of the ticket, and looks very much like a hieroglyphic to the uninitiated. I've watched tho where they marked off on the chart when they sold me the ticket, and the usher got me to the right place somehow.

The chief differences between movies here and at home are in the number of shorts, and the intermission. You get from four to six shorts including music, cartoon, one or two news reels, March of Time, and others. Then comes an intermission of ten or fifteen minutes for eating, drinking, stretching, and what not,—afterward comes the prevue and feature. There is very little advertising. After the show is over they play the National Anthem and all rise until it is over and then leave. A number start slipping out just before the show is finished and are in the clear before the music starts. It wouldn't be a bad idea once in awhile but coming at every show that way becomes a trifle monotonous not only to me but everyone, and soon loses its effectiveness.

Backsheesh

Backsheesh, which includes both tipping and alms is the curse of the country—you pass it out for everything, and with such low native salaries anyone will take it. You pay 10% for tips at the hotel but had better pass out a little individually if you want service. The dragoman charges so much and puts out his hand for more. You tip the barber and assistants who look on and later they get your coat and hat for you. If you go sightseeing a long line forms. As I went to leave the Coptic church in Old Cairo an old woman stood by the gate with a stick and threatened to put a curse on my head if I didn't kick thru with a half piaster. Natives start to pass you on the streets, stop and put out a hand saying "Backsheesh" at the same time. It is a pestiferous nuisance. At the pyramids I tipped the man who took me thru Cheops and had to slip each of his friends at the door who had done nothing at all, a half piaster each to get out. A guard at the Egyptian Museum turned on a light so I could see one exhibit better and held out his hand, and so it goes but you'll hear more of it later as the story unfolds.

The Mahmal occurred while I was here but I didn't get to see it. Once each year they send a sacred carpet to Mecca for the Pilgrimage and I believe bring back the old one that has stayed there. It is quite a ceremony with the king, officials, church, army and a lot of others taking part and I was sorry to miss it.

Odd Sights and Customs

Then one sees odd sights. For example I saw one shop with a flock of what looked like brass pots with brass and wooden handles, and couldn't imagine what they were for. Then I saw the pots on a sort of stove and stopped for a look only to find they were cleaning and blocking fezes and each pot contained one.

The sidewalks are cluttered with hawkers of odds and ends averaging one to every ten feet as you go along on the busier streets. They sell lottery tickets, locks, shoe laces, toys, slippers, fezes, laces, cloth, roasted chestnuts, candy, fruit (apples, oranges, and bananas), and in fact almost anything. The chestnut sellers have a tray on a small stove about a foot from the ground and squat on their haunches behind it usually at a very busy place. They occupy fully half of the sidewalk and I've wondered many times why someone didn't accidentally kick the tray over. These peddlers must have a license so every so often you see a policeman chasing one who hasn't obtained one. I have also seen barbers shaving men out on the sidewalk with the shavee either squatting, or sitting on a wooden bench or stool. There are also many gambling games going on particularly just outside the Pari-mutuel office where the natives swarm to bet on the horse races Saturday afternoon.

Most Egyptian women of the better class and some of the poorer class go out with their husbands without the veil but many of the poorer class women still wear it. Apparently they have dresses of colored material but they cover up with a black cloak or shawl and sort of cap for the head and appear to be in mourning. The veil covers the lower half of the face and is held in place in front by a funny little gadget on the nose that connects up with the head covering. With some the veil is really a veil, but with many others it is just something that must be worn hence it is as diaphanous as possible and conceals none of the features. The better class look alright but I don't blame some of the poorer class from taking advantage of the veil. They black their eyelids along the eyes instead of rouging the cheeks and the result is a peculiar wild eyed look which is supposed to make the eyes more attractive. I haven't lived here long enough to be very favorably impressed with that style of "War Paint." There are not, as a rule, many women on the street tho, except foreigners or non-Moslems as the Moslem women seem to stay at home.

(To be concluded next month)

NEW THEORIES AND CONCEPTS IN ANALYTIC SOIL MECHANICS

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Introduction

In order to make a theoretical investigation of the behavior of a physical structure it is, of course, necessary first to establish sufficient working knowledge of the material involved. This basic information must come from laboratory or field investigations. The coordination of available test data and formulation of general mathematical procedure for the prediction of behavior under various field conditions should, however, be undertaken before laboratory methods have gone so far astray that nobody knows how to use the obtained information. Much of today's experimentation is done as a routine procedure, and the results merely filed away never again to be seen or thought of.

In the formulation of a basic theory on stability of soil structures, much can be learned from the methods of the mathematical theory of elasticity. In fact, a thorough working knowledge in this field will be found to be extremely useful, if indeed not necessary, in dealing with materials which do not follow exactly the empirical Hooke's elastic stress-strain relations. After all, the final problem in analytic soil mechanics is similar to the elastic problem; namely, the prediction, or rather estimation, of stresses and displacements under given load conditions.

The elastic theory is now often applied to such materials as concrete, although it does not follow Hooke's Law very well. It is, however, tacitly assumed that no tensile stresses are allowed to develop in such structures. This means that the permissible stress distributions must be restricted by the criterion of failure for concrete, generally the Mohr relation between normal and shear stresses in the critical planes.

Likewise, the elastic stress distribution might be thought of in soil structures with the proviso that the criterion of failure is not violated at any point. The main difference in the structural properties of concrete and soil is the magnitude of cohesion, high in the former and low in the latter. For this reason it will be most often found that the elastic stress distribution will not be tenable in the boundary regions of soil structures.

I. Concepts and Stress Definitions[1, 2]

An earth structure is a continuum of solid particles. These may vary in shape, size, density, roughness, elastic properties, spacing, etc. It may, however, be assumed that the mean physical properties taken over every cubic foot, say, of the material remain constant within specified finite regions. The spaces or voids between the solid particles are filled with air or water or a mixture of both, and the air may be either free or absorbed in the pores of the water. The most important and the most difficult problem in analytic soil mechanics is to determine the existing liquid pressure in the voids of the soil mass as a function of space and time under given boundary conditions. These pressures play an important part in the determination of the stress distribution and, consequently, in the stability throughout the structure.

Now consider, at a given time and location, a small cubical volume of unit sides in a soil structure. The boundary lines of the cubical volume are supposed to undulate slightly so as to pass through all the contact areas and not cut through the grains. The contact areas between the individual particles are assumed so small that they can be considered points. The resultant of all reactions between particles acting in the boundary contact points are now treated statistically as normal and shear stresses. These shall here be known as "contact-stresses." The resultant of liquid pressures acting on a unit boundary area shall be known as pore pressures. The total force acting on a side of the unit cube is then the sum of the "contact-stresses" and the "pore pressures" and shall be termed "total-stresses" or, for brevity, merely "stresses." It will be noticed that the pore pressures at a point only contribute to the total normal stresses and not to the shears. In addition to the forces acting on the boundaries, there are forces acting on the total mass of the cube. Besides gravity, there may be horizontal and vertical inertia forces, as in the case of an earthquake.

Let the elementary cube, *figure 1*, under consideration have sides parallel to a chosen coordinate system *(XYZ)*, and let the normal contact stresses and shear components be designated σ_x', σ_y', σ_z', and τ_{xy}, τ_{xz}, τ_{yz}, respectively, and let σ_x, σ_y, σ_z, designate the total normal stresses. Further, let the component of the total body or mass forces per unit volume along the coordinate axes, including earthquake accelerations if they exist, be designated g_x, g_y, g_z. Finally, let the pore pressure at point (x, y, z) be p, then, by definition

$$\begin{aligned} \sigma_x &= \sigma_x' + p \\ \sigma_y &= \sigma_y' + p \\ \sigma_z &= \sigma_z' + p \end{aligned} \qquad (1)$$

The stresses and pore pressures in any finite region are assumed to be continuous functions in time and space, and if the total structure is to be in equilibrium, all points must be in equilibrium simultaneously under the acting total stresses and body forces. This enables us to write the well known differential equations of equilibrium, as for elastic structures:[6]

$$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} + \frac{\partial \tau_{xz}}{\partial z} - g_x = 0 \qquad (2)$$

and the two analogous equations.

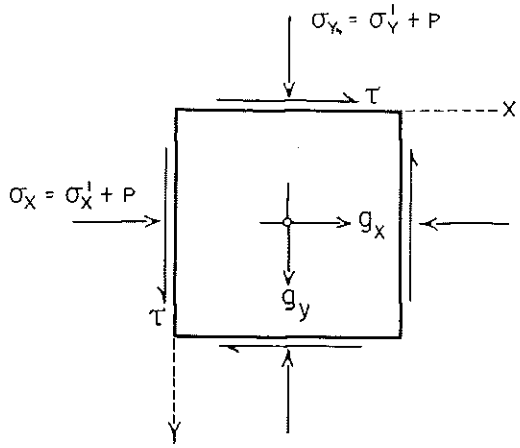

FIGURE 1 – UNIT CUBE

It will be sufficient for the present purpose to confine the treatment from here on to two dimensions, and it will be a simple matter to extend the general formulation into three dimensions.

With normal stresses taken positive in compression and the shear direction defined positive as in *figure 1,* the two equations of equilibrium in two dimensions become

$$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau}{\partial y} - g_x = 0$$
$$\frac{\partial \sigma_y}{\partial y} + \frac{\partial \tau}{\partial x} - g_y = 0 \qquad (3)$$

It will be seen that the two equations (3) contain three unknown stresses σ_x, σ_y, and τ so that an additional equation is needed. In elastic bodies this would come from compatibility considerations; in a soil structure there is not much sense in talking about compatibility since the soil mass is continuously consolidating. Under a given set of conditions, including a complete knowledge of the pore pressures p, the soil mass will, if possible, adjust itself until the stresses at all points are in stable equilibrium. The criterion of stability (or failure) will furnish the needed equation between the stresses.

Criterion of Stability

For elastic bodies, many hypotheses of failure have been suggested, but it is now generally conceded that the Mohr hypothesis best expresses the relation between the stresses which exist at the point where failure occurs.[19] Triaxial tests on soil samples in which pore pressure is absent have verified that the Mohr hypothesis is applicable also to soil, and that the Mohr envelope is practically a straight line. *(See figure 2.)* Tests on samples in which pore pressures do exist also verify the hypothesis when the contact stresses are plotted in place of the total stresses. In many laboratories, the direct shear method is employed, and no consideration is given to the pore pressures in the sample. When the total stresses are plotted, the Mohr envelope curves and flattens out for high compressions. This becomes more pronounced the less pervious the sample is and the more moisture it contains, due to the fact that higher pore pressures will be induced. In other words, the apparent angle of internal friction ϕ and cohesion C would both be functions of the "total-stresses," moisture contents, and compressibility of the soil, whereas ϕ and C have been found to remain stationary when defined in terms of the "contact-stresses," and thus assume the role of real physical constants for each type of soil.

From the Mohr hypothesis, *figure 2,* the relation between the angle of friction ϕ, the cohesion C, and the greatest and smallest principal contact-stresses, σ_1' and σ_2' at failure is easily found to be

$$\frac{(\sigma_1' + \sigma_2') \sin \phi + 2C \cos \phi}{\sigma_1' - \sigma_2'} = 1 \qquad (4)$$

Expressing the contact stresses in terms of total-stresses and pore pressures by equation (1), the above equation can be written

$$\frac{(\sigma_1 + \sigma_2 - 2p) \sin \phi + 2C \cos \phi}{\sigma_1 - \sigma_2} = 1 \qquad (5)$$

or solving for the pore pressure

$$p = \frac{\sigma_2 (1 + \sin \phi) - \sigma_1 (1 - \sin \phi) + 2C \cos \phi}{2 \sin \phi} \qquad (6)$$

The principal stresses are

$$\left.\begin{matrix}\sigma_1\\ \sigma_2\end{matrix}\right\} = \frac{1}{2}\left(\sigma_x + \sigma_y \pm \sqrt{(\sigma_x - \sigma_y)^2 + 4\tau^2}\right) \qquad (7)$$

The differential equations (3) restricted by equation (5) are then the theoretical tools available for the stability analysis of a soil mass under given conditions. It should be emphasized that a unique solution of the problem is not possible with our present tools.[17, 23] If a unique solution could be obtained it would only be of academic interest, because the pore pressures would be continuously changing. The main object for practical design is to be able to study certain critical states. The procedure should be to determine a set of stresses which satisfy the differential equation (3) and the given boundary conditions and then compute by equation (6) the permissible or critical pore pressures p and compare these with the actual pore pressures which may exist in the soil mass. If the former are sufficiently above the latter the structure may be considered safe. The stability problem thus becomes twofold, namely:

1. The determination of the "critical" or permissible pore pressures, and

2. The determination of the actual or "maximum" pore pressures which do exist under given conditions.

The second part of the problem will be discussed later in this paper.

Boundary Conditions

On the boundaries the stresses must assume the values given by the loadings. A few specific cases will be discussed here.

1. In the unloaded areas of the boundary, the smallest principal stress σ_2 and the pore pressure p are both zero. Then by equation (5)

$$\sigma_1 = 2C \frac{\cos \phi}{1 - \sin \phi} \qquad (8)$$

or $\sigma_1 = 0$ if $C = 0$.

The cohesion C is a very dubious quantity, especially for saturated soil. It is believed that in partly saturated granular materials cohesion is only the effect of capillary action and would disappear under complete saturation or in the complete absence of moisture and natural cementation. In any case, the magnitude is small and unimportant compared with other stresses when the real angle of friction ϕ is defined by the contact-stresses. It is, therefore, recommended to place cohesion C equal to zero in most practical stability problems when the pore pressures are taken into consideration.

2. In the areas of the boundary where a hydrostatic pressure p and no other loading exists, the principal stress σ_2 is equal to p. Then, by equation (5)

$$\sigma_1 = \frac{p(1 - \sin \phi) + 2C \cos \phi}{1 - \sin \phi} \qquad (9)$$

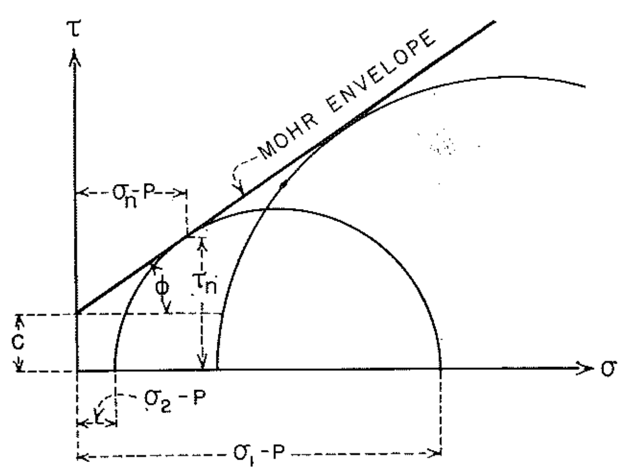

FIGURE 2 - MOHR CRITERION

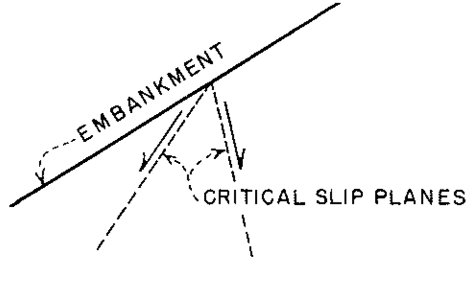

FIGURE 3 - CONSOLIDATION FAILURE

or $\sigma_1 = p$ if $C = 0$.

3. Finally, let the normal load on a boundary be σ_n and let the shear load be τ_n per unit area and the pore pressure $p = 0$, then

$$\sigma_n = C + \tau_n \tan\phi \qquad (10)$$

or $\sigma_n = \tau_n \tan\phi$ if $C = 0$ gives the critical relation which must exist between these loadings.

4. In order to establish a critical pore pressure system at which the structure will just fail, it is often possible from the geometry of the structure and the boundary conditions to determine a minimum value of the effective or fictitious angle of friction under which the boundary regions of the structure would just be stable. With this value of ϕ a set of stresses is then determined such that the entire structure is just stable, assuming no internal pore pressures to exist. The permissible or critical pore pressures are then computed by using this set of stresses in equation (5) but with the real physical value of the angle of friction ϕ as determined by field or laboratory tests.

Slip Planes

By consideration of *figure 2*, it is easily deduced that the critical slip planes at failure under stresses σ_1 and σ_2 are located at an angle, $45° - \frac{1}{2}\phi$, on either side of σ_1. The stresses acting on these planes are σ_n and τ_n. When the critical stresses have been determined at all points of the structure, it is of course, possible to determine the continuous curves of slip correspondingly. These have only academic interest inasmuch as the stability analysis deals with the structure from the point of view that such slips actually will not occur. The question of critical slip planes, however, becomes of importance when two possible critical solutions show up in the course of the analysis due to the fact that equation (5) becomes of second degree when the principal stresses are expressed by its components, as in equation (7).

In the case of an earth embankment or dam, one solution has the top shear components on the critical planes near the boundary slopes directed into the embankment, corresponding to a consolidation of the soil mass, which theoretically shows up as a "failure" *(figure 3)*. The other solution has these shears directed outwards and must be interpreted as the ultimate state before disastrous failure will occur *(figure 4)*. The permissible or critical pore pressures computed from the last solution are higher than those from the first solution. Thus, the dam always consolidates before the disastrous pore pressures are reached.

A similar situation arises in the analysis of soil pressures on retaining walls, only here four possible limiting solutions show up. By a proper consideration of the critical slip planes, the four solutions can be shown to correspond to each of the following:

(b) Deflecting the wall towards the soil mass with a companion solution corresponding to pressing the wall downwards.

II. Pore Pressures[1, 2]

The second part of the stability problem, namely, the determination of the actual or existing pore pressures, shall now be briefly treated. The general theory of slow viscous flow in the steady state has been published so frequently[8] and is so well known that it will suffice here to say that the pressures in such cases must satisfy La Place's equation $\Delta^2 p = 0$, which with given boundary conditions makes it possible to obtain unique solutions.[22] Quite often the pore pressures in the steady state are determined experimentally by the electric analogy or rubber membrane method.[2] In this theory the fluid and soil are both considered to be incompressible, assumptions which often are satisfactory. On the other hand, the results obtained in this manner are in many cases so far from the truth, and not even conservative, that it is necessary to formulate a theory in which proper consideration is given to the air content in the voids and the compressibility of the soil mass.

The problem is twofold; namely, to determine:

1. The magnitude of the initial pore pressures, and

2. The time rate of dissipation of these pressures under known boundary conditions. These will in most of the important practical cases themselves vary with time.

Assumptions and Definitions

It is assumed that a consolidation modulus E exists for moist soil when no pore pressure is present. The quantity E is similar to the elastic bulk modulus for a liquid and is naturally defined in terms of the increase in contact stresses

$$E = \frac{\sigma - p}{\Delta} \qquad (11)$$

where σ is the increase in average loading or $\sigma = \frac{1}{3}(\sigma_x + \sigma_y + \sigma_z)$; σ_x, σ_y, σ_z are the stresses defined earlier in this paper; Δ is the dilatation or consolidation per unit volume accompanying σ; p is the pore pressure induced by the load σ and is measured as the increase in pore pressure over p_o which existed before the load σ was applied. p_o will usually be atmospheric pressure. σ, p, and Δ are all functions of time. E will depend on the placement conditions of the soil preceding the increase in loading σ. It is not necessarily a constant, but it will be assumed stationary in the range to be dealt with, using an average value. Further:

v is the volume of moisture per unit volume of soil sample at time t. Water itself is assumed incompressible.

v_o is the initial value of v.

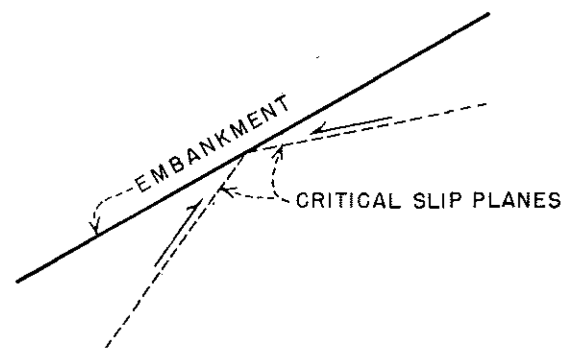

FIGURE 4 - DISASTROUS FAILURE

a is the volume of free air in the voids at any time t under pressure p.

a_0 is the initial value of a under pressure p_0.

b is the volume of air absorbed in the moisture v under pressure p_0. It can be taken equal to the pore volume of the water.

$a_1 = a_0 + b$.

Consolidation Without Percolation

If a sealed sample of soil with the properties as defined above is compressed, and nothing is allowed to escape, it is evident that all the consolidation and absorption takes place at the expense of the originally contained free air volume so that

$$a = a_0 - \Delta \qquad (12)$$

It is evident that Δ must be less than a_0 and that if a_0 is zero Δ must be zero. If it is assumed that the air behaves as a perfect gas under constant temperature and that Δ is small, then by Boyle's Law:

$$(a + b)\,(p + p_0) = (a_0 + b)\,p_0$$

or

$$p\,(a + b) = p_0\,(a_0 - a) \qquad (13)$$

By using equation (12)

$$p = p_0 \frac{\Delta}{a_0 + b - \Delta} \equiv p_0 \frac{\Delta}{a_1 - \Delta} \qquad (14)$$

This equation is convenient for the determination of pore pressure under consolidation Δ.

By using equations (11) and (14)

$$p = \frac{1}{2}\left[(\sigma - p_0 - a_1 E) + \sqrt{(\sigma - p_0 - a_1 E)^2 + 4\sigma p_0}\right] \qquad (15)$$

which is useful for the determination of the initial induced pore pressure when the mean load σ, the consolidation modulus E, and the initial air content a_1 are known. Finally, the following formula for E is easily obtained by elimination of p by equations (11) and (14):

$$E = \frac{\sigma - \dfrac{p_0 \Delta}{a_1 - \Delta}}{\Delta} \qquad (16)$$

which is independent of the pore pressure p. In experimentation with sealed samples it is important that no air or water is allowed to escape and that the sample be given ample time to come to rest. It is the final value of Δ which is to be used in the formulas.

In concluding this chapter, it might be of interest to consider a sample with absolutely no free air. If water is still considered incompressible, the pore pressure p will be equal to the mean load σ. Water is actually compressible with bulk modulus E' in which case

$$p = \frac{\sigma}{1 + \dfrac{E}{E'}\,v_0} \qquad (17)$$

If all the free air can be removed, this formula might be useful in connection with high compression triaxial testing proposed on concrete for the determination of the effective pore volume in uplift which here has been assumed to be one hundred percent.

Time Consolidation Accompanied by Percolation

In studying the variation of pore pressure in a structure as a function of space and time, equation (12) is no longer valid because as the pore pressure changes, air and water will escape across the boundaries of the unit volume under consideration.[21] The following equation will then express continuity:

$$\frac{\partial}{\partial t}(v + a) = -\frac{\partial \Delta}{\partial t} \qquad (18)$$

remembering that Δ is defined positive when the volume decreases. Equation (18) merely expresses that the time change in consolidation Δ is numerically equal to the time change in total void volume, $v + a$.

The time rate of consolidation is obtained by differentiating equation (11) with respect to time, thus

$$\frac{\partial \Delta}{\partial t} = \frac{1}{E}\left(\frac{\partial \sigma}{\partial t} - \frac{\partial p}{\partial t}\right) \qquad (19)$$

The time change of the quantity $v + a$ is due to two major effects; namely, (a) flux into the unit volume due to percolation, and (b), the change in the free air volume, a, due to changes in pressure and temperature, and due to absorption or release of air by the water under changing pressures. The first part may be computed by Darcy's Law,[2] by which the total flux into the unit volume is

$$k \nabla^2 p \equiv k\left(\frac{\partial^2 p}{\partial x^2} + \frac{\partial^2 p}{\partial y^2} + \frac{\partial^2 p}{\partial z^2}\right) \qquad (20)$$

where k is the percolation factor defined as the quantity which flows across a unit area in unit time under unit pressure gradient. It will, for the present, be assumed that the temperature remains constant, thus the time change in the free air volume due to change in pressure is obtained from equation (13),

$$\frac{\partial a}{\partial t} = -\frac{a_1 p_0}{(p + p_0)^2}\,\frac{\partial p}{\partial t} \qquad (21)$$

By introducing equations (19, 20, 21) into (18), the differential equation for the transient state of pore pressure is obtained:

$$\left[\frac{E\,a_1\,p_0}{(p + p_0)^2} + 1\right]\frac{\partial p}{\partial t} - EK\,\nabla^2 p - \frac{\partial \sigma}{\partial t} = 0 \qquad (22)$$

The operator $\nabla^2 p$ is defined in equation (20).
Now define

$$\alpha = \frac{1}{1 + \dfrac{E\,a_1\,p_0}{(p + p_0)^2}} \qquad (23)$$

Then equation (22) can be written

$$\frac{\partial p}{\partial t} - \alpha \frac{\partial \sigma}{\partial t} = \alpha\,EK\,\nabla^2 p \qquad (24)$$

From equation (23) it is seen that the value of α only varies from zero to unity. In practical problems it will be sufficient to treat α as a constant using average estimated or experimental values in each particular case, as will be explained later.

Many solutions to (24) have been obtained for various boundary conditions, but only the most important cases shall be discussed here. It is, of course, necessary to know approximately the values of the physical constants which enter equation (24). This information must come from laboratory experiments on actual field samples. An apparatus suitable for this purpose has been constructed by the Bureau of Reclamation. The apparatus consists of a steel pressure cylinder large enough to contain a rubber-sealed cylindrical soil sample. The clearance between the cylinder and the sample contains the pressure medium, air-free water. Gages are provided to measure the pressures in the chamber and at both ends inside the sealed soil sample. The flow of pressure water into the pressure cylinder can be measured and reflects the volume change of the sample. An outlet valve is provided at the lower end of the sealed sample and arrangements are made to measure the escaping air and water separately.

(Continued on page 656)

MINE SAFETY AND ACCIDENT PREVENTION

By

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Part II
Rock and Roof Falls

More men are killed and injured in the metal mines of the United States from falls of rock or ore than from any other cause. Copper mines show the largest percentage of men killed from rock falls; iron mines come second; and lead, zinc, gold, and miscellaneous metal mines are third in order. This indicates that the greatest number of accidents from falls of rock or ore occur in ore bodies of great size and width.

The problem of preventing accidents from rock falls is almost wholly in the hands of the miner. A mine equipped with thousands of dollars worth of safety devices and worked by careless and indifferent miners will have more accidents than a mine without a single safety device but with miners who are always thinking of preventing accidents. Therefore it is up to the management to train and instruct the workmen so that they will do their work safely and not take chances, and it is further up to the bosses to weed out the habitually careless man from their ranks—the repeater, the fellow who is continually getting hurt, the one who simply will not follow instructions.

A careful study of many accidents from falls indicates that a large proportion of the accidents might not have happened if the miner or underground boss had used more judgment or care. Of course, many falls are unforeseen, such as those caused by the movement of a large block of ground, or by the falling of ground that even the most experienced miner would have no reason to believe unsafe.

There are many varied conditions in metal mines. Ore deposits vary greatly in size, shape and occurrence. They may occur in veins, beds, masses, shoots or irregular pockets. They may be flat, sloping or vertical. Some classes of ore deposits are found only at or near the surface; others extend a mile or more underground. The ore may be as soft as mud or it may be so hard that sparks fly when it is drilled, and the same is true of the wall rock.

In many mining districts faults or breaks in the rock are numerous, and at such places there is often a marked change in the nature of the ground. If the fault is sharp and well defined, there may be no change in the nature of the ground, but where the rock has been crushed and broken, blocky and heavy ground may be expected. Sudden changes are met with when drifting into a dike, or through a contact.

Accidents from falls of rock may be due to the dropping of small pieces of rock or ore, as well as those resulting from the caving of large masses of ground. The great majority of accidents from falls of rock involve the dislodgment of comparatively small rocks or slabs, from a few pounds up to several hundred pounds in weight, from the roof, walls, or breast of a working place. Miners have been killed by being struck on the head by a piece of rock no larger than a baseball, although the use of hard shell hats has greatly reduced accidents of this kind. In general, if a large block of ground starts to move it will give warning; noticeable cracks will appear, sometimes accompanied by air blasts or other sound. Often small ... in a timbered stope, timbers will begin to crack and show signs of crushing some time before they give way. Rarely does a considerable block of ground give way without some warning. The miner should keep on the lookout for any such indications of movement, and should any be noticed, he should keep clear of the affected area, and notify his boss at the first opportunity.

Rock or ore falls because it lacks support. Although hard and firm ground is often self-supporting, there is a limit to the size of the excavation that may be made without providing support. The usual tendency, whether drifting or stoping, is to use too little timber, or to wait too long before placing the timber.

One of the most important principles to be dealt with in underground work is well known to most experienced miners. In fact it is so well known that he oftentimes forgets to keep it in mind and his neglect of this principle causes over half of the fatalities in metal mines from falls of rock. This principle is that *ground changes after being opened.*

Dan Harrington of the Bureau of Mines says that the only safe way to regard back is to assume that there is no such animal as good roof, and points out the significant fact that in mines where this is literally true and treated accordingly, far less accidents occur from falls of rock than in mines with supposedly good roof. Back should be regarded as a potential danger at all times, and no chances should be taken with it.

Ground changes and a rule which should be compulsory in all mines is to test that part of the back which you have to work under at least twice each shift.

In drifting without the use of timber it is taken for granted that the ground is firm enough to support itself. In this class of work falls occur when the opening is too large or is not of proper shape. Ground that will not stand if the drift is large may hold well if a small, well-arched opening be carried. All loose rock should be removed from the face, back, and sides as driving progresses. This should be done immediately on returning to the face after blasting.

In drifting or crosscutting in ground where timbering is required, many varying conditions are met. In heavy ground, where the rock is soft, mud sills must be used, for without them the posts will be forced into the floor. If the timber is not large enough the caps and posts will be crushed. If the sets are placed too far apart the lagging may break. Weak hanging wall, weak footwall and weak back each requires a different method of timbering, lagging and blocking.

In stoping, large falls may be caused by taking too wide a span. Often men are injured by smaller pieces of ore or rock falling from the back or sides. In order to avoid these two dangers, rooms, chambers or stopes should not be carried larger than the nature of the ground will warrant, and loose rock and ore should be carefully trimmed from the back and sides.

In general, accidents from falls are due chiefly to the following causes:

1. Mining large areas underground without the use of timber.
2. Failure to trim or pick down loose rock or ore from working places.
3. Improper timbering, including the use of too little timber, or the use of timber that is too small or not strong enough, improper spacing, placing, blocking, and lagging.
4. Delay in placing the necessary timber.

Any or all of the above causes are directly traceable to lack of knowledge of the nature of the ground, lack of knowledge of timbering, or carelessness.

On account of the varied nature of the ground in different mines, no set rule can be laid down for detecting an unsafe place. Experience and care are very necessary to prevent accidents. The usual method of spotting a dangerous piece of rock is by tapping with a pick handle or other tool. As a rule, rock that sounds "drummy" is not safe. It is the duty of the underground boss to carefully inspect all timbering and general conditions at working faces, and to see that all orders in regard to timbering and other safety practices are promptly obeyed.

Following are some safety rules which if followed by the workman, would prevent 90% of the fatalities and most of the serious accidents from falls of rock:

1. Thoroughly inspect the back on entering the working place at the beginning of the shift, regardless of whether or not there has been blasting on the previous shift. If there is any loose material, scale it down and make the place safe before doing any other work.
2. Stand in the clear, not only when barring down but when testing ground.
3. When testing the back or barring down, use a scaling bar, and not a pick or shovel, or whatever tool comes handy.
4. It is up to the shift boss to see that each working place is supplied with a scaling bar of the proper length.
5. When barring down or testing the back, be sure you have a firm footing and see that the floor is not so badly littered with boulders, loose timber or other hazards that you cannot move quickly and surely, if necessary.
6. Before barring down a piece of loose back, sound the ground adjacent to it to make sure that the ground over your head does not come down with it.
7. Manways and passageways should not only be kept cleaned down and free of loose rock, but they should be systematically inspected at regular intervals for loose back, keeping in mind the fact that ground changes.
8. Do not remove a stull or other timber supporting ground without first placing another timber to hold the ground.
9. If necessary to change a post or a stull holding lagging or gob in place, always make sure the back is safe first.
10. Use temporary timbers until permanent stulls can be put in when timbering or working in bad ground.
11. Place timbers in the manner best designed to support the ground, rather than the easiest way. Use headboards wherever possible as they will invariably give warning when the stull begins to take weight.

The falls of roof "slate" or coal is responsible for about 48% of the fatal accidents in coal mines. The public hears most about the loss of life in coal mine explosions and fires for the reason that in each of such accidents many lives may be lost. However, records show that by far the largest death list, including nearly one-half of all the deaths, comes from falls of roof and coal. About these the public hears little because the men are killed one, two or three at a time. In addition to the fatal accidents, hundreds are injured from these falls.

In 1911 an average of five men lost their lives and a dozen men were injured every working day from falls of roof or coal in the United States. Probably these accidents from falls cannot be wholly prevented, on account of the natural dangers of mining, but in the last 15 or 20 years wonderful strides have been made in preventing such accidents. Some coal mines now have a record of no men killed in more than a year's work.

Accidents from falls of roof are less frequent on roadways, headings or passageways than at the working face, because the roof is constantly inspected by foremen and other bosses. Only when derailed cars knock out timbers so that the roof comes down can injuries from roof falls be considered at all excusable, and not always then. The burden of preventing falls in entries and passageways rests largely upon the foreman and other company inspectors. If loose pieces are noticed they are taken down or are supported by timbers. Figures indicate that in the coal mines in this country less than one-tenth of the accidents from roof falls happen in entries or gangways.

About two-thirds of the accidents from falls occur at the face of rooms or chambers, and one-fifth in pillar workings. The reason for the smaller number in pillar workings is not because pulling pillars is less dangerous, but because of the smaller number employed and because this work is given to the most experienced miners.

The principal causes of accidents from falls are the following:

1. Failure to use sufficient props or timbers.
2. Going back to the face without testing the roof after shot firing.
3. Undermining the inner edge of a block that seems to be safe, but actually is loose.
4. The sudden loosening of a concealed "pot," "kettle bottom," "bell," or a fossil stump.

The first two causes are generally avoidable, but some accidents from the second two causes may be considered unavoidable.

Most accidents from falls of roof can be prevented by always testing the roof and either pulling down loose pieces or else setting props under it. One of the things that causes a large number of accidents is the "draw slate" in the upper part of the coal bed or just above the coal. This may be hard when first exposed to the air but rapidly softens and falls. Props will not hold this up so the best thing to do is to take it down immediately.

Great damage is done to a roof by using too much explosives, not having the shots placed properly, or by not undercutting the coal far enough. Also props may be blown down. When going back after a shot it is particularly necessary to thoroughly test the roof.

The responsibility for preventing accidents from falls of coal is almost wholly in the hands of the miner. Most of these accidents occur through failure to block or sprag the coal while undercutting it, or in a thick seam, while slabbing it off. Special care needs to be taken in longwall work, where there is little room between the face and the gobbed material.

heading, passageways and the working faces, and to see that timber and supplies are promptly furnished and properly used.

Part III
Haulage and Hoisting

Haulage accidents are responsible for about 17% or 18% of all coal mine fatalities and about 21% of all non-fatal coal mine accidents. When the relatively small number of employees continuously exposed to haulage hazards is considered, it would appear that haulage is more hazardous than any other phase of coal mine operation.

Haulage accidents have increased from year to year, doubtless due to the increase in electrical haulage, use of larger cars, heavier locomotives, longer hauls and greater speeds.

Haulage accidents may be classified according to responsibility into two groups—those for which the management is largely responsible, and those for which the employee is largely to blame; there is however, an overlapping of responsibility from one group to the other.

In the first group for which management is largely responsible may be included accidents due to faulty equipment, poor track, a poorly arranged system of haulage, lack of clearance or overhead protection, and dirty roadways. Even in these features the employee may be partly to blame, as failure of haulage equipment may be due to lack of care on his part, failure to report when equipment is out of order, or failure to do a good job of installing, repairing or operating.

To the second group of accidents, for which the employee may be largely responsible, belong those caused by careless practices such as jumping on and off fast moving trips, coupling on the "fly," running at excessive speeds, failure to properly block cars, and similar hazardous acts of omission or commission. If, however, management condones such practices, or in some instances, insists upon them, it must accept its share of responsibility for the accidents that result.

Poor track is as inimical to efficient mine operation as it is to safe haulage. The track should be laid with rails and ties large enough to withstand the weight of cars and locomotives operating at reasonable speed, otherwise it will be impossible to keep the track in a safe and efficient operating condition. The track should be ballasted properly and the roadbed adequately drained. The curves of all turnouts should be of maximum radius consistent with surrounding conditions. The frogs and switches and switches should be blocked to prevent employees from getting their feet caught in them. All switches should be equipped with switch stands or throws. Loose switch points or latches that are kicked into position by the haulage crew while on moving cars or locomotives have caused many accidents and should not be used. The switch stand or throw should be set as far back from the rail as possible, preferably in a recess. All stumbling hazards at the switch stand should be eliminated.

Large percentages of fatal and non-fatal accidents chargeable to haulage are due to lack of proper clearance between cars on parallel tracks, or between cars and rib or roadside posts and timbers. Faulty conditions with regard to overhead clearance also cause many accidents. Where natural conditions permit, it is desirable to drive haulage entries wide enough to allow ample clearance on both sides of the track. Where this is not possible a continuous clearance should be maintained along one side, and the side opposite the trolley wire should be given clearance. Proper overhead clearance is also essential for safety. Abrupt changes in overhead clearance are dangerous, and when it is not possible to eliminate them, they should be marked by lights, whitewashing, reflector buttons or some other way to call attention to them.

Low and unguarded trolley wires are a hazard to haulage crews. They should be guarded at all switches and other points where they cross over the haulage road, and, preferably, they should be guarded their entire length, especially if the entries are low. The real solution of this phase of the haulage accident problem is to substitute storage battery or other types of haulage for the trolley system.

The general adoption of hard hats and safety-toe shoes has eliminated many injuries in connection with haulage operations. Their use should be mandatory in all mines. The wearing of loose or torn clothing should also be prohibited.

Shelter or refuge holes should be maintained at stated intervals along haulage roads. The holes should be kept free of refuse, materials, etc., and should be plainly marked.

Stumbling hazards along haulage roads are responsible for many accidents. Refuse materials, rock, and dirt should not be allowed to accumulate along the sides or roadways, and timbers, ties and rails should not be stored where they will form stumbling hazards.

Proper illumination aids greatly in preventing all types of accidents in bottoms, partings, and switches or turnouts from the main haulage ways should be well lighted. In addition there should be a light in front of each shelter hole along the haulage roads.

Poorly designed and poorly maintained haulage equipment is both inefficient and hazardous. Mine cars may have too long wheelbase for the curves, too long bodies for the wheelbase or inadequate bumpers, which cause derailment and consequent accidents to workers. Open couplings are dangerous because they are likely to come unhooked. Link and pin or clevis and pin couplings often cause accidents when the men reach between the cars to couple or uncouple them. At some mines steel hooks are provided with which to couple and uncouple the cars. It is desirable to have brakes on cars in either mechanical or animal haulage. Sprags are more hazardous and less efficient than brakes.

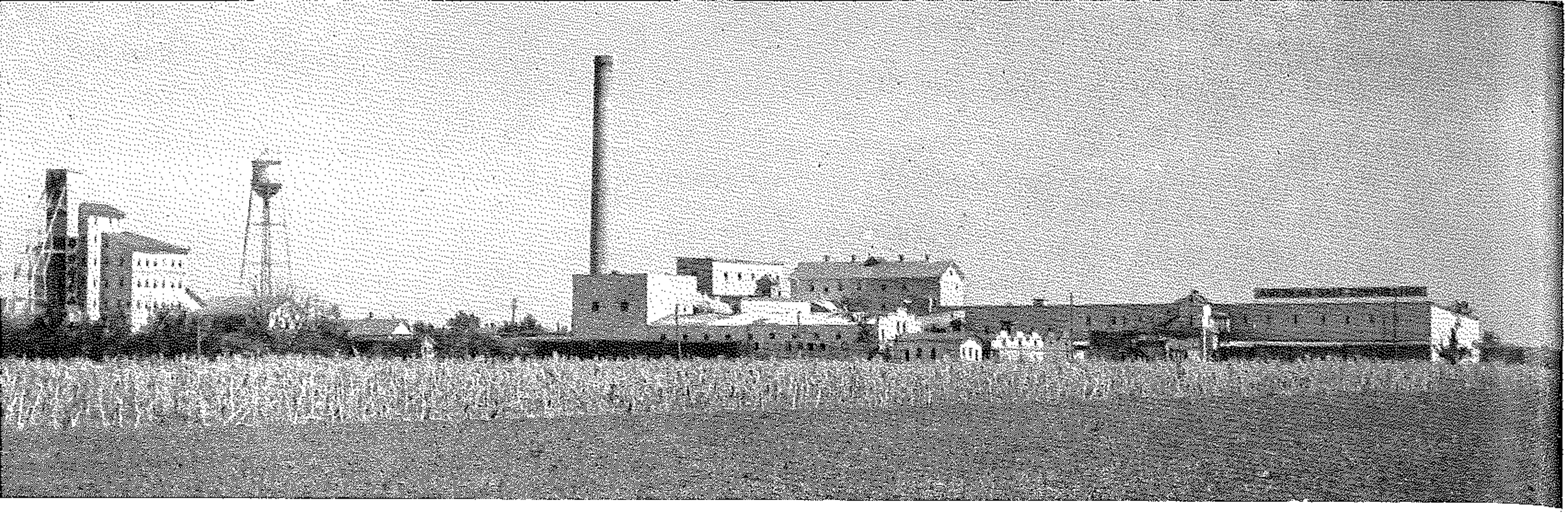
Failure to block cars properly at the face has resulted in many accidents in which the miner is caught between the car and the face. The car should either be blocked securely or secured by a chain and clevis.

In larger mines block signal systems and electrically operated switches have proven very effective in control of haulage and prevention of accidents. Some method of control should be used in any mine which has more than one train operating at a time.

In mines where men are hauled to and from work in man trips special precautions should be taken, especially when the men are getting on and off. Men should not be allowed to get on or off while the train is moving. Trolley wires should be guarded at the place where men get on and off the train. All man trips should be operated at a moderate speed and safety devices provided on slopes or inclines. No tools or explosives should be permitted in man cars.

Some of the dangerous practices of employees which should be prohibited are: Jumping on and off moving trips; operating locomotives from outside the cab; backpoling or running with the trolley pole in the reverse position; kicking switch latches over while riding moving cars or locomotives; reaching between moving cars to hold latches in position; coupling and uncoupling cars from the inner side of curves; failure to keep switches to rooms and other working places closed; running out onto the haulage road without first determining if the road way is clear; riding on haulage locomotives; and pulling cars by hand

(Continued on page 648)



▼ Figure 1. The American Salt Company—Lyons, Kansas. *Credit—Kansas Geological Survey.*

NON - METALLIC MINERALS

By
KENNETH E. HICKOK, '26
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Part 6

Salt

Common Salt, sodium chloride, known to every man, woman and child throughout the whole world because it is an important item of their diet, has been the cause of wars, revolution, political upheavals, and social unrest when nations have tried to exercise political control over the marketing of this common Non-Metallic.

It is probable that workable deposits of salt occur in every political division of the world, or if not workable deposits, some substitute such as sea water, brine springs or salt lakes. Many countries have great beds of rock salt underlying their terrain and where these deposits are accessible they have been exploited from early antiquity. In the United States, New York, Michigan, Ohio, Kansas (Figs. 1 and 2), and Louisiana are large producers.

The mining methods used in the salt industry may be the usual underground mining methods similar to coal mining or where the salt deposit is capped and underlain with impervious strata the salt may be mined by dissolving the salt bed, pumping it to the surface and reclaiming the salt by evaporation.

The beneficiation of salt by means of flotation shows promise of great commercial use, although, so far as I know it is not used commercially, as yet. It will undoubtedly become used for reclamation of lean salt deposits near consuming centers as well as to eliminate impurities present in some salt deposits which makes them commercially worthless at present.

Halite (sodium chloride) is easily floted in a saturated brine with excellent recovery and grade, at a very reasonable cost. The most common flotation reagents are fatty acids and soaps used with a heavy metal salt as activator[1].

The processing of crude salt for human consumption or dairy products consists, primarily, of the removal of iron, magnesium and calcium compounds, which occur with the salt in nearly all deposits.

In the elimination of these impurities, salt brine is chlorinated and aerated to oxidize the iron salts. Following the oxidization of the iron salts the magnesium and calcium are precipitated by the addition of lime and soda ash. The precipitate containing the impurities is allowed to settle in large tanks and the brine is drawn off into vacuum drying pans heated by low pressure steam[2].

To make a "free pouring" table salt small amounts of calcium or

(Continued on page 655)

▼ Figure 2. View in Carey Salt Company Mine—Lyons, Kansas. *Credit—Kansas Geological Survey.*

POLAROGRAPHIC ANALYSIS

By
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Introduction

Specific chemical methods of qualitative and quantitative analysis for almost all cations, many anions, and many organic chemical compounds have required much time and expense in the chemical laboratory. A new field of analytical research, the polarographic method of analysis, has been extensively studied, in recent years, in an effort to simplify and to improve these laborious and costly specific chemical methods.

J. Heyrovsky and M. Shikata of the Charles University, Prague, were the originators of the polarographic method of analysis and are largely responsible for the extensive literature now available on this subject.[1]

The advantages of the polarographic analysis are numerous and are as follows:

1. It accords a faster, more sensitive method of analysis.
2. The elimination of the inaccuracies of personal technique.
3. Permits the recording of indisputable and permanent current-voltage curves.
4. The simultaneous recording of current-voltage curves for from one to seven components.
5. Allows the analysis of solutions whose volume are as small as 0.4 ml.
6. The analysis of any one sample may be repeated as many times as are desired without affecting the composition of the sample or without altering the results of the determination.

Part I

The Polarographic Method of Analysis

The polarographic method of analysis employs a dropping mercury cathode, Fig. I, to furnish a completely polarized electrode in conjunction with a mercury "pool" anode, which is non-polarizable.

The amount of a constantly increasing increment of voltage applied across these electrodes plotted against the current flow through the cell at all increments of voltage increase yields data which, when plotted to scale, indicate the composition of the material subjected to reduction.

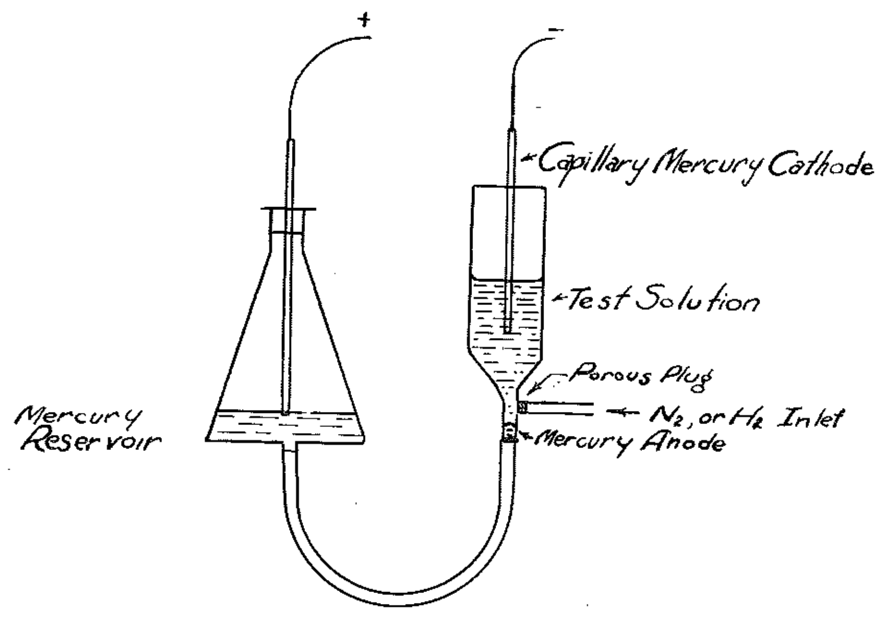
Apparatus employing the dropping mercury cathode has been highly perfected and should contain the following features:

1. A sensitive measuring and recording device.
2. A completely polarized cathode.
3. A high hydrogen — overvoltage at the cathode.
4. A minute cathode surface so that the current is limited to the rate of anion or cation diffusion.
5. The constantly renewing of the cathode surface.
6. A non-polarizable anode.
7. The deposited anion or cation must be continuously redissolved.

The application of a constantly increasing increment of voltage to the cell is accomplished by means of an accurately calibrated bridge wire wound about a cylinder which is rotated at a constant speed by an electric motor.

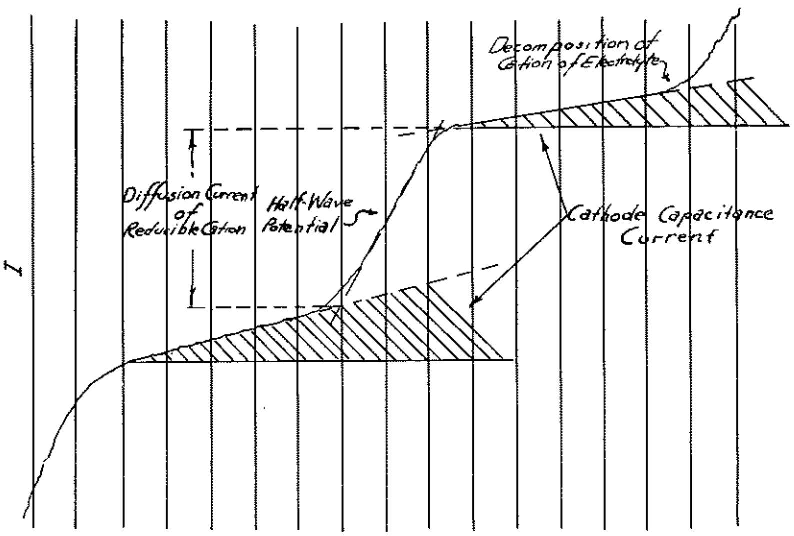
The current recording system consists of a highly-sensitive galvanometer, equipped with a constant damping shunt applied across the galvanometer in order that a wide range of sensitivities may be obtained.

Since the measure of current-voltage must be observed at all times, the most accurate method of measurement can only be obtained by using a graphic recording device. This is accomplished by incorporating an automatic sensitive polarographic recording mechanism whereby a curve is plotted on sensitized photographic paper which is wrapped about a cylinder rotated at a constant speed by an electric motor. The polarograms thus obtained are then developed, stopped, fixed, washed, and dried on ferrotypes.



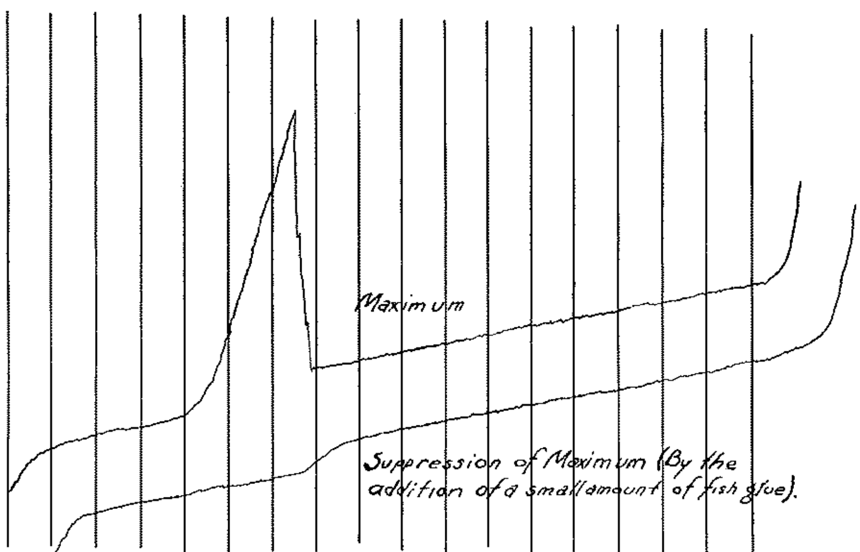
DROPPING MERCURY CATHODE AND POLAROGRAPHIC CELL

FIG. I



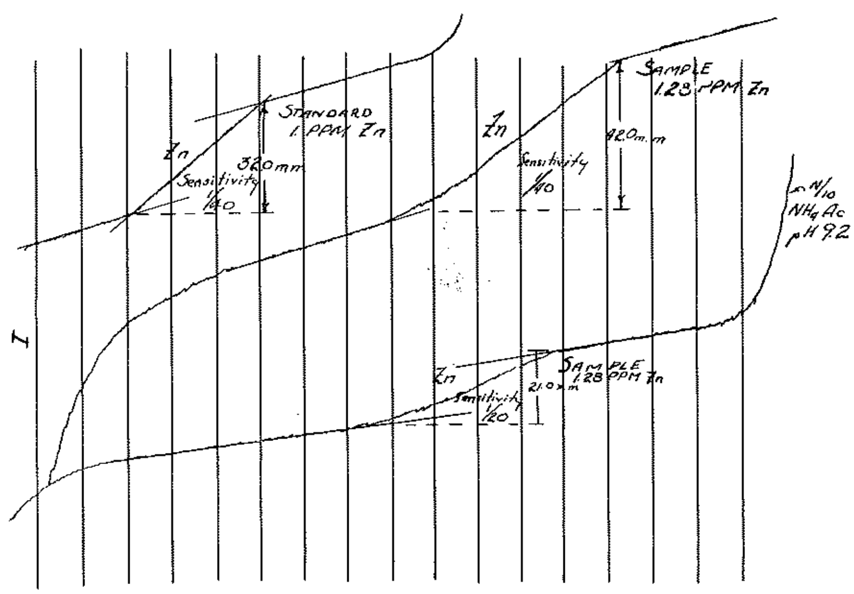
Typical Polarogram of a Reducible Cation

Fig II



Maximum

Fig III



Polarogram for Zinc

Fig. IV

Part II

The Polarogram

A. Interpretation of Curves Obtained

The polarogram is a two dimensional graph on which the applied voltage is plotted as abscissa and the current flow, or linear galvanometer deflection, is plotted as ordinate. Fig. II shows a typical polarogram obtained by the reduction of a cation in an aqueous solution containing an excess of an electrolyte whose cation decomposition potential is considerably higher than, and thus far removed from, the voltage under consideration.

The gradual slope of the first section of the curve in Fig. II indicates that the cathode capacitance current is increasing gradually with the increase in applied voltage. This current increase represents the amount necessary to maintain the charge on the dropping mercury cathode. As the reduction potential of a reducible ion present is reached, a rapid acceleration of current is registered which ultimately decelerates due to the removal of the reducible ion. The height of this rapid current change-curve is a quantitative measure of the reducible ion present. The section immediately following indicates that the reducible ion is being diffused into the cathode region at a rate almost entirely independent of the applied voltage. The rapid rise of the curve at the end of the polarogram indicates that the decomposition potential of the cation of the electrolyte has been reached.

B. Maxima.

When an ion, while being reduced, is adsorbed on the cathode surface, a maximum ΔI appears as is shown in Figure III. This phenomenon is due to an abnormally high rate of discharge of the reducible ion. This maximum is characteristic of the ion being reduced and can be depressed by the addition of a small amount of organic matter which can be adsorbed at a much higher rate, thus preventing the reducible ion from being adsorbed on the cathode surface.

Since the degree of adsorbability of certain adsorptive substances varies and since the extent of suppression of a maximum is dependent on the amount of adsorbable matter present, it is evident that this method can be employed quantitatively for the determination of an adsorptive substance which is not reducible.

C. Interpretation of a Working Polarogram

All cations have a definite half-wave cathodic decomposition potential and all anions have anodic depolarization half-wave potentials or cathodic half-wave reduction potentials. Therefore, the location of a zone of rapid current change with respect to applied

(Continued on page 660)

EXAMINATION OF ALLUVIAL DIAMOND PROPERTIES

GOLD COAST – BRITISH WEST AFRICA

With Notes on the Mining Industry

By
THEODORE L. GOUDVIS, '40
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Introduction

Alluvial diamonds are found in many and varied localities of the world, though rarely in commercial quantities. The fact that they occur so widely distributed suggest that diamonds may be found in places other than India, West Africa and northern South America, were the companies conducting exploration work, familiar with the methods of prospecting and examination.

Although no originality is claimed for this paper, the only references are reports written by R. S. McClellan and the author.

Notes on the Gold Coast

The Gold Coast is a British Colony, located in West Africa between 1° 14′ E and 3° 7′ W longitude and 4° 45′ and 11° 10′ N latitude. It is surrounded by the Gulf of Guinea, and on the remaining sides by French Territory Mandated Togoland on the East, Upper Sengal and Sudan on the North and the Ivory Coast on the West.

The total area of the Gold Coast is 91,690 square miles. The entire country is divided into large districts, which, in turn, are split into lesser areas and provinces. The Gold Coast Colony, Ashanti, the Northern Territories and the British Mandate of Togo make up the Gold Coast.

The population of the Gold Coast taken from census reports of 1931 was 3,160,386. The capital of the Gold Coast is Accra with a population of 60,726, while Kumasi, the largest city in Ashanti, has 35,829 people and ranks second.

There are definitely marked climatic seasons in the Gold Coast, the controlling factor being the lowering of temperatures of northern land areas during winter and their rise in summer months, while the temperature of the adjacent sea remains relatively constant throughout the year. Cyclones and tornadoes occur rarely in the country. Rainfall varies in different parts from thirty to over eighty inches per year.

Agriculture is the major industry of the land. The cocoa industry is the largest in the Gold Coast. Palm oil, Kola nuts, mahogany, coconuts, bananas, etc., are exported while small scale or experimental work is being carried on with rice, cotton, coffee, limes, etc. A low grade of rubber is cultivated, although production has steadily declined.

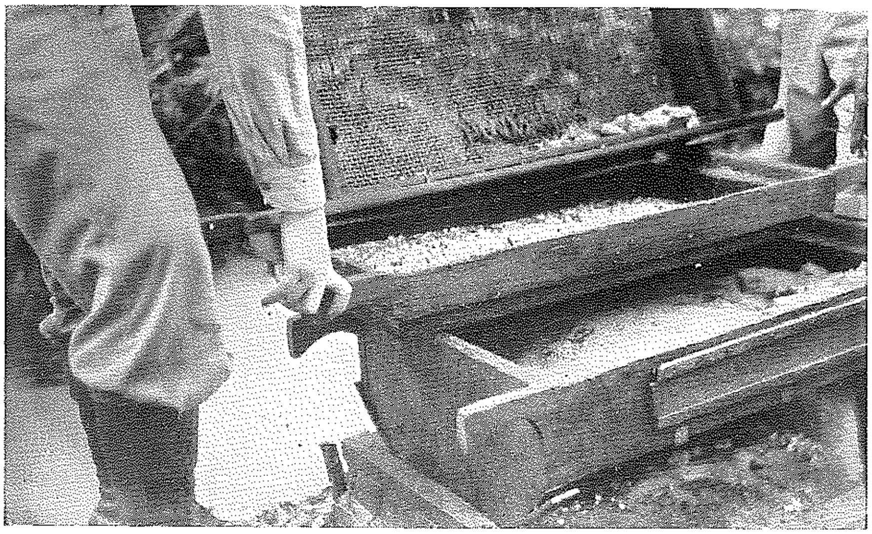
The Gold Coast Colony and Ashanti are covered mainly with thick forests and jungles. Forest reserves have been set up on many miles of this land to protect the jungles, which are being wastefully destroyed through the ignorance of farmers and timber merchants. Some government schools and agricultural stations have been set up, but, however, there is much constructive work yet to be done along this line.

The humid climate and the low standard of living of the natives makes health conditions exceedingly bad, both for the Africans and for the Europeans. Much is being done by the Department of Sanitation in making large towns healthy and habitable for everybody, by sending inspectors to the smaller native settlements. Malaria is the most prevalent tropical disease but there are many others, the majority of which are caused by unsanitary conditions and degeneracy among the native population. European doctors are available in all the larger cities and there are several European hospitals.

Lacking navigable rivers of any size, and since there is no animal transport because of sleeping sickness, the Gold Coast offers difficulties in transportation.

The only harbor along the coast is Takoradi Harbor. A series of open roadsteads still are used along the whole coast line, serviced by lighters, with continual danger and damage to cargoes. A 3′ 6″ gauge railway system feeding Accra and Takoradi, converge at Kumasi. A light motor road system feeds the railways in the interior and the ports. A majority of the roads are impassible part of the year and are in poor condition. Surfacing of certain trunk roads and the continual building of roads is part

▾ Figure 1. Diamond Shaker.



▼ Figure 2. Three Trays of a Diamond Shaker.

of a program which will enable all parts of the country to be reached directly by motor. Cars may be purchased in the larger cities and there are some trucks and passenger cars for hire. Gasoline is sold and transported in five gallon cans—the average price being about forty-five cents per gallon. Cars drive on the left-hand side of the road, and left hand drive cars require a permit to enter the country.

Communications, both internal and with other countries, are completely controlled by the government which operates regular mail service and telephone and telegraph lines. Money and postal orders may be purchased at all post offices. The Gold Coast is a member of the postal union, and mail to the United States, United Kingdom, and West African countries are served direct. Mail to other countries are forwarded from England. Telephone exchanges are installed in all the principal cities.

Electricity and running water can be obtained in the larger cities and while the costs of installation and rates are high, rapid growth and progress is being made.

The Gold Coast is a backward country, with no attractions to visitors and few accommodations for visiting Europeans. In the three largest towns there are hotels for Europeans and in a good many of the smaller towns there are government rest houses. In all the larger cities where there are European residents it is possible to obtain canned food and in the very large cities it is possible to get fresh meats and vegetables which are supplied by private "ice" companies. All European food is expensive.

The Mining Industry

From the standpoint of value of output, gold mining far surpasses the other two mining industries, manganese and diamonds. The following table gives figures for the year 1935:

	Quantity	Value
Gold bullion produced, fine oz.	367,819	£2,574,733
Diamonds exported, carats	1,489,410	601,636
Manganese ore exported, tons	439,096	665,492

The history of gold production in the Gold Coast is a long and rather colorful one, dating back, according to some authorities, to the year 943 when the Saracens reached the Niger River, overcame the armies of Oden and Timbuctoo, and established a settlement. From then on for centuries, it is reported that gold was carried overland to Northern Africa and Europe by Moors, Arabs and others. It is said that the coinages of Portugal, Spain and Italy in the fourteenth and fifteenth centuries were based on gold from the Gold Coast.

The first authentic record of trade in gold was in 1471 when the Portuguese landed on the shores of the Gold Coast near the mouth of the Pra River, and commenced trading. In 1553 an Englishman named Wyndham returned to London with 150 pounds of gold dust and nuggets and in 1554 another English mariner returned with some 400 pounds in weight. All of this gold, of course, had been produced by the natives mostly from gravel beds and beach sands, using crude washing methods, the most common implements, apparently, being a series of different sized wooden bowls which were used in much the same manner as our miners gold pan of today.

Shortly after they landed, the Portuguese commenced underground and surface mining operations, and with some interruptions, European-directed operations have continued up to the present. One of the most important Portuguese underground operations in the early days was destroyed by an earthquake with large loss of life, which caused a discontinuance of this type of mining for some time.

The Dutch arrived in 1595 and by 1642 the Portuguese had evacuated all of their settlements and forts. In 1872 the Danish and Dutch holdings were ceded to Great Britain.

In 1877 mining concessions were first taken out on a substantial scale, and some 6,000 natives were estimated to have been employed in gold mining operations during that year. The first of the substantial companies to be formed was the famous Ashanti Goldfields Corporation, Ltd., in 1897. Up to September 30, 1935, this company had paid out some £6,350,000 in dividends, from a production of about £14,000,000. The ore is higher grade than in any other property in the Gold Coast, and is one of the richest properties in the world.

In the late eighties and nineties, as the widespread occurrence of gold in the country began to be realized, a sizeable boom in gold mining took place, and inevitably collapsed due to wasteful promotional methods and duplication of concessions resulting from inadequate mining laws and uncertainty as to native tribunal boundaries. Gold production fell off to 22,000 ounces in 1901, but increased steadily due to a few good mines and reached a peak of 410,655 ounces in 1914. This is the highest production to date.

From 1914 lode production declined steadily and reached a low of £710,000 in the year 1928-29. Since that time it has slowly risen to £1,562,495 for 1935-36, excluding the value of the gold premium. The new figure would be about £2,574,000. This improvement is due to more efficient equipment, better labor supply, improved transport and health conditions and to the premium on gold.

The manganese output of the Gold Coast is accounted for by one company, the African Manganese Company, Ltd. It is believed that the bulk of their production goes to the United States.

The Alluvial Diamond Industry

Unlike gold, alluvial diamonds were not discovered in the Gold Coast Colony, British West Africa, until 1919. The Director of the Geological Survey was the first to recognize

Exploitation appears to have followed soon after, for in 1920 the first shipment of diamonds, some 215 carats, were exported by the first company on the diamond fields. From that time until the present, production has increased steadily, save for a slight slump in 1931 and 1932.

All the diamonds found in the Gold Coast are alluvial. No lode deposits at all have been encountered. The source of the diamonds mined at present are gravel beds varying from several inches to perhaps ten feet in thickness, covered with several feet of overburden and dense tropical vegetation. The gravel beds extend to bedrock, and the diamonds follow, to a large extent, old stream courses. The terrain is between 100 and 200 feet above sea level, and is of the low, rolling topography.

While diamonds may be found in practically every section of the country, the fields now producing the very great majority of the diamonds are in the Western Province.

Although it is beyond the scope of this paper to deal further with the geology of the region, in view of the widespread exploration for a lode source of diamonds in the proximity of the alluvial concentrations, with no encouraging results, it is believed that the original lode source of the diamonds has been completely eroded away.

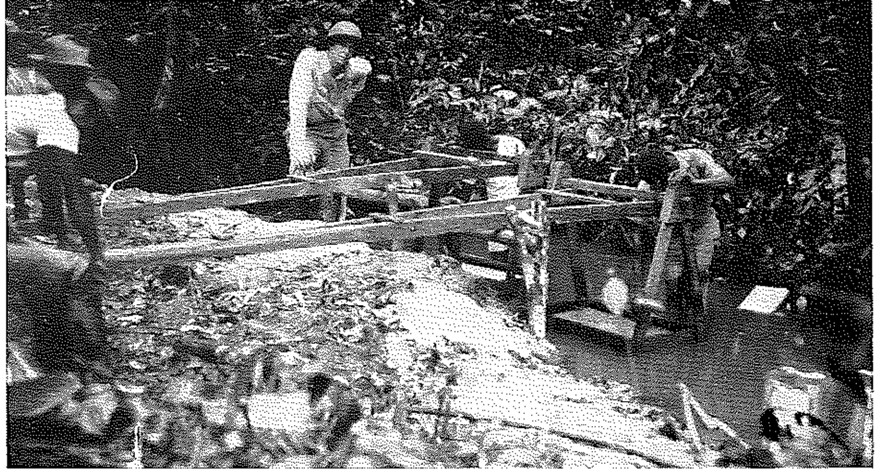
Alluvial diamonds have as their market the commercial diamond industry. To this date, no artificial diamonds have been able to replace these alluvial bortz in industry.

Nevertheless, while production has steadily increased since the early days, the price per carat has declined sharply. The average price of the stones reported in 1934-1935 was about $1.50 per carat, as compared with $2.70 in 1933-1934, $4.37 in 1929-1930, and $5.63 in 1925-1926.

Figures are lacking as to the average size of the diamonds mined, but it is believed that the average stone weighs approximately one twentieth of a carat. It is reported that occasionally a diamond as large as three carats is found, but the instances are very exceptional.

The Examination of an Alluvial Diamond Property

The examination of property alleged to bear diamondiferous gravels offers many difficulties to the exploration party. Conditions spoken of here were encountered in the Gold Coast Colony, British West Africa. When working in tropical countries under climatic handicaps and primitive conditions, it is best for the exploration party to camp as close to the work on hand as is possible.



▼ Figure 3. Diamond Jigs.

In the absence of any surface exposure of diamondiferous gravels, the general practice is to examine first the areas adjacent to present stream chanels for the following reasons:

1. The present streams may have concentrated or may be concentrating diamonds from the beds in which they were originally deposited.
2. To test for diamonds, a flow of clear water is desirable.
3. Streams traverse the valleys of the district where alluvial deposits usually occur.

The method of winning diamonds is that employed throughout the Gold Coast wherever handwinning of diamonds is carried on.

To recover diamonds from the gravels in which they occur, use is made of their high specific gravity. Diamonds are concentrated by means of shakers (Figs. 1 and 2) and jigs (Fig. 3), and then are selected by hand from the remaining gravels in the final stage of separation.

Sampling of an area is done by means of digging representative test pits, and then obtaining diamonds from the gravels encountered. Lines through the jungle bordering streams are cleared. At right angles to the path of the stream more lines are cut, the length of both systems of lines depending upon the area to be examined.

At regular intervals, pits are dug to bedrock, underlying diamondiferous gravels. Overburden is piled on one side of the pit and gravel on the other, of course. Where clay occurs beneath a gravel bed, a long, thin iron rod is driven into the bottom of the pit, and should more gravel beds exist, a grating feeling will be felt on the rod. Should bedrock be encountered before any gravel beds, the pit is not extended in depth. The most convenient size of pit to dig, giving a representative sample, is 5.2 feet square. Hence, every foot in depth represents a cubic yard of material.

The gravel is then conveyed in buckets on the heads of natives to shakers. The shakers and jigs are usually located on the bank of a stream to insure an adequate water supply, but, if this would mean too long a carry, pits are dug for a water supply, into which water seeped fairly rapidly in most areas.

The shakers usually consist of a series of three wooden trays, each two feet eight inches long by one foot four inches wide, with sides three to four inches high, with short handles projecting beyond each end, the bottoms of the trays being screens of different sizes, the largest aperture at the top. The three trays, or screens, nest into each other, and the bottom screen has rockers underneath it at right angles to the long dimension, so that from a distance the whole affair looks like an old-fashioned cradle.

Gravel is dumped on the top screen. Water is poured over it almost continuously by a native with a bucket who stands in the stream beside the shaker. The shaker is given a shaking motion by two natives who stand facing each other on the top screen and rock it rapidly and sharply from side to side. The usual sizes of the screens are as follows: Coarse—seven millimeters (about ¼"); medium—four millimeters (about one-eighth inch; fine—one-sixteenth inch.

The material which remains on top of the coarse screen, after shaking and washing, and the material which passes through the fine screen are thrown away. The material on top of the fine screen and on top of the medium screen is then placed in separate containers (usually empty five gallon gasoline cans), and jigged separately.

The jig consists of a tray about two feet eight inches long by one foot six inches wide, with sides three inches high, the bottom of which is a screen of one-sixteenth inch mesh. The tray is suspended from a round wooden shaft (which is parallel to the long dimension of the screen and about three feet above the center of it) by wooden strips which run to the four corners of the tray; a standard, which consists of two stakes driven into the ground on the edge of the stream with a crossbar fastened to the tops so that the crossbar is about three feet six inches above the ground; and an A shaped handle ten feet long, the open ends of which are fastened to the ends of the shaft above the jig screen.

The handle is placed across the standard at a point about three feet from the jig end. The screened gravel is placed in a jig tray. The tray is lowered a few inches below the surface of the water, and by means of short strokes on the handle the tray is moved up and down under the water over a range of about one inch for a period of two or three minutes.

The upward current of water through the screen, which is the result of a sudden downward movement of the tray causes a concentration action to take place in the material in the tray. The heavier diamonds (specific gravity 3.5) settle to the bottom and the lighter quartz (specific gravity 2.6) and pebbles tend to form the top layer of material. Every two or three minutes the top one-quarter inch of material is carefully scraped off and thrown away.

When these operations have been repeated to the point where only a thin bed of material is left on the screen, fresh gravel is added and the sequence repeated until all of the material from that particular pit has been jigged, at which time the remaining thin bed of concentrate is carefully removed and given to native women for final hand sorting.

This is done by the women in small, flat, black pans which contain about one half inch of water. The concentrate to be sorted is heaped on one side of the pan and then brushed little by little with a broom straw across the bottom of the pan, under water, to the other side. Owing to their different indices of refraction, the diamonds will gleam under water, while the quartz will not. When found, the diamonds are picked out and placed in a small container. Both the jigging and sorting operations are carried out under the close supervision of trusted native watchers.

Record is kept of the weight of the diamonds and the volume of gravel from which they are obtained. Should the value per cubic yard be encouraging, further areas would naturally be tested.

Mine Safety—

(Continued from page 641)

instead of pushing them. Many of these practices seem to save time and may even be encouraged by the management, but they are dangerous and should be strictly prohibited.

Although shaft accidents are relatively few, compared to those due to underground haulage, accidents of this type are likely to have fatal results, and every possible precaution should be taken to prevent them.

The hoisting equipment at all shafts where men are handled should be of ample capacity and of a standard safe design. Where shaft accidents have occurred because of failure of the hoisting equipment, they have been due almost always to lack of inspection and proper maintenance of the equipment, rather than to inherent weaknesses.

Every hoisting engine at shafts where men are hoisted should be equipped with an overwind and overspeed device, which will automatically control the speed of the hoist and prevent overwinding if the hoistman should suddenly become incapacitated.

Frequent thorough inspections and tests should be made of the hoisting engine, brakes, safety devices, safety catches and rope attachments to the cage, the entire rope, cage and sheaves. Every cage or skip on which men are hoisted should be equipped with a suitable steel bonnet extending over the entire cage to protect the men from objects that might fall down the shaft. Ample hand holds should be provided for the men and the cage platform should be enclosed on the sides by steel plates extending at least five feet above the platform. Before hoisting or lowering men after the hoisting equipment has been idle for some time the empty cage should be run the length of the shaft to make sure that it is open and safe.

The shafts at all surface landings should be enclosed to prevent men or materials from falling into it. The gates at all shaft loading pockets should be tight to prevent muck from falling down the shaft after the skip is loaded.

A definite code of signals governing the movement of the cage should be used and posted in a conspicuous place. The signals should be given to the hoistman by some reliable and properly installed signalling device. There should be at least two distinct means of signalling so that one is likely to remain in effect in case the other fails.

Workmen should be required to wear safety belts and hard hats while making repairs in and around shafts where there is danger of men falling down the shaft or being struck with falling material. Men working in the sump should be protected by heavy timbers over the sump or by having the skip lowered to a short distance above the sump and left there as long as they are working in the sump.

At mines where men are hoisted at the main shaft it is often the practice for some of the men to wait at the shaft bottom while coal or ore is being hoisted, and thus are exposed to the hazard of moving cars as well as to possible injury from material that may fall in the shaft and bounce out into the shaft station. To avoid this hazard, a waiting place convenient to the shaft bottom should be provided where the men can wait until the end of the hoisting shift.

At most mines where the cars are hoisted on self dumping cages and where the hoisting is rapid, considerable coal or ore falls off the cars as they are dumped; and unless the bottom cagers are given some protection they are apt to be struck by falling material. This protection may be accomplished largely by hanging plates from the door head timbers on the side from which the cars are caged. These plates should extend down low enough just to clear the loaded cars, and should also be hinged at the top to permit them to swing out of the way while rails or other long material are lowered.

The law in most coal mining states requires that a runaround or passageway be maintained at the bottom of the hoisting shaft to enable employees to go from one side of the shaft to the other without crossing over on or under the cage or skip. This should be a law in all mines, metal as well as coal mines.

All landings and shaft stations should be well lighted and kept free of timbers, loose rocks, and trash or waste material.

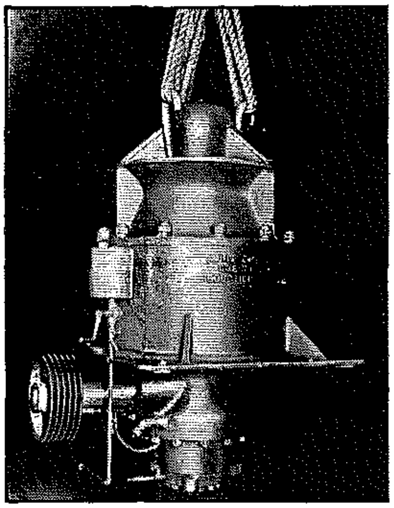
Accidents from haulage as well as from other causes can be reduced to a minimum as compared with present occurrences. To do this, however, the operator must be keenly interested in accident reduction and must be willing to take the initiative by removing all physical hazards within his power, and then through precept and example on the part of the supervisory force, eliminate the many unsafe haulage practices that in the past have been responsible for such a large percentage of haulage accidents.

With the Manufacturers

EQUIPMENT NEWS

Allis-Chalmers Adds Larger Size Type "R" Crusher

Allis-Chalmers Mfg. Company, Milwaukee, Wisconsin, in response to the wide acceptance of their No. 322 Type "R" Gyratory Crusher, has now added a larger size designated as their No. 636 Type "R" Crusher, having a 6" width of feed opening and a 36" diameter crushing head. Like the smaller size, it operates at higher speed than other crushers of the gyratory type. It has a crushing stroke selected for a high capacity, cubically shaped product, and is suitable for handling large tonnages of stone or ore. Type "R" crushers are shipped assembled, ready to set on foundations without dismantling on arrival at the Purchaser's plant.



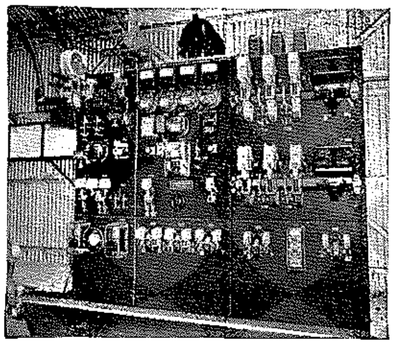
This type crusher is of simple all-steel construction—providing great strength and conserving weight. The spider and top shell are cast integral, and readily removable for replacing of its one-piece manganese steel concave ring and head mantle. Adjustment for taking up wear on this liner and on the head mantle is easily accomplished by means of a simple oil filled hydraulic jack which supports the main shaft and is located on the bottom plate of the crusher. The jack, under normal operation, firmly holds the head and shaft in position for maintaining a uniform product, but the arrangement also readily provides adjustment for product size. A safety feature permits automatic relief for tramp iron.

The crusher is driven by means of high speed cut steel gears, located in the bottom shell and operated in a bath of oil. The oil is cooled in an external cooling tank. The counter shaft is driven by flat-belt or Texrope drive from the motor or engine, as the case may be. Dust seals keep the working parts of the crusher clean—helping to reduce wear. Obstruction of crushed material is prevented by using open type bottom plate.

A number of these larger Type "R" Crusher units are already in successful commercial operation in plants throughout the country. Further information may be obtained direct from the Company's Crushing and Cement Division or the nearest district office.

Automatic Substation for the Mine

A new and completely automatic switchgear equipment for controlling one or more a-c synchronous converters in mining service is announced by the Westinghouse Electric & Manufacturing Company. Although standard for use on 2300-volt a-c 60-cycle service, with 275-volt d-c converter output, special adaptations may be had for other voltages.



The complete switchgear represents a compact unit with a length of only approximately 8 feet, and consists of hi-tension equipment, a-c starting and running panel, relay panel, and a d-c panel. All relays, meters, circuit breakers, and auxiliaries are surface mounted on ebony asbestos panels supported by a steel structure.

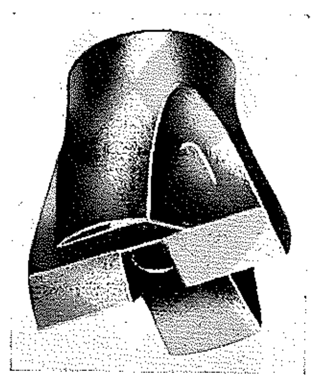
The unit features several distinctive control and protective improvements. Starting and stopping sequences are entirely automatic, and protection is continuously afforded throughout all points of the operating cycle against abnormal conditions. The d-c converter breaker may be used as a feeder breaker, thus over-current protection is incorporated in the control. Automatic reclosing is available when this breaker is used for this purpose.

For two-unit stations, there is available a "load responsive" equipment which provides for the automatic starting and stopping, in response to load demand, of both units. Manual selection of the lead-off machine is a feature of this equipment.

For further details write department 7-N-20, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

New Bulletin on Sullivan Detachable Bits—"The Bit That Holds Its Gauge"

These bits are designed so that a greater area of the cutting edges are located at the extreme outside diameter where they are most needed, providing broad chopping and reaming edges. The bits are made from electric furnace steel, forged, machined, heat treated and finished to exact gauge under automatic control to assure precision and uniformity. This provides a bit "that holds its gauge," resulting in smaller losses in gauge, fewer steel changes, fewer re-grinds, elimination of rifling in holes, no binding or catching of bits.



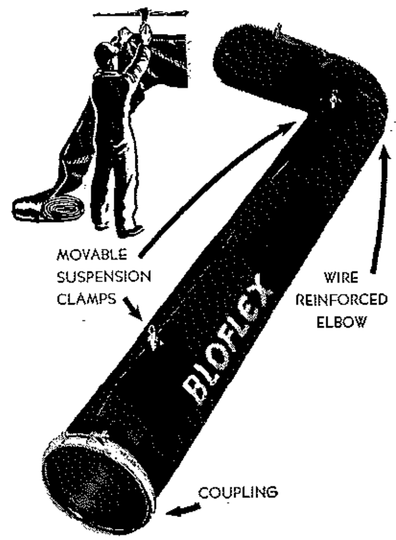
Center hole and side hole types. The rod, fitted with special rugged acme thread, bottoms into the bit so that the full force of the blow is not centered on the threads.

Bit gauges 1½ to 2¾ inches. Rods: 2 ft. changes to 30 ft. Threading tools and detachable bit grinders also available.

Write for bulletin 87-G, Sullivan Machinery Co., Michigan City, Indiana.

Two Types of Flexible Ventilating Duct

After two years of development, Hersey & Company, Inc., Minor N. & East Newton Streets, Seattle, Wash., are now announcing two types of flexible ventilating duct, "Bloflex" and "Flexaust." The former is of particular interest in the mining industry.



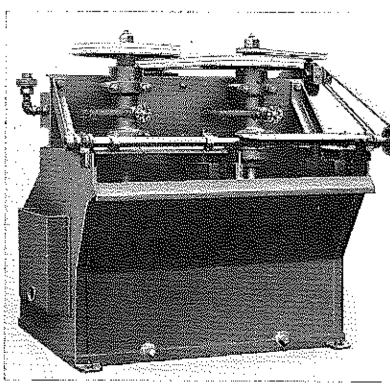
"Bloflex" is the trade name of a new type of flexible ventilating tubing made in 8" to 24" diameter. It consists of canvas specially rubberized for the purpose by the manufacturer and supported by movable aluminum grips on the seam. The latter eliminates the need of the usual suspension wire. The coupling is demountable and consists of a 60° sided rustproofed clamp squeezing two solid rings together over which the tubing ends are folded like a cuff.

"Flexaust" is a wire-reinforced ventilating duct, shown in the illustration as an elbow in "Bloflex." Besides its value as a creaseless self-adjusting elbow for fabric ventilation tubing, it makes ideal elbows for metal ventilation lines under suction. Use of short sections between lengths of metal pipe makes it possible to follow irregular workings and to pass around chutes, etc., without the difficult installation of special metal fittings.

Detailed information will be gladly furnished.

New Duplex Flotation Machine

The Morse Bros. Machinery Company announces the addition of the Morse-"Weinig" Duplex (2-Cell) Flotation Machine to their full line of Morse-"Weinig" Flotation Machinery. This new duplex machine embodies the same principles throughout as the standard Morse-"Weinig" Flotation Cells except that the liners and impellers are made of rubber so the maximum length of service may be expected from these wearing parts. The duplex cells are supplied with hand operated weir gates to control the pulp level separately in each cell. The construction is of all metal and the duplex cells are especially adapted for the treatment of coarse feeds of high density and for application at gravity concentration mills where only a small volume of flotation capacity is necessary.

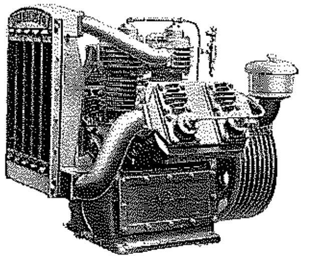


The Morse-"Weinig" Cells are also manufactured in single cell units called the Morse-"Hydra-Cell." They are recommended for use in the grinding circuit and will treat a high density feed direct from the grinding mill. Special features are incorporated in the Morse-"Hydra-Cell" to make a high grade flotation and gravity concentrate prior to treatment of the pulp by classification.

The Morse-"Weinig" Duplex Cells are illustrated and described in the new flotation bulletin No. 402 and copies of the bulletin are available promptly upon request to the Morse Bros. Machinery Company, Denver, Colorado.

Balanced Angle Two-Stage Air Compressors

The illustration below shows a Two-Stage Worthington Balanced Angle Air Compressor, which is rapidly becoming a very popular unit. Among the many features which make for efficiency and convenience in the operation of this unit are its sturdy construction combined with light weight, balanced angle compressor with Timken Roller Main Bearings, articulated type connecting rods, force-feed lubrication, deep-finned air cooled cylinders, Worthington patented feather valves, and by-pass on loader control.



▼Two-stage air compressors, displacements to 445 c.f.m., pressures to 125 lb./sq. in.

This unit is built in sizes from 83 c.f.m. piston displacement up to 445 c.f.m. piston displacement, requiring from 15 to 75 horsepower.

Further details on this equipment will be furnished by Worthington Pump and Machinery Corp., Harrison, New Jersey.

Randall P. Akins

Mines Men will be grieved to learn of the death of Randall P. Akins, one of the best known mill men in the Rocky Mountain Region. Although he never had the privilege of attending the Colorado School of Mines, yet he was a great Mines booster and numbered amongst his friends many Mines Men.

The professional career of Bill Akins, as he was known by his friends, was linked closely with the Colorado Iron Works. He joined their staff in 1888 and was associated with them in various capacities for the rest of his life. His construction ability was soon recognized and he was sent out on many assignments to build mills and smelters. He built the Portland Mill at Victor, Colorado—at times he supervised the construction of several mills at the same time.

Perhaps Bill Akins will be remembered, during the years to come, by his invention of the Akins Classifier, which has found use in mills all over the world. He also invented a flotation machine and was instrumental in the development of a number of other metallurgical machines, all of which were manufactured by the Colorado Iron Works.

Mr. Akins was born in Nebraska City, Nebraska. He was 69 years of age at the time of his death on October 25th, 1940. He came to Denver with his parents when 10 years of age and made Denver his home ever since. He is survived by his wife, Mrs. Stella Akins, and a daughter, Mrs. Helen Van Brocklin, both of Denver.

Mines Grad Announces New Resistant Steel

Earl R. Parker, '35, metallurgist for the General Electric Company, in attendance at a meeting of the American Society for Metals in Cleveland recently, announced that he had discovered a new alloy for the making of a new type of heat resisting steel for use in steam turbines.

Parker reported that his experiments with columbium a relatively rare element, have produced an alloy of exceptional properties when added in small amounts to iron. He also stated that the alloy is superior to expensive steels in meeting the demands for metals to withstand high temperatures and stresses.

Special steels are available for use in steam turbines with high temperatures of about 1,000 degrees Fahrenheit, but Parker claims the new alloy is capable of successful operation at 1100 degrees or more.

While at Mines, Parker was a member of the Alpha Tau Omega social fraternity; also Tau Beta Pi and Sigma Gamma Epsilon honorary fraternities. In addition he was president of his junior class and R.O.T.C.

College Graduates Offered Marine Corps Reserve Commissions

Due to the rapid expansion of the Marine Corps a large number of Reserve Officers will be needed on active duty with regular Marine units during the next year, according to information recently received from Lieutenant Clyde C. Roberts, officer in charge of the Marine Corps Recruiting Station, Denver, Colorado.

Applicants must qualify under the following requirements:

Be graduates of nationally or regionally accredited colleges or universities having a full four year course. Medical, dental, and theological students will not be considered.

Be native born male citizens of the United States.

Be over twenty and under twenty-five years of age on the date of acceptance of commission as Second Lieutenant, Marine Corps Reserve.

Be unmarried.

Be recommended as to character and qualifications by the President of the institution from which graduated, by one member of the faculty, and by at least three citizens of good standing in the candidate's home community.

Pass the physical examination prescribed for second lieutenants of the regular service.

Not be a member of the Army Reserve, National Guard, or Naval Reserve.

Applicants that meet the above requirements will be sent to the Marine Barracks, Quantico, Virginia, for three months basic training. During these three months they will receive food, clothing, dental and medical attention, and pay of $36.00 per month. Men that successfully complete the three month's training will be commissioned as Second Lieutenants in the Marine Corps Reserve and sent to an officer's training school for three more months. As Second Lieutenants they will receive pay and allowances totaling $183.00 per month. Upon completion of the course at the officer's training school the Reserve officers will be assigned to duty with regular Marine units for a period of six months, making a total of one year of training. As Reserve Officers they will not be eligible to be called for training under the Selective Service Act.

Reserve Officers that make outstanding records may be offered a commission in the regular Marine Corps.

Past graduates, or mid-year graduates, who believe they can meet the requirements for a reserve commission in the Marine Corps are urged to apply immediately as only about eight hundred candidates will be accepted from the entire United States. Applicants may receive complete information by writing to the Marine Corps Recruiting Station, 16th & Arapahoe Streets, Denver, Colorado, or to Headquarters, U. S. Marine Corps, Washington, D. C.

TRADE PUBLICATIONS

(1210) MINE HAULAGE AND HANDLING EQUIPMENT. Catalog No. 40, Card Iron Works Co., Denver, Colo., is a new publication covering coal, ore and industrial cars, wheels, trucks, rope haulage equipment, track work and tipple equipment with new price list covering the various items. This catalog contains a large amount of engineering and descriptive material together with dimension tables on equipment, which will all be very useful to the average mine operator.

(1211) YOUR ENGINEERING NOTEBOOK. "Trefoil" for December, published by the Denver Equipment Co., Denver, contains, among other items, an article illustrating the use of the Pan Filter Unit for small flotation milling plants. Notes and flow sheets are given on plants of Comision De Fomento Minero. Here will be found a large amount of very useful information.

(1212) ELECTRIFUGAL PUMPS. Bulletin B-6140 by Allis-Chalmers Mfg. Co., Milwaukee, Wisc., illustrates and describes the new all-in-one "Electrifugal" Pumps for 1 to 10 horsepower inclusive, and heads up to 160 ft. The bulletin fully describes the construction and many important features of this pump.

(1213) PRESSURE VALVES. Mechanical Topics, Volume 4, No. 3 by International Nickel Co., 67 Wall St., New York, gives a well written and illustrated article on the adaptation of Monel nickel in the manufacture of valves to be used in high pressures up to 5,000 lbs. per sq. in.

(1214) BALL MILLS. Bulletin No. 405 by Morse Bros. Mchy. Co., Denver, Colo., illustrates and describes ball mills manufactured by this company. Table of dimension, capacities, horsepower and shipping weights are given.

(1215) CONVEYING AND SORTING. Link-Belt News for November 1940, published by Link-Belt Co., 307 No. Michigan Ave., Chicago, Ill., contains a very interesting article showing how one gold mine has handled over 5,000,000 tons on sorting tables and equipment during the last 9 years. Other interesting articles will be found in this 8-page publication.

(1216) PILOT PLANT. Folder AH-352 by Hardinge Co., York, Pa., illustrates two small grinding units for wet and dry pilot plants.

(1217) MISCELLANEOUS EQUIPMENT. H & B Bulletin, November-December 1940, by Hendrie & Bolthoff Mfg. and Supply Co., Denver, Colo., contains 64 pages illustrating and describing a large number of new tools and appliances which may be used to advantage in connection with mining and metallurgical operations.

(1218) SHOVELS AND DRAG LINES. Bulletin D-1007 by Bucyrus-Erie Co., So. Milwaukee, Wisc., describes and illustrates the construction and operation of the Bucyrus-Erie 100-B combined shovel and drag line unit. In this 32-page bulletin will be found much important information for operators of power shovel and drag line equipment.

(1219) ELECTRICAL EQUIPMENT. The General Electric Co., Schenectady, N. Y., have recently published the following bulletins: GEA-3020A which describes and illustrates an Electrostatic Voltmeter; GEA-3480 describes and illustrates Frequency-Modulation Communication Equipment; GEA-2964A describes and illustrates use and construction of the new Magnetic Motor Starter; GEA-2968 explains and illustrates the new Nozzle-Swirl Process as applied to the production of oxide-free lead sheath; GEA-2963B shows Time Switches for indoor and outdoor service in use for control of A-C circuits; GEA-3191 illustrates and describes A-C Magnetic Control for cranes, derricks and material-handling equipment; GEA-2165A shows construction, operation, dimensions and ratings of oil circuit breaker, 25,000 kva, 400 to 800 amps and 5,000 to 7,500 volts.

(1220) TOOL JOINTS. A recent bulletin from the Reed Roller Bit Co., Houston, Texas, illustrates the construction and use of Reed Shrink Grip Tool Joints and their many advantages.

(1221) INCREASED AIRPLANE OUTPUT. Automobile Facts, November 1940, by Automobile Mfg. Assoc., New Center Bldg., Detroit, Mich., gives a good illustrated article on how motor plants are tackling the complex new task to aid the airplane industry.

(1222) AIR COMPRESSORS. Bulletin H-620-B-16D by Worthington Pump and Mchy. Corp., Harrison, N. J., illustrates and describes the construction and operation and many valuable features of the Air-Cooled, Balanced Angle Two-Stage Air Compressors. Dimensions and specifications together with tables of capacities are included.

(1223) NICKEL STEEL TOPICS for October 1940, published by International Nickel Co., 67 Wall St., New York, contains 12 pages including many well written articles showing advantages and use of nickel steel for equipment used in the mineral industries. You will find much of interest in this publication.

FOR YOUR CONVENIENCE

Send your publications to Mines Magazine, 734 Cooper Building, Denver, for review in these columns. Readers will please mention Mines Magazine when requesting publications from the manufacturer. Readers may order publications from this office by giving index number.

(1224) CABLEWAY EXCAVATORS. Catalog No. 18, Section 3 by Sauerman Bros., Inc., 438 So. Clinton St., Chicago, Ill., contains 14 pages illustrating the uses for Slacklime Cableway Excavators, illustration of actual operation and equipment used.

(1225) MECHANICAL LETTERING. The Master Printer and Lettering Guide Manual distributed by W. H. Kistler Stationery Co., Denver, Colo., contains 24 pages showing the use of the Master Printer outfit in connection with drafting. Every draftsman should have a copy of this manual.

(1226) CYANIDE MACHINERY. Bulletin C-40 by Morse Bros. Mchy. Co., Denver, Colo., contains a general flow sheet with illustrations and descriptions of all equipment used in a modern cyanide plant, together with estimated horsepower of various machines and shipping weights.

(1227) CABLE JOINTS. Bulletin GEA-2987 by General Electric Co., Schenectady, N. Y., contains 44 pages illustrated with detail drawings of various connections and how they are made for the lead covered cable.

(1228) SHAKER CONVEYOR ACCESSORIES. Bulletin L-352 by Goodman Mfg. Co., Chicago, Ill., contains 12 pages showing accessories used in connection with Shaker Conveyor Equipment, giving many illustrations and dimensions which will be useful to operators.

(1229) OIL FIELD DRILL WORKS. Bulletin No. 286, National Supply Co., Toledo, Ohio, illustrates a new disengaging coupling attachment and independent hydromatic brake mountings for use in connection with new draw works or those already in the field.

(1230) DENVER THICKENERS AND DIAPHRAGM PUMPS. Bulletin G3-B7 illustrates Denver Lowhead Thickeners and Diaphragm Pumps to be used in connection with the same, and also other equipment used for speeding up modern gold production.

(1231) HIGH PRESSURE PUMPS. Moly matrix for August 1940, by Climax Molybdenum Co., 500 5th Ave., N. Y., is devoted to the use of molybdenum steels in connection with high pressure pumps. Analysis of steels especially adapted to this work are given.

(1232) 4-WHEEL SCRAPERS. Bulletin 4WS-3 by Bucyrus-Erie Co., So. Milwaukee, Wisc., contains 24 pages illustrating the construction and application of their 4-Wheel Scrapers for the rapid handling of earth and broken material. Full specifications are included.

(1233) COMPRESSORS. Bulletin AC-8 by Gardner-Denver Co., Quincy, Ill., illustrates and describes their Vertical "V" Type Air-Cooled Compressors and Vacuum Pumps, single and two-stage built, or direct motor driven. Tables of sizes, capacities and horsepower are shown.

(1234) THERMOMETERS AND PRESSURE GAUGES. Catalog No. 6706 by Brown Instrument Co., Wayne & Roberts Ave., Philadelphia, Pa., contains 20 pages illustrating various types of recording thermometers and pressure gauges for use in connection with different industries. This book also shows methods of installation.

notes on accident prevention which will save the operator much in time and money.

(1236) ELECTRIC WELDED PIPE LINES. Folder, dated November 14, by H. C. Price Co., Bartlesville, Okla., gives an example of their crew electric-welding a 20" gas line in Northern Illinois. They have 10,000 miles of electric welded pipe lines to their credit.

(1237) PUMPING PROBLEMS. A 16-page folder of semi-technical nature published by the International Nickel Co., 67 Wall St., N. Y., contains a great deal of information, well written and well illustrated that will be useful to most everyone associated with the mineral industries.

MUSEUM NOTES

The Geological Museum depends on gifts from students, alumni, and friends for growth. The following were received by J. Harlan Johnson, curator.

JULY TO NOVEMBER, 1940

W. S. LEVINGS, '20
$15.00 to assist in collecting material.

JOHN M. CLAUSER, St. Louis, Missouri
Numerous fossils from St. Louis region.

D. MCDONALD, Denton, Texas
Collection of Comanchean fossils—Grayson Co., Texas.

CLARENCE M. JENNI, Festus, Missouri
Collection of fossils, Festus region, Missouri and Illinois.

HARRY MCDANIELS
3 specimens sphalerite—Big Four Mine, Green Mountain.

E. A. WALDRON, Alpine, Texas
Cinnabar and other mercury minerals, and some fossils, from the Terlingua District, Texas.

B. GOLSON, Los Angeles, California
Collection of Cretaceous fossils from Tennessee.

JACK ADAMS, '41, Golden, Colorado
Specimens of Colorado minerals.

R. K. DEFORD, '21, Midland, Texas
Fossil salt crystals—New Mexico.

BRADLEY DEWEY, San Marino, California.
15 modern echinoids.

J. HARLAN JOHNSON, '23
Collection of minerals and fossils from the Terlingua District, Texas.

C. LAVINGTON, Continental Oil Company
15 specimens of rocks and fossils from Wyoming.

VIC HENDRICKSON, Denver, Colorado.
25 algal biscuits or concretions from east of Denver.

N. BOSCO, '35, Golden, Colorado
5 mineral specimens from Brazil.

JOHN C. HAFF, Golden, Colorado
Minerals and rocks from Georgetown District, Colorado.

ALLAN CAPLAN, New York City
5 crystals of Chrysoberyl, Brazil.

R. V. WHETSEL, '16, San Antonio, Texas
Placer cassiterite, Zacatecas, Mexico.

L. W. LEROY, '33, Sumatra, N. E. I.
Collection of type specimens of ostracods from the Tertiary and Recent of the Nederlands East Indies.

25 topographic maps from the estate of W. C. Brown (through Dr. Boyd, '32.

MINES MAGAZINE
734 Cooper Building
Denver, Colorado

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New Chemistry Building To Be Reality

Plans have been announced for construction, in the near future, of a new Chemistry building, tentatively named, Chauvenet Hall. The plans have been discussed with Mr. R. K. Fuller, Denver architect, who will present rough drawings the early part of January.

Mr. Fuller has conferred with Dr. Ward and has gone over the present chemistry building and the plans of the sections of the building drawn up by the different divisions of the department. The building is being designed with the future expansion of the school to an enrollment of 1200. The new building will be placed on the lot where the Physics building is, facing Fourteenth street.

A chemistry building of this size will require four main laboratories, a frosh lab with a capacity of about 400, quant lab for 300, physical chem lab for 200, and organic lab for 150. Eight or ten class rooms will be needed, one of which must be large enough to accommodate the largest class, and should be complete with sound and projection equipment and facilities for demonstrations. Several smaller labs will be needed, such as research labs for seniors and graduate students, investigational, gas and fuel, steel, spectroscopy, and X-ray laboratories.

This is the second unit of the ten year building program embarked upon in 1937. It will rank with the new Geology-Geophysics building in beauty and utility.

New Option in Curricula

Mining Geology is a new option to be added to the curricula next fall. Graduates in this option will receive a mining degree, and will be included in the mining department. This course has been planned for several years, and is in response to many inquiries about mining with emphasis on geology instead of metallurgy.

The freshmen and sophomore years are identical with the regular mining course. In the junior year, geophysics 301 and 302 replace general metallurgy and pyrometallurgy. In the senior year, ore dressing is replaced by optical mineralogy and mineralography. In addition, a new course, Field Methods in Mining Geology, will be required in the Mining Geology option. This four-credit course will be for the study of the applications of geology in the location and development of mineral deposits, with field problems.

Dr. Adams Heads Defense Unit

Dr. Arthur S. Adams, former head of the department of mechanics at the Colorado School of Mines, has been placed in charge of a new course in mechanics of airplane structures in the interest of national defense. Dr. Adams, who is now assistant to the dean of the College of Engineering, Cornell University, and two other Cornell professors who are teaching the new course, initiated the project at the request of the Curtis-Wright and Bell Aircraft companies, at the Burgard Vocational high school in Buffalo, New York.

The course will provide men holding engineering degrees with special training in airplane design. Initial enrollment was 140 men, most of whom hold engineering degrees but desire special training in airplane design to qualify for better positions with the companies as their organizations expand.

Classes are being held in the evening so that the men will not be away from their jobs during the training period. There are eight sections, two on each night of the first four evenings of each week.

Professor Fitterer Recovering

Professor Fitterer, head of the Mathematics department and one of the senior members of the faculty, is recovering nicely from an operation performed November 4 at the Corwin hospital in Pueblo. He will resume his duties at the School following the Christmas vacation.

New Apparatus for Testing Lenses

Dr. Merideth of the Physics department is developing a new type of apparatus to test the "astigmatic characteristics and the curvature of fields" of lenses. Using an old spectrometer as a base, Prof. Merideth designed an optical bench, a lens clamp, and a few minor parts to build the present tester.

The optical bench is a one foot brass tube in which slides another brass tube with cross-hairs in it. The clamp holds the lens to be tested between the bench and the lens of the instrument. A mercury vapor lamp throws a dull green light through the hairs, and, if the lens is perfect astigmatically, both hairs will focus at the same time. If they do not focus simultaneously, the degree and type of astigmatism can be ascertained. The school machine shop made the supplementary parts.

Former Grid Coach Visits Campus

"There wasn't any grass on this ground when I was here," commented Ted Stuart, Blaster grid mentor three decades ago, as he looked the home ground over last month for the first time since his tutoring days at Mines.

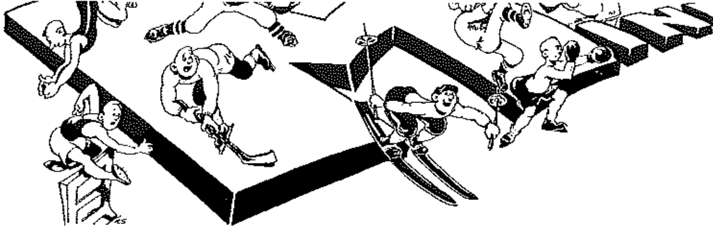
Stuart, now a prominent San Francisco attorney, taught the Miners how to play football in 1910 and 1911. He said that the ground at Brooks field was a hard and plenty hard alkali dirt that gave players infections from the slightest scratch.

The former Mines' football coach played for Denver and Michigan. He was a famous halfback and punter for Michigan and was on his way to the coast after attending the Wolverines' homecoming honoring Fielding Yost.

"Pop" Buell Placed on Faculty

A recent appointment on the faculty at *Mines* was that of A. W. ("Pop") Buell in the Descriptive Geometry and Petroleum departments.

After his graduation in 1908, "Pop" spent several years in Ecuador as chief chemist and superintendent of the cyanidation plant, South American Development Company. Upon his return to the States he did geological work until the beginning of the World War when he entered the service. He returned to *Mines* in 1922 on a fellowship, teaching chemistry. He received his Master's degree in Petroleum in 1923. He then became associated with the Midwest Refining Company (now Stanolind Oil and Gas Co.), serving as Petroleum and Experimental Engineer and Chief Chemist until 1936 when he resigned. Since then he has resided in Golden and doing consulting work in Mining and Petroleum.



Sports March

By J. W. HYER, Jr., '42

Fresno Game

Fighting against superior manpower and weight, Colorado Mines climaxed its season holding the heavily favored Fresno State Bulldogs to a 28 to 0 win in the California team's homecoming tilt at Fresno, Thanksgiving day before a crowd of more than 8,000.

Approximately 400 of the Colorado Mines Alumni in California met the team when they arrived in Fresno and attended the game. They were hosts to the Mines coaches and team after the game.

The Miners played a hard game the first half and held the Bulldogs to a lone marker, a reverse from the 18 by Lester Terry in the second period. Fresno State struck twice in the third period and once in the fourth stanza when Mulkey intercepted Hallman's pass on the 28 and scampered to a touchdown.

Two desperate drives were staged by the Orediggers. In the third period, they drove eighty yards to the Fresno one but were stopped by a fumble. The game ended with the Orediggers on the Fresno 12.

Dick Moe, John Gargan, Joe Berta, and Harry Hallman played outstanding football for the Miners.

After the game, at the banquet given by the California Alumni Association, a cup was presented to Joe Berta for being the most valuable player on the team. The Mines coaches gave talks and head coach, John Mason, introduced his squad of twenty-nine players.

The Miners left Golden Monday, November 18 and returned to Golden one week later after visiting Los Angeles and the Grand Canyon.

Frosh Game

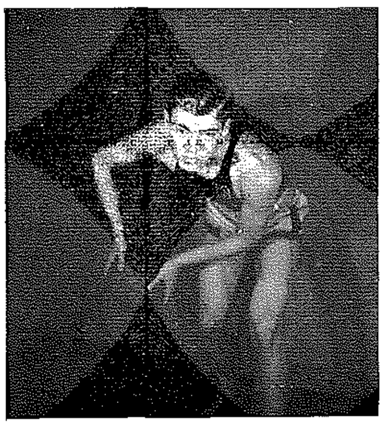
Colorado Mines Baby Blasters pulled all the passing tricks out of the bag and came from behind to tie a heavier Colorado College Cub eleven 20 to 20 in a game played at Colorado Springs, Saturday, November 16.

Pitching Joe Murphy, accurate heaver from Canyon City, Colo., hit his man twenty-four times in a wild game that saw the Miners overcome a 20 to 0 half time lead of the Tigers and score 20 points in an aerial second half that had all the elements of a baseball game.

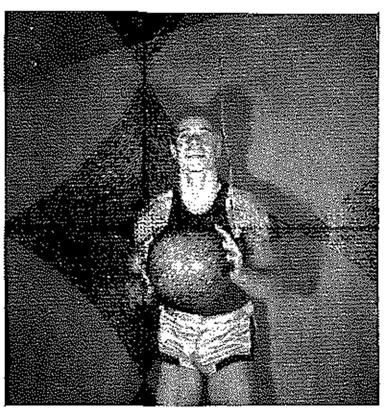
Bill Brown, blocking back, Joe Murphy, tailback, and Dell Redding, fullback, starred for the Miners and are considered excellent prospects for the varsity.

Basketball

Spirit and optimism is prevalent on *Mines'* campus for the prospects of the coming basketball season. Coach Doy Neighbors takes over the reins for the second year and has seven lettermen reporting for practice. Besides the lettermen there are three squadmen and three star, last-year freshmen practicing.



Lee Talbot



Harold Rogers

Sports writers' opinion and those in the know tab the Orediggers as the team to beat in the coming Rocky Mountain race. So far on paper the Miners appear tough enough to scare big seven opponents into not signing them up for pre-season games. The Blasters have a game scheduled with the Denver University Pioneers in Denver January 3. On January 11 and 12, the Miners face Greeley State in their first conference games.

Competition is high for the forward spots on Neighbors' five. Lee Talbott and Bill Bousman, veteran junior guards, have the inside on the guard positions. Hal Rogers, all-conference forward and conference high scorer last year, has practically cinched the pivot post. High in the running for the forward positions are Dean Thompson, junior, letterman, Lou De Goes, senior one hand artist, Bob Comstock, senior, letterman, and John Keating, last year frosh hot shot. Lou De Goes was injured in the Greeley game midseason last year and was out for the rest of the year but is alright now.

Bob Bernstein, center, Red Retallack, and Paul Davis, last year squad men, and Robin Anderson and Fred Doty, sophomores are pushing the regulars for their first team berths.

Thumb-nail sketches of the team:

Hal Rogers, junior, letterman, height, 6-1½; "Rog" hails from Jonesboro, Ark. He is one of the fastest men on the squad and drives hard. He was all-conference last year and conference high scorer. This ought to be another banner year for "Rog" who will be one of the main cogs in the Oredigger offense.

Lee Talbott, junior, letterman, height, 6-2; "Smooth" comes from Kansas City and directs most of the team's floorwork. He is a team player and a dead shot with either hand and from the back court. Talbott is a cool player and should be right behind Rogers in the scoring column.

Bill Bousman, junior, letterman, height, 6-2; "Bousie" is from Denver where he starred on the North high school team. He and Talbott form a

(Continued on page 655)

FROM THE *Local Sections*

BAGUIO

L. W. Lennox, '05, President; Frank Delahunty, '25, Vice-President; T. J. Lawson, '36, Secretary-Treasurer, Box 252, Baguio, P. I. Monthly dinner meeting third Wednesday each month.

BIRMINGHAM

W. C. Chase, Ex-'05, President; W. C. McKenzie, '22, Vice-President; Hubert E. Risser, '37, Secretary, Flat Creek, Alabama. Meetings upon call of secretary.

A dinner meeting of the Birmingham Steel Empire Section was held at the Tutwiler Hotel in Birmingham, on Saturday evening, November 9, 1940.

It was a business meeting, called for the election of officers and other matters needing attention. The election was held with the following results:

W. C. Chase, Ex-'05, President; W. C. McKenzie, '22, Vice-President; Hubert E. Risser, '37, reelected as Secretary.

Methods were discussed for increasing the membership and attendance. The desire was unanimous that some of the Alumni from neighboring states meet with us.

Plans were made for the annual banquet on December 14 which all Mines Men in the district are invited to attend and bring their wives.

This section was happy to welcome a new member, Tench G. Swartz of the class of '39.

The following men were present:

Will Coghill, '03; T. C. DeSollar, '04; W. C. Chase, Ex-'05; W. C. McKenzie, '22; Walter J. Hulsey, '27; J. W. Scott, '31; Tench G. Swartz, '39; Hubert E. Risser, '37.

BAY CITIES

Ronald S. Coulter, '19, President; R. P. Obrecht, '34, Vice-President; Leslie E. Wilson, '27, Secretary-Treasurer, 215-7th Avenue, San Mateo, Calif. Four meetings per year, 2nd Monday, March, June, September and December.

BUTTE

E. S. McGlone, President; H. M. Strock, '22, Secretary, 1309 Platinum St., Butte, Mont. Meetings upon call of Secretary.

CHICAGO

A. L. Lynne, '06, President; M. E. Frank, '06, Secretary, 4537 Drexel Blvd., Chicago. Meetings upon call of secretary.

CLEVELAND

K. D. True, '35, President; R. J. Maloit, '37, Secretary-Treasurer, 9701 Lamont Ave., Cleveland, Ohio. Four meetings during year, 4th Friday, March, June, September and December.

DENVER

Paul Archibald, '35, President; Duane Gleghorn, '34, Vice-President; Earl Durbin, '36, Secretary-Treasurer, 3338 Gilpin St., Denver, Colo. Four night meetings per year. July, October, January, April.

HOUSTON

Clark W. Moore, '32, President; R. J. Schilthuis, '30, Secretary, 1410 Gustav, Houston, Texas. Dinner meeting, second Friday of month. 6:00 P. M., Lamar Hotel, Houston, Texas.

The Houston Chapter held its regular monthly meeting on Friday, November 8, 1940 at 6:00 P.M. in the cafeteria of the Lamar Hotel in Houston. The following three men were in attendance:

M. E. Danitschek, '40; C. W. Maguire, '36; Ralph J. Schilthuis, '30.

LOS ANGELES

R. S. Brummett, 26, President; William Dugan, Ex-'12, Secretary, 315 West 9th St., Los Angeles, Calif. Four meetings during the year, 2nd Monday of month, January, April, July and October.

MANILA

A. F. Duggleby, '15, President; Ralph Keeler, '31, Secretary, Box 297, Manila. Dinner meeting, first Friday each month.

NEW YORK CITY

C. L. French, '13, President; Ben W. Geddes, '37, Secretary, 1112 University Terrace, Linden, N. J. Meetings held at the Western Universities Club, 4 West 43rd St., New York City, the second Tuesday of each month. Visiting miners please note.

The November meeting of New York Section was unusually well attended and bespeaks well of the value of a planned and interesting program.

The New York Section by vote placed itself on record as supporting the following resolution:

"Whereas, in view of the foreign situation and other reasons which it considers good and sufficient, the majority of the electorate has decided to return the present administration to power despite not only the violation of the third term tradition but also the failure of the administration to solve the problems of unemployment, business recovery, and the mounting national debt;

"Therefore, be it resolved that the New York Section of the Colorado School of Mines Alumni Association are in wholehearted support of an intelligent, loyal, and cooperative minority opposition which will oppose the policies of the present administration which it considers unsound, while supporting such policies as time has proven to be for the best interest of the country at large."

The speaker of the evening was Dr. C. C. Van Nuys formerly head of the Physics Department at *Mines* and for the last twenty years Chief Physicist to the Air Reduction Co. In the hands of a less capable speaker, his subject might have been too "highbrow" for most Miners, but Dr. Van Nuys gave a very interesting talk on the relationship of the development of physics to the classical or philosophical trend of thought. He began his discussion with a history of Grecian scientific philosophies as developed by Pythagoras, Plato, and Aristotle. Then he discussed the relationship of these ancient philosophies to the most recent trends in physics such as Einstein's Theory of Restricted Relativity and the Quantum theory.

We were glad to have Ray McKinless back with us for this meeting. Mac has been with us several times previously on his trips to the States from Venezuela.

Those present at the meeting were:

Harry J. Wolf, '03; Ted Pilger, Ex-'10; Warren Currens, '12; C. L. French, '13; Geo. Roll, '19; J. G. Bevan, '21; Frank McKinless, '23; Wm. Berry, '24; Ray McKinless, '25; S. Del Rio, '28; Ted Carter, '31; Ben Geddes, '37; Bill Sparr, '39; Bob Johnston, '40; I. C. Sleight, '40; Dr. C. C. Van Nuys, and D. M. Armstead.

SALT LAKE CITY

Otto Herres, '11, President; Kuno Doerr, Jr., '27, Secretary, 700 McCormick Bldg., Salt Lake City, Utah. Meetings upon call of secretary.

SEATTLE

Axel E. Anderson, '04, Seattle, Wash., President; Louie C. Rhodes, '20, Spokane, Wash., Vice-Pres.; R. Kenneth Burgess, '28, Portland, Ore., Vice-Pres.; Daniel L. Beck, '12, Secretary-Treasurer, 1020-21 Lloyd Bldg., Seattle, Wash. Meetings: 2nd Monday, September, December, March, June. Visiting Mines Men please notify secretary and called meetings will be arranged.

PHOENIX

Two meetings in year, second Saturday in April and October. T. E. Giggey, '34, President; A. F. Hallett, '09; Percy Jones, Jr., '08, Vice-Presidents; E. M. J. Alenius, '23, Secretary-Treasurer, Box 2751, Phoenix, Ariz.

PITTSBURGH

S. L. Goodale, '04, President; A. M. Keenan, '35, Secretary, Box 146, Pittsburgh, Pa. Meetings upon call of secretary.

TULSA

John R. Evans, '23, President; D. H. Peaker, '32, Secy.-Treas., c/o The Carter Oil Co., Tulsa, Okla. Meetings upon call of secretary.

WICHITA

Thomas H. Allan, '18, President; John T. Paddleford, '33, Secretary-Treasurer, 429 First National Bank Building, Wichita, Kansas. Meetings upon call of secretary.

Sports March—

(Continued from page 653)

deadly defense combination that keeps the opposition worried. Bousman is one of the best guards in the conference and a sure shot from the back court.

Dean Thompson, junior, letterman, height, 6-0; Dean hails from La Grange, Ill., and is a junior college transfer. Dean plays either guard or forward dependably and may get the starting call this year.

Bob Comstock, senior, letterman, height, 6-1; "Tony" comes from Nashville, Tenn. Around the foul circle, "Tony" is a dead-eye.

Lou De Goes, senior, letterman, height, 5-11; Lou is from Los Angeles. He had some tough luck last season and received a knee injury in the Greeley game. However this year Lou is raring to go and puts plenty of spark in the team. When he is "on" with his push shots he is dangerous.

Paul Davis, junior, letterman, height, 6-0; "Stinky" is from Denver and was a reserve on last year's team. He plays guard and is a good set shot.

Bob Bernstein, junior, height, 6-3; Bob comes from Denver and is the tallest man on the squad. He was a squad man last season at the center spot. Bob has improved a great deal this year and should see plenty of action.

Bob Retallack, junior, height, 5-8; "Red" hails from Wheatridge, was a squad man last season, and is the smallest player on the team. He is fast, an excellent shot, and has plenty of spirit.

star of the frosh team last year. He is an aggressive player and potential star on the varsity. He sinks them from any place on the floor and should be good addition to the regulars at forward.

Fred Doty, sophomore, height, 6-1; Another Wheatridge product, Fred has great possibilities. He is a one-handed artist and plays the forward spot.

Robin Anderson, sophomore, height, 5-11; Robin comes from Vancouver, British Columbia. A center prospect, Robin is a hard player. With experience he should develop into a first string man.

Neighbors' first string lineup will probably include four juniors and a senior or sophomore. Talbott and Bousman will hold down the guard positions, Rogers at center, Thompson and Comstock or Keating at forwards.

Soccer

Colorado Mines emerged from the first half of competition in the Denver Soccer League as champions. In the final game they tied the Denver Danes 2 to 2. Morales, Moya, Regalado, and Roberts have been the mainstays of the Miners' team.

NEW MEMBERS

November 1940

Alumni

J. N. Adamson, '22 - Denver, Colorado
L. J. Brewer, '39 - - Pioche, Nevada
Wayne H. Denning, '26 - Pasadena, Calif.
C. J. Elmer, '34 - - Houston, Texas
F. G. Fleischman, '36 - Kernville, Calif.
H. L. Halstead, '32 - - Dundalk, Md.
Joseph L. Hohl, '25 - - Fullerton, Pa.
K. P. Hurley, '22 - - Houston, Texas
R. B. Innis, Jr., '40 - Kansas City, Mo.
M. K. Lindsay, '40 - Hamilton, Ontario
A. F. Richards, '09 - Dockton, Wash.
Merle N. Shaw, '25 - - Bishop, Calif.

Associate

Walter Balazy, Ex-'37
Farmington, Conn.

(Continued from page 642)

magnesium chloride are used to coat the grains of salt and thus prevent the absorption of moisture from the air. Iodized salt is made by adding minute amounts of potassium iodide.

The uses of salt make up a formidable list and surprising as it may be, human consumption is far down the line. By far the largest user of salt is the chemical industry where it goes into the manufacture of soda ash, caustic soda, and various refined chemicals.

Packing houses are the next large users of salt where huge tonnages are consumed yearly for the preservation of meats and hides as well as brine for refrigeration.

Human consumption includes table use, bakery goods, crackers, pretzels, canning, cheese, butter, oleomargerine, sauces, salad dressing, olive and pickle preservatives, tooth paste, patent medicines, bath and medicinal salts, and many others.

Salt is also used in the ceramic industry in glazes on pottery and porcelain. It is used in the making of dyes, leather, glass, steel, textiles, soap, pulp and paper, laundry powders, and tobacco.

Large quantities of salt are used in packing ice cream and other perishables which must be kept frozen while in transit.

Salt is also used in the extermination of weeds and grass along railways, and at the same time considerable tonnages of salt are used in the manufacture of fertilizers[3].

From this list of uses it is obvious why any attempt at political control is likely to result in widespread dissatisfaction among the people of a nation.

Notwithstanding the political upheavals that are bound to result, a great many countries today exercise political control over the salt industry

(Continued on page 660)

Analytic Soil Mechanics—

(Continued from page 638)

The theoretical solution for transient pore pressures at time t in a cylindrical soil sample under a constant load σ and initial pore pressure H throughout the sample which is draining against the atmospheric pressure at both ends ($x = 0$ and $x = L$) has been found to be[1]

$$\frac{p}{H} = \frac{4}{\pi} \sum_{1,3,5\ldots}^{n=} \frac{1}{n} e^{-A\pi^2 n^2} \sin \frac{n\pi x}{L} \qquad (25)$$

where

$$A = \frac{\alpha E K t}{W L^2} \qquad (26)$$

and W is the weight of a unit volume of water. It satisfies the differential equation (24), remembering that in this case

$\frac{\partial \sigma}{\partial t}$ is zero.[5] At $t = 0$, equation (25) gives

$$p = \frac{4H}{\pi} \sum_{1,3,5\ldots}^{n=} \frac{1}{n} \sin \frac{n\pi x}{L}$$

which is the Fourier sine-expansion for H in the interval $0 \leq x \leq L$, so that initially the pore pressure is H throughout. When $x = 0$ and $x = L$ the pressure is zero, so that (25) satisfies all requirements.

The solution has been plotted in *figure 5* for various values of the parameter A as defined in (26). If the soil-sample is closed at one end and free draining at the other

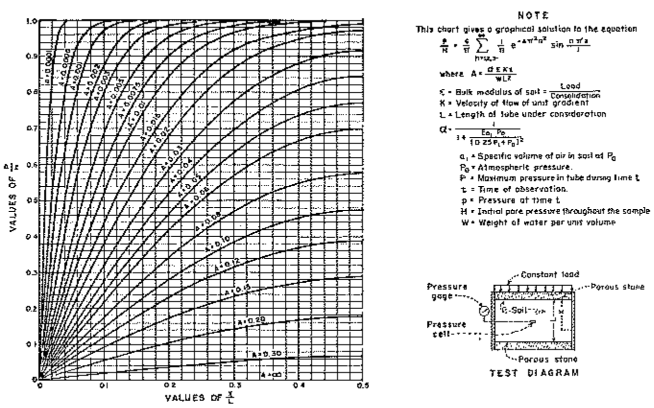


FIGURE 5 - PRESSURE VARIATION DURING CONSOLIDATION OF A SOIL SAMPLE

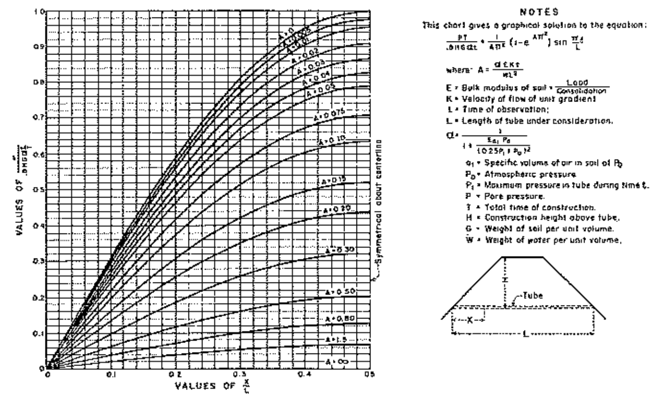


FIGURE 6 - PORE PRESSURES INDUCED DURING CONSTRUCTION

end, the same solution may be used simply by considering a sample of twice the length and free draining at both ends.

The procedure in determining the quantities α and αEK experimentally under given conditions is to place a sealed sample of the soil in the apparatus described above and subject it to a uniform pressure σ estimated to exist in the actual structure. The sealed sample is allowed to consolidate until the pore pressures at each end have become equal. The ratio of this pressure H divided by the load σ has been found to be the best average value for α under the given conditions. The sample is then allowed to drain at one end, and at given time intervals the pressure p is read at the closed end. Let the time lapse from beginning of drainage be t and the simultaneous pressure reading be p and let twice the length of the sample be L. Compute the ratio $\frac{p}{H}$ and in figure 5, on the ordinate $\frac{x}{L} = 0.5$, interpolate the corresponding value of the parameter A. Equation (26) then gives

$$\alpha EK = \frac{A \cdot W \cdot L^2}{t} \qquad (27)$$

By repeating the pressure readings at intervals, a good average value of αEK can be obtained. The entire experiment must, of course, be repeated if α and αEK are desired for other field magnitudes of the load σ. A few practical cases of pore pressures shall now be considered in connection with earth dams.

Construction Period

During the course of construction, the soil mass will consolidate as the construction progresses. Consequently pore pressures will build up to magnitudes depending on the physical constants of the soil, the geometry and drainage of the structure, and the rate of construction. At the same time these pressures will attempt to dissipate. The problem time during construction and compare these with the computed permissible pore pressure dealt with in the earlier part of this paper.

In *figure 6* is plotted a solution suitable for the estimation of the induced pore pressures in a triangular dam constructed at a nearly uniform rate.[1] In *figure 7* is given a theoretical solution suitable for the computation of the pressures induced in an impervious stratum in the foundation loaded at a uniform rate.[1] In this case the drainage is assumed to take place vertically at both top and bottom of the layer. If the layer is located on impervious rock so that drainage is only possible at the top, simply consider a layer of twice the thickness free draining at both top and bottom. The charts only take into consideration the pore pressures induced by the change in loading σ. If hydrostatic pressures exist before construction begins, these must be estimated separately and added to the induced pressures. The loads σ in all cases must be estimated from the stresses determined by the methods mentioned earlier in this article.[3, 4]

In case the estimated maximum pore pressures exceed the computed permissible or critical pressures, the remedies are (1) slower construction, (2) more effective drainage, (3) flatter slopes, and (4) more air in the soil.

Full Reservoir

The existing pore pressures in case of a full reservoir are generally determined as the steady state which would exist after a long period. The methods for this have already been discussed.[2] In some cases induced pressures may also exist in the dam proper or in impervious foundations. These may be residual from the construction period or may be caused by a change in the stress σ due to the load on the upstream face when the reservoir is filled.[3] The critical

of the dam and its foundation. In case the estimated existing pore pressures exceed the computed permissible pressures, the remedies are (1) more effective drainage in the downstream region, (2) flatter slopes, (3) cut-offs which will prevent the high percolation pressures from reaching the downstream region, and (4) sufficient delay in filling the reservoir after construction to allow induced pore pressures to dissipate.

Reservoir Draw-Down

As the reservoir level is gradually lowered, the pore pressures installed in the dam during the full-reservoir period will, of course, gradually decrease. This is due to two effects; namely, (1) percolation out of the dam as the hydrostatic head on the upstream face decreases, and (2) expansion of the entire soil mass, especially in the upstream regions, due to the decrease in total normal load on the upstream face. Coupled with these effects must now be considered the expansion of the entrapped air in the pores or voids of the soil which tends to maintain the pore pressures. It is readily understood that the pressures at any time will be functions of the physical properties of the soil in connection with the rate of draw-down. In *figure 8* is plotted a solution applicable to this case.[1] It takes into consideration all of the above-mentioned effects and enables the determination of the pore pressures when the rate of draw-down and α and αEK are known.

The critical region occurs near the upstream face. If the estimated existing pore pressures exceed the permissible pore pressure,[3] a sloughing of the upstream face may occur. This type of failure is generally not disastrous but it is costly. The remedies are (1) adequate drainage of the upstream region, (2) flatter upstream slope, and (3) slower draw-down. In other words, each dam has its permissible

(Continued on page 661)

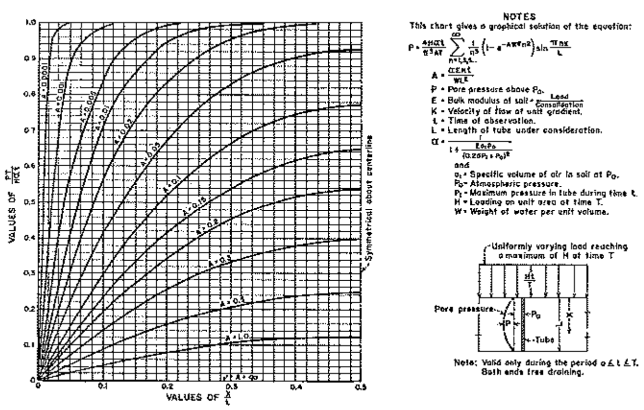


FIGURE 7 - PORE PRESSURES INDUCED IN HORIZONTAL LAYER DUE TO UNIFORMLY INCREASING LOAD - VERTICAL PERCOLATION

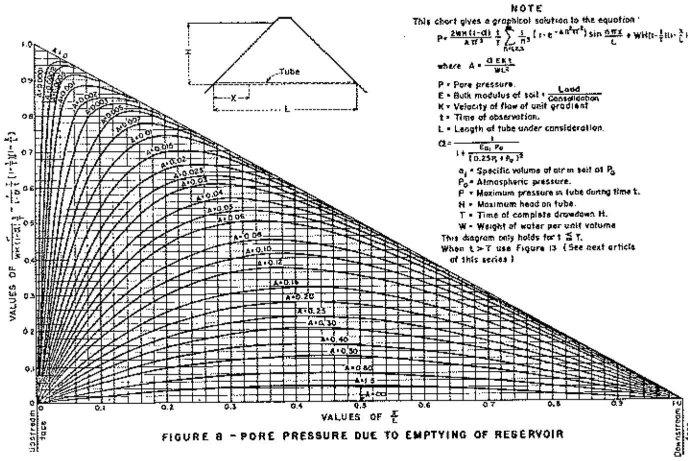


FIGURE 8 - PORE PRESSURE DUE TO EMPTYING OF RESERVOIR

Professional CARDS

A. E. Anderson, '04
E. I. DuPont de Nemours & Co., Inc.
1110 Hoge Building
Seattle, Washington

Jack P. Bonardi, '21
New York Representative
The Mine & Smelter Supply Co.
1775 Broadway New York City

George R. Brown, '22
Brown & Root, Inc.
Engineering Construction
Houston Austin Corpus Christi

G. Montague Butler, '02
Mining and Geological Engineer
Dean, College of Engineering, University of Arizona, Tucson. Examinations and problems involving persistence, change in character, and loss of ore.
Diamonds and other gems secured for Miners or their friends at reduced rates.

Walter E. Burlingame, '01
Assayer—Engineer—Chemist
2040 Broadway Phone: TA. 3615
Denver

Fred C. Carstarphen, '05
Specializing in Design and Erection
Aerial Tramways
Consulting Engineer
721 Marion St. Denver, Colo.

C. Lorimer Colburn, '07
Mining Engineer
Cooper Bldg. Denver, Colo.

Allan E. Craig, '14
Marcy Mill Division
The Mine & Smelter Supply Co.
Denver Colorado

W. C. Douglass, '11
Mining Engineer
Hedley British Columbia

Thomas S. Harrison, '08
Consulting Oil Geologist
1104 First National Bank Bldg.
Denver, Colorado

Harlow D. Phelps, '10
Mining Engineer
U. S. Mineral Surveyor
Prescott Arizona

Alfred E. Perkins, '10
Western Division Manager
Crucible Steel Co. of America
2635 Walnut Street Denver, Colo.

Personal Notes—

(Continued from page 625)

department of Phillips Petroleum Co., is now recuperating after a several months serious illness and is being addressed in care of Ed Holbrook, Ashland, Montana.

E. F. Petersen, Jr., '37, has accepted a position with the U. S. Bureau of Mines and is stationed at Shoshone, Nev., in care of the Tungsten Metals Corp.

Edward F. Porter, '40, is at Westport, Conn., where he is employed by The Dorr Company in their Research laboratory.

David Roberts, '40, is Industrial Hygienist for the Colorado Fuel & Iron Corporation, and resides at 111 East Grant Street, Pueblo, Colorado.

William C. Rogers, '38, formerly with Creede Mills, Inc., is now associated with Ingersoll-Rand Company at their Phillipsburg, New Jersey plant. His mailing address is 283 Bates Street, Phillipsburg, N. J.

Dr. J. L. Soske, '29, President of the Geophysical Engineering Company of Pasadena, California, left San Francisco on December 10, via Clipper plane for the Philippines. His company has a contract to do exploration work for the Philippine government.

T. J. Trumbull, '38, Sales Engineer for E. I. du Pont de Nemours & Co., has moved his residence in Albuquerque to 402 South Yale Street.

Charles Van Gilder, '22, is now being addressed in care of the Seismograph Service Corporation, Jonesville, Louisiana.

F. G. Van Voris, '39, who is associated with the Bethlehem Steel Company, makes his home at 156 Humboldt Parkway, Buffalo, N. Y.

Meldin Volin, '33, Junior Engineer, U. S. Bureau of Mines, is at present, in Tracey, California.

WEDDINGS

Lewis-Pyles

William R. Lewis and Miss Barbara Ann Pyles, daughter of Mr. and Mrs. F. L. Pyles of Eads, Colorado, were married at the Methodist church of Albuquerque, New Mexico, the evening of July 27, 1940.

Mrs. Lewis was graduated from the University of Colorado last June. Upon his graduation from *Mines* in May, Mr. Lewis became associated with Ingersoll-Rand Company but later resigned and accepted a position with Crane-O'Fallon Company in Denver. The couple are residing at 3722 Gilpin Street, Denver.

Jeffries-Douglass

At a beautifully appointed formal wedding, September 19, in St. Ann Church, Cleveland, Ohio, Miss Maurine Douglass and Edgar H. Jeffries were united in marriage at a High Nuptial Mass.

The bride is a daughter of Mr. and Mrs. Charles Franklin Douglass of Cleveland, and the groom a son of Mrs. Frances Jeffries of Berkeley, Calif. William Jeffries, '37, attended his brother as best man.

Mr. Jeffies, who graduated in 1934, is Sales Engineer for the Surface Combustion Company. The couple are at home at 1721 Page Avenue, East Cleveland, Ohio.

Professional CARDS

Root & Simpson, Inc.
Metallurgical Chemists, Assayers
Denver, Colo.

W. G. Swart, Hon. '17
Mining Engineer
916 Union Street
Alameda, California

Cecil R. Walbridge, '29
Sales Engineer
Worthington Pump and Machinery Corp.
1640 Blake St. Denver, Colorado

Wm. D. Waltman, '99
Franco-Wyoming Oil Company
601 Edison Bldg., Los Angeles

Norman Whitmore, '26
Minerals Engineering Co.
Assayers — Engineers
417 South Hill St. Los Angeles

Elmer R. Wilfley, '14
Wilfley Centrifugal Pumps
Denver, Colo.

Henson of Boulder were married on November 16. They are now at home in Climax, Colorado, where Mr. Paris is engineer for the Climax Molybdenum Company.

Bradley-Joyer

Tom Bradley, '37, was married on October 1st to Miss Elizabeth Joyer of Denver, the ceremony being performed in Burbank, California.

Mr. Bradley is detail draftsman for the Lockheed Aircraft Corporation. The couple are at home at 3908 Olive Street, Burbank.

Cadwell-Whitmoyer

Donald E. Cadwell, '39, and Miss Marcella Whitmoyer, daughter of Mr. and Mrs. W. R. Whitmoyer of Denver, were married on November 10.

The bride attended Denver University where she was a member of Alpha Nu honorary fraternity in addition to her social sorority. Mr. Cadwell has been associated with the Stanolind Oil and Gas Company since his graduation from *Mines*. He is at present located at Gorham, Kansas, where he and Mrs. Cadwell are at home.

BIRTHS

"Casano Ka Pay!
I came to tell you about
John McMurray Carpenter, III
who came to our house at
Lepanto, Mankayan, Mt. Prov.,
P. I., September 29, 1940."

The above announcement, showing a picture of the three-year old son of Mr. and Mrs. John M. Carpenter, Jr., was recently received. The new arrival is the first American child to have been born at Lepanto.

Mr. Carpenter, '35, has been employed by Neilson & Company for the past several years, at present being connected with the Lepanto Consolidated Mining Company. His mailing address is Box 246, Baguio, P. I.

Mr. and Mrs. M. C. Carosella are the proud parents of a baby daughter, Judith Anne, who arrived at their home on October 30, tipping the scales at 7 pounds.

Mr. Carosella, of the class of '34, is chemist for the U. S. Vanadium Corporation at Laws, California.

Mr. and Mrs. Donald M. Ray announce the arrival of Donald Vonne on November 14, at Des Moines, Iowa. Weight: 6 lbs., 4 ounces.

Mr. Ray, '29, is mill superintendent for Sociedad Minera Puquio Cocha, Morococha, Peru.

Two Ex-Mines Men Killed

Walter P. Scott, Jr., freshman president of the class of '40, was killed in Juneau, Alaska, July 11, by a fall while working at the Alaska Juneau mine. He attended *Mines* on a scholarship in the year 1936-37, and was a member of the A. T. O. fraternity. After leaving *Mines* he went to the University of Washington. Last Spring he passed the examinations for the Flying Cadet Corps and planned to enter next year after finishing school. While at *Mines* he was an honor student and was prominent in campus activities.

Arthur R. Hess, Ex-'38, of Edgewater, Colorado, was killed October 11, near Auburn, Nebraska, when the car in which he was riding collided with a truck. At the time of his death he was employed by the government rural electrification division.

PRIZE OFFER

Check the errors found in Mines Magazine as you read it. The reader reporting the most errors receives FREE one year's subscription to the magazine. The winner will be announced in the magazine the second month after publication. Send list of errors to Mines Magazine, 734 Cooper Building, Denver, Colorado.

Polarographic—

(Continued from page 644)

e.m.f. determines the identity of the cation or anion represented.

Since the element, thallium, has the same half-wave decomposition potential in acid, alkaline, or neutral solutions, small amounts of this element can be added to the solution to be tested in order to facilitate the accurate calibration of applied e.m.f. In this manner the identity of cations or anions present can be more readily established, although it must be stated that the identification of ions presents no problem.

The height of the increasing current change step is a direct measure of the concentration of the anion or cation being reduced. Reduction curves are plotted on known amounts of the ion being considered and these serve as standards for quantitative comparison. See Fig. IV.

Part III—The Preparation of Inorganic Cation Solutions

The material to be analyzed must be rendered soluble in an aqueous solution containing an electrolyte whose cation or anion decomposition potential does not interfere with the current-voltage graph characteristics of the cation or anion being reduced. As a general rule, in the analysis of cations such as Cu^{++}, Cd^{++}, Pb^{++}, Zn^{++}, Ni^{++}, Mn^{++}, etc., a N/10 ammonium acetate aqueous solution of pH 8 to 9 will be found satisfactory, although there are many more electrolytes equally as desirable.

The concentration of the unknown ion should be within the range of the current-voltage curves which have been or will be plotted for known concentrations of ion and which serve as standards of quantitative comparison. The capacity of the cell determines the size of the sample to be used and can vary from 0.4 to 50.0 ml.

The maxima can be depressed by adding a drop of a weak aqueous solution of fish glue, starch, or a dyestuff. Oxygen must be removed from the solution to be analyzed, since its half-wave decomposition potential of approximately —1.6 volts will give a current step which will render unreadable the analysis of any anion or cation having a half-wave potential within the region of —1.6 volts. The removal of oxygen is accomplished by sweeping the solution with purified hydrogen or nitrogen gas for three minutes prior to analysis. Moreover, it is advisable to allow the purified hydrogen or nitrogen gas to bubble slowly through the solution during the entire analysis.

Part IV—The Preparation of Organic Solutions

The method of analysis of organic compounds which contain electro-reducible groups is much the same as the method of analysis of inorganic compounds outlined in Part III. The half-wave potentials of electro-reducible organic groups are constant just as are the potentials of inorganic electro-reducible anions and cations.

The method of analysis of certain adsorbable organic substances has been briefly discussed in Part II, Section B, titled "Maxima."

Part V
Applications of the Polarographic Method of Analytical Determination

A. Analytical Chemistry

The detection and accurate analysis of impurities found in technical grade, C.P. grade, and U.S.P. grade chemicals. For example the determination of nickel and copper in caustic soda within the limit of accuracy of one to three parts per million has been accomplished by polarographic analysis.

The determination of minute quantities of copper, nickel, chromium, molybdenum, tin, and vanadium in ferrous alloys and steels.

The estimation of fructose in saccharose, honey, and fruits can be obtained within very accurate limits, viz., less than ± 0.005 per cent.

The quantitative determination of gold in the presence of silver, copper, lead, and antimony as a complex cyanide has been successfully developed.

Quantitative determination of oxygen in water or gases is very accurately measured by the polarographic method.

B. Industrial Applications

In the metallurgical industry the quantitative and qualitative analysis of various ores, concentrates, tailings, refined metal, ferrous and non-ferrous alloys is accomplished conveniently by the polarographic method.

The chemical industry uses the polarographic method for the estimation of small amounts of impurities in products such as caustic soda, caustic potash, sulfuric acid, nitric acid, hydrochloric acid, and organic solvents.

The dyestuffs industry, by the maximum depression method, is able to determine the adsorptive power of its products.

The petroleum industry employs the maximum depression method as an indication of the composition of various fractions of distillate.

In the pharmaceutical industry the purity of various chemicals such as ether, formaldehyde, distilled water, alcohols, and ketones is conveniently obtained by established polarographic methods.

Table I
Half-Wave Potentials of Metals

Metal	Volts (referred to the normal calomel electrode) In Neutral or acid solutions	In alkaline solutions
Al^{+++}	—1.79	
NH_4^+	—2.09	
Sb^{+++}	—0.21	—1.8
Cd^{++}	—0.63	—0.80
Ca^{++}	—2.23	—2.23
Cu^{++}	+0.09	—0.14
Au^+		—1.2
H^+	—1.6	
Fe^{++}	—1.33	—1.56
Pb^{++}	—0.46	—0.81
Ni^{++}	—1.09	
Th^+	—0.48	—0.48
Sn^{++}	—0.47	—1.18
Zn	—1.06	—1.41

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Non-Metallics—

(Continued from page 655)

of those countries by means of a government monopoly. Our Latin American neighbors are prone to "Press the crown of thorns" onto the brow of the people by governmental control of the salt industry as a means of raising revenue.

The U. S. A. is both an importer and an exporter of salt. Canada accounted for the majority of the imports and at the same time was the biggest receiver of our exported salt. Imports for 1938 were about 40,000 tons while exports amounted to about 65,000 tons[4].

As mentioned before the geographical distribution of salt deposits is world wide but in spite of this distribution many Asiatic and African peoples have neglected to exploit their natural resources, particularly salt. None the less this geographic distribution of salt has prevented any attempt at political domination outside of the borders of the individual countries. Almost every country, including the U. S. A. has a stiff tariff on importations of salt. In general, this seems to be for revenue rather than as protection for their own industry.

The year 1937 set an all time record for the salt industry both in tonnage production and value but 1938 was a poor year, some 13 per cent less than '37. During 1938 the U. S. A. produced slightly over 8,000,000 tons of salt which had a value of $23,240,000[4].

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(Continued from page 657)

rate of draw-down which is an important factor in the proper design of a dam from the utility point of view.

III. Displacements

Another important problem in analytic soil mechanics is the prediction of the displacements in soil structures. In a foundation which can be treated as a semielastic body, the methods of the elastic theory may be employed and possibly yield reasonable results.

It is to be noted that the displacements will be functions of the contact stresses which themselves depend on the existing pore pressures. These, and consequently the displacements, are functions of time and loading.

It has been observed in triaxial testing of soil samples that definite compressions along the major principal stress and expansions along the minor principal stress exist for each set of stresses before ultimate failure occurs, in accordance with Mohr's criterion. This would lead one to believe that a definite relation exists between longitudinal and lateral strain for each state of stress similar to Poisson's ratio in elastic bodies. In soil, the compression modulus and the above-mentioned ratio will vary with placement conditions and will not be linear functions of the superposed loads. However, it may be possible to assign reasonable mean values in the stress range to be dealt with; otherwise the curves must be plotted as functions of the stresses and the displacements determined by an integration based on those curves and the time variation of the stresses. There has not been sufficient experimental work done yet along these lines, from which to draw definite conclusions. It is, however, evident that the rebound when the loading is removed is only a fraction of the original displacement, so that a portion will remain permanent. This further complicates the problem under changing boundary conditions such as for example, the filling and emptying of reservoirs. Again, the best one can hope for is to be able to determine some critical or ultimate state to which the structure may subside under certain assumed or estimated adverse conditions. Even if exact theories could be established to meet all known conditions, it must be remembered that our knowledge of the physical properties of foundations will in all practical cases be very sketchy.

If a foundation can be treated as an elastic medium, the stresses and displacements due to superimposed surface loadings are generally treated by integration of the Boussinesq solution[12] for concentrated loads. In soil foundations the pore pressures are of importance and the usual elastic stress-strain equations must be modified as follows:[18]

$$\frac{\partial u}{\partial x} = -\frac{1}{E}\left[\sigma_x - \mu(\sigma_y + \sigma_z) - p(1-2\mu)\right]$$

$$\frac{\partial v}{\partial y} = -\frac{1}{E}\left[\sigma_y - \mu(\sigma_x + \sigma_z) - p(1-2\mu)\right]$$

$$\frac{\partial w}{\partial z} = -\frac{1}{E}\left[\sigma_z - \mu(\sigma_x + \sigma_y) - p(1-2\mu)\right]$$

$$\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} = -\frac{2(1+\mu)}{E}\tau_{xy} \qquad (28)$$

$$\frac{\partial u}{\partial z} + \frac{\partial w}{\partial x} = -\frac{2(1+\mu)}{E}\tau_{xz}$$

$$\frac{\partial v}{\partial z} + \frac{\partial w}{\partial y} = -\frac{2(1+\mu)}{E}\tau_{yz}$$

where u, v, and w are the displacements in the three positive coordinate directions. E and μ are mean values of Young's modulus and Poisson's ratio in the regions to be integrated.

The stresses and pore pressures are the differences between

In two-dimensional analysis [15, 16, 22] only the first two and the fourth of the above equations are needed, and the entire problem is best handled by the Airy stress function.

Finally, cases occur when no stable equilibrium can be demonstrated without lateral plastic flow of the soil mass. Each such problem must be treated individually as it involves inhomogeneities[20] in the foundation, finite displacements, and possibly a change in the geometry of the ground line, "counter-banking."

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Acknowledgments

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GEOPHYSICAL News and Review

Compiled by the Geophysics Department, Colorado School of Mines

Pendulum and Gravimeter Measurements:

FISHER, J. W. *An Experimental Device for Computing Magnetic and Gravitational Anomalies.* Geophysics 5(1), 22-30, Jan. 1940.

The basis of the paper is the fact that the gravitational and magnetic anomalies are functions of the solid angle subtended at the point of measurement by the contours of the anomalous body. The mathematical expression of the above is given and chart methods of calculating anomalies from assured subsurface shapes are considered.

The use of a model of the subsurface structure made in the form of a coil of wire in which the vertical spacing of the turns is kept constant and the shape of the helix being built conforms to contours of the structure is described. With a known current through the model and by using a small search coil, measurements may be made at points corresponding to those for surface observations. The mutual inductance between the model and the search coil as measured on a Campbell inductometer bridge expresses the magnetic or gravity anomaly arising from the simulated structure. The coil must be properly oriented.

The method treated permits a great saving of time in determining anomalies from assumed situations.—D. W.

ECKHARDT, E. A. *Gravity Method Produces Results at Low Cost.* Oil Weekly 97(2), 71-75, April 1940.

Background history of gravity prospecting beginning with pendulum methods for geodetic purposes, steps in the application of the torsion balance are presented. First commercial applications are noted for the torsion balance in the U. S. as October 1922 and of the pendulum in 1925-26.

The gravimeter was first developed by the Humble Oil and Refining Co. in 1932. With the first instrument in the field by that company in March 1935, with some eight instruments in the field by the end of 1936.

Up to Jan. 1, 1940 some 200,000 gravity stations have been observed with the gulf companies. Gravimeters, a monthly average output per instrument is set at 400 stations with 110 as a day's record.

A graph showing the number of seismic reflections, torsion balance and gravimeter parties in the gulf coast shows the fluctuation of geophysical activity in these methods since 1935.

It is noted that adequate data on discoveries by the gravimeter is not available.
—D. W.

GAY, M. W. *Relative Gravity Measurements Using Precision Pendulum Equipment.* Geophysics 5(2), 176-191, April 1940.

Data and values obtained by pairs of specially designed pendulums are presented which illustrate the precision with which relative gravity values can be obtained between two stations. The pendulums which are made of fused quartz are described and the field procedure and the various effects causing disturbances of the observed period of oscillation and the methods of controlling or eliminating them are discussed.

Two methods of making relative gravity determinations with this equipment are covered. An accuracy of 10^{-7} g. was obtained. The objections of known gravity difference against which gravimeters could be checked.—D. W.

BORN, W. T. *Geophysical Applications in the Production of Oil.* Oil Weekly 97(2), 76, April 8, 1940.

Electrical logging, radioactivity logging, and sound wave studies to determine the fluid level in wells as well as temperature depth measurements are discussed. These developments and methods are cited as the contribution of geophysics to production problems and the recognition of the character of formations penetrated by the drill.

A map showing a gravimeter survey of the Big Lake Field by Brown Geophysical Co. is given.—D. W.

Magnetic Measurements:

JENNY, W. P. *Some Practical Examples of Micromagnetic Prospecting.* Oil and Gas Jnl. 38(50), 132-134 and 139, April 25, 1940.

As proof that oil is increasingly hard to find it is noted that 92% of the 1,196 wildcats in Texas in 1939 were failures, despite advanced geological and geophysical experience. This also indicates the need for further improvement in known geophysical methods. The writer brings out the usefulness of high accuracy or "micromagnetic" surveys by a set of examples. Such magnetic work predicts structures within the sedimentary column due to the magnetic content of certain sedimentary strata and is in contrast to the point of view, in earlier magnetic surveys where the anomalies mapped were considered to arise from the basement complex.

Example one shows a micromagnetic preliminary survey of the Eola Prospect, Avoyelles Parish, La., together with subsequent drilling results. The top of the structure on the Wilcox coincides well with the magnetic high. Sparta-Wilcox (Trend) structures seem to indicate, according to the writer, that uplift well expressed in the Wilcox only slightly affects the younger strata. The agreement between magnetic prediction and Wilcox structure indicates the magnetic effects come from beds of Wilcox or lower Eocene ages. This agreement points to the usefulness of such work along the trend.

The micromagnetic picture together with torsion balance gradients and well information for the northwest extension of the Anahuac structure in Chambers Co., Texas, from another example. A fault was indicated and a negative magnetic zone along the crest of the structure was traced.

The magnetic survey near Adern in San Antonio Co., Texas, indicates a fault near the Seaboard Oil Corp. discovery well verifying the prediction of low structural relief and faulting.

The Edwards Salt Dome, Hinds Co., Mississippi, is shown by a micromagnetic closed negative and the Elgin prospect in Bastrop Co., Texas, a serpentine plug shows by the abnormal size of the magnetic anomaly it produces why the plug was dry since it indicates a solid relatively shallow unaltered mass of serpentine.

The examples offered verify the usefulness of such high accuracy magnetic surveys and the discrimination possible in their interpretation.—D. W.

Seismic Methods:

HOWELL, L. G., KEAN, C. H., AND THOMPSON, R. R. *Propagation of Elastic Waves in the Earth.* Geophysics 5(1), 1-14, Jan. 1940.

An investigation of the propagation of single frequency waves of from 20 to 1400 cycles through near-surface materials. One source of waves was an electrodynamic shaker in which the weight of the field magnet of some 300 lbs. rested on the ground to impart a vibration; with a driving plate attached to the shaker by a pipe. The impulse could be applied at the bottom of an 11-foot hole. Studies were made of the amplitude of the waves received for various applied frequencies on a pickup at various depths (from 20 to 120 feet) in a hole at 18 feet and at 50 feet from the shaker; other experiments used two 400 feet core holes.

Refraction profiles across the Hawkinsville Salt Dome and the Pierce Junction Dome (Texas) were made using high frequency wave pulses of short duration.

Among the conclusions reached is that in dry surface layers, the attenuation of high frequencies is very great, but drops in deeper water saturated layers. Low frequencies are not much attenuated by surface layers but there is evidence that in deeper beds there is great attenuation. Refraction profiles gave velocities close to that of sound in water with no break in the travel time curve to 1200 feet.

Results indicate complex problems are involved requiring considerable research in this important problem.—D. W.

BEERS, R. F. *Velocity Stratification as an Aid to Correlation.* Geophysics 5(1), 15-21, Jan. 1940.

Seismic refraction work in the West Texas Perrman Basin has shown that it is possible to establish correlations between seismic stations on a basis of wave velocities. A schematic diagram of velocity stratification of the geologic section in Ector Co., Texas, is given. Velocity stratification is suggested as a means of correlation and as a possible clue to obscure stratigraphic relationships.

In developing the subject reflection coefficients are discussed and it is brought out that the existence of seismic reflections gives a substantial basis to the concept of velocity stratification in sedimentary beds.
—D. W.

HONNELL, P. M. *Record Counter Aids in Seismograph Computations.* Oil & Gas Jnl. 38(36), 44, Jan. 18, 1940.

Describing a unit of equipment with which to mark every tenth time line on a seismic record. This greatly simplifies the work of counting time lines. A "multivibrator" with a period of oscillation controllable and correlated with the time marks on the seismic record and the associated circuits is utilized for this purpose.—D. W.

SPECHT. *Problem of Inclined Layers in Seismic Reflection Methods.* A. I. M. E., T. P. 1177 (class L. 69), 7 pp., Feb. 1940.

Certain elementary features pertaining to seismic reflection methods are discussed time distance data is presented. Seismic exploration the Carpathian foreland of Poland forms the background of the paper. In this area where geological conditions are complicated and it is not always possible from such work to determine depth and dip of reflecting beds. It is important to have a method that will give reliable data as to direction of dip without knowledge of the average velocity and depth of horizons involved.

Theoretical considerations and equations for reflections from horizontal layers and from dipping ones are discussed. The equation and criteria for dip in terms of spread distance to each geophone and the reflection time to each geophone is set up. The criteria for dip thus established are reported as verified in field investigations. The paper is illustrated with diagrams and examples of reflection records from the area.—D. W.

SHEPARD, E. R. AND WOOD, A. E. *Application of the Seismic Refraction Method of Subsurface Exploration to Flood-Control Projects.* A. I. M. E., T. P. 1219 (class L. 71), 13 pp., Feb. 1940.

The setup and status of Federal Government Flood Control, Reservoir, Canal, and waterway improvements is sketched. A map showing the location of some 1600 projects at an estimated cost of eight billion dollars as planned by the U. S. Army Corps of Engineers subdivided as to projects authorized, as recommended as most useful and urgent and as other new projects is presented.

The need for a rapid method of subsurface exploration has been met by highly to Dec. 1939 over 225 damsites and several canal projects have been exposed by this method and many sites have been eliminated without drilling.

The theory of seismic exploration, field technique used in the application of the refraction method, examples of records and calculations of bedrock depth are discussed and illustrated.

It is brought out that a maximum crew is three men: an operator, shooter, and laborer. Though for detailing work small survey party must be added. With a seven man party some eighty shots per day can be made. An office computer is also required.

Work is of two types, viz.: preliminary or detailed, the first consisting usually of six or more seismic lines and the latter thirty or more lines for average cases.

Experience shows that the average difference between drill depth to bedrock and seismic prediction for 30-40 records in New York and New England was within two feet.

A true cost comparison between drilling and seismic depth determinations is difficult because of the nature of the information given in each case. A comparison, however, between a drilling program sufficient for preliminary design and a similar seismic program shows that at a cost of $100 per day usually two or three days are sufficient for such seismic work per site while drilling at the low cost of $2.00 per foot would represent from $600 to $1000 per site and require from seven to fourteen days depending whether one or two drills were used. A ratio of about 1 to 3 for preliminary survey costs. number of depth points to bedrock seismic work cost about 10% that of drilling though the comparison avoids the question of sampling.

It is also brought out that the usefulness of seismic work for such governmental programs has been amply demonstrated, particularly in making cores between alternate sites, preliminary studies and cutting down the number of drill holes required in detailed studies. The method, however, by its nature will not entirely replace drilling.

The paper well shows the important scope of such seismic work.—D. W.

Soil Analysis:

LEBARON, M. *Determining Presence of Oil by Soil-Analysis Methods.* Oil & Gas Jnl. 38(35), 43-47, Jan. 11, 1940.

A discussion of various methods of sample analysis for hydrocarbons, both solid and gaseous, applicable in soil-analysis methods. The paper is divided into subsoil and surface-soil wax determinations. Methods of sampling, determination of total volatile hydrocarbon content, separation of methane from higher constituents are discussed. Apparatus and methods are covered.

The need for research on the fundamentals of the entire method are discussed, such as, for example, the hypothesis as to the photosynthesis of waxes at the surface from unsaturates, and the adsorption characteristics of various soils which are known to differ widely.—D. W.

Patent Service

Recent Patents Relating to the Mineral Industries, edited by James Atkins, registered patent attorney, Munsey Building, Washington, D. C.

Inquiries with reference to this subject or to any patents appearing in this department should be addressed to Mr. Atkins.

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METHOD FOR COMPLETING OIL WELLS. Patent No. 2,219,022, issued Oct. 22, 1940, to Ivan S. Salnikov, Tulsa, Okla., assignor to Standard Oil Development Co., a corporation of Delaware.

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TREATMENT OF WELLS. Patent No. 2,219,319, issued Oct. 29, 1940, to Carroll R. Irons, Midland, Mich., assignor to The Dow Chemical Co., Midland, Mich., a corporation of Michigan.

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METHOD AND APPARATUS FOR SEISMIC SURVEYING. Patent No. 2,219,508, issued Oct. 29, 1940, to Lawrence F. Athy and Elton V. McCollum, Ponca City, Okla., assignors to Continental Oil Co., Ponca City, Okla., a corporation of Delaware.

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WELL DEVICE. Patent No. 2,220,359, issued Nov. 5, 1940, to Sheridan P. Tschappat, Tulsa, Okla.

PUMP VALVE. Patent No. 2,220,392, issued Nov. 5, 1940, to Joseph H. Butler, Tyler, Tex., assignor of one-half to Dan R. Boissear, San Antonio, Texas.

WELL CAP. Patent No. 2,220,431, issued Nov. 5, 1940, to Adam J. Strehs, Miami, Fla.

PROCESS AND APPARATUS FOR EXPLORING GEOLOGICAL STRATA. Patent No. 2,220,509 issued Nov. 5, 1940, to Folkert, Brons, Kilgore, Tex., assignor to Shell Development Co., San Francisco, Calif., a corporation of Delaware.

METHOD OF WELDING OIL WELL CASINGS. Patent No. 2,220,773, issued Nov. 5, 1940, to Ralph O. Moore, Tulsa, Okla.

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WELL AGITATOR. Patent No. 2,221,057, issued Nov. 12, 1940, to Joseph H. Notley, Oklahoma City, Okla., assignor of one-half to Arthur Thatcher, Oklahoma City, Okla.

STRUCTURAL STEEL DERRICK. Patent No. 2,221,067, issued Nov. 12, 1940, to John Hart Wilson, Wichita, Falls, Tex.

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DRILL. Patent No. 2,221,242, issued Nov. 12, 1940, to David McClelland, Maracaibo, Venezuela, assignor to I. H. Lyons, Los Angeles, Calif.

METHOD OF TREATING WELLS. Patent No. 2,221,261, issued Nov. 12, 1940, to Philip J. Lehnhard, Jr., Tulsa, Okla., assignor to The Dow Chemical Co., Midland, Mich., a corporation of Mich.

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CORE CATCHER. Patent No. 2,221,392, issued Nov. 12, 1940, to Carl F. Baker, Taft, Calif.

SWAB. Patent No. 2,221,427, issued Nov. 12, 1940, to Myron M. Kinley, Houston, Tex.

MINING MACHINE. Patent No. 2,221,454, issued Nov. 12, 1940, to Lewis E. Mitchell, Columbus, Ohio, assignor to The Jeffrey Mfg. Co., a corporation of Ohio.

ORE CONCENTRATING MACHINE. Patent No. 2,221,589, issued Nov. 12, 1940, to George Kunkle, Grand Junction, Colo.

COPPER SMELTING. Patent No. 2,221,620 issued Nov. 12, 1940, to Richard A. Wagstaff, Salt Lake City, Utah, assignor to American Smelting & Refining Co., New York, N. Y., a corporation of N. J.

NEW QUARTERLY

The Department of Publications, Colorado School of Mines, Golden, Colo., announces the publication in January 1941 of the following paper as Volume 36, number 1 of the Colorado School of Mines Quarterly:

SMALL FORAMINIFERA FROM THE LATE TERTIARY OF THE NEDERLANDS EAST INDIES

By L. W. LeRoy

Micropaleontologist, Nederlandsche Pacific Petroleum Maatschappij

The paper will comprise three parts as follows:

Part 1—Small Foraminifera from the Late Tertiary of the Sangkoelirang Bay Area, East Borneo, Nederlands East Indies. (152 species)

Part 2—Small Foraminifera from the Late Tertiary of Siberoet Island, off the West Coast of Sumatra, Nederlands East Indies. (128 species)

Part 3—Some Small Foraminifera from the Type Locality of the Bantamien Substage, Bantam Residency, West Java, Nederlands East Indies. (47 species)

Many of the forms described are widely distributed and will therefore be of interest to students of the Foraminifera. The approximately 120 pages will include 13 full-page plates, reproducing specimens described, and 13 figures including 4 maps.

Price: $2.00 the copy postpaid.

The edition will be limited and it will be well to order a copy early to assure delivery.

REVIEW OF *Articles Worthwhile*

Compiled by Departments of Mining, Metallurgy, and Petroleum, Colorado School of Mines

Organic Content of Recent Marine Sediments, by Parker D. Trask. U. S. Geological Survey, Washington, D. C. Recent Marine Sediments—The Amer. Assn. of Petroleum Geol.

The quantity of organic matter in sediments is determined indirectly usually by multiplying by an appropriate factor, some property of the sediment that is related to the organic content—such as the content of carbon, nitrogen, phosphate, or volatile substances; or the loss on ignition; or the texture of the sediments.

The quantity and nature of the organic matter that is deposited are intimately related to the environmental conditions of deposition. A large number of factors are involved, many of which are interdependent. The three main factors are: (1) the supply of organic matter in the overlying water; (2) the rate of decomposition of the organic substances while they are in the water or after they have accumulated in the sediments; and (3) the movement of the water in which the materials are deposited. The supply of organic matter in typically marine deposits depends chiefly upon growth of the plant mineral in the water, which in turn depends primarily upon the supply of sunlight and mineral nutrients. The supply of nutrients is influenced by the movement or circulation of the water, which in turn is affected by other factors. The decomposition of the organic matter depends upon many things, but mainly upon the supply of oxygen. The supply of oxygen is influenced chiefly by the amount of organic matter that is decomposed and by the circulation of the water, which may or may not bring the water to the surface where the oxygen can be replenished. The deposition of the organic matter depends mainly upon the movement of the water. If currents are strong, little organic matter is deposited and if they are weak, much is laid down.
—Author's Abstract.

Tungsten-Bearing Manganese Deposit at Golconda, Nevada, by Paul F. Kerr. Geological Society of America, vol. 51, pp. 1359-1390, 5 pls., 6 figs., September 1940.

The tungsten deposit lies just above the former high water level of Quaternary Lake Lahontan and a short distance east of Golconda, Nevada. Tungsten-bearing manganiferous and ocherous deposits underlie calcareous tufa. The tungsten ores lie blanket-like on an erosion surface which truncates tilted Triassic sediments. Beneath the blanket deposits are veins of similar mineralization which are thought to have provided the source of the overlying ores. The blanket deposits are sufficiently large and contain enough tungsten to justify economic development. The ore minerals are colloidal in origin, tungstic acid having been adsorbed in psilomelane and limonite while both were gels. Both the ore-bearing layers and the tufa are considered to be chiefly of hot spring origin rather than the result of precipitation from Lake Lahontan.

A jarosite-bearing vein containing small amounts of tungsten crops out at a slightly higher elevation where the hot springs deposit has been removed by erosion. The vein cuts steeply inclined limestone which has been considerably altered to chert and highly silicified with the production of quartzose masses. This vein is thought to be indicative of a still lower level of mineralization than the veins immediately below the blanket deposits.

It is believed mineralization started with chertification and silicification but ultimately resulted in precipitation of tungsten, iron, manganese, and tufa. The source of the tungsten is not exposed, but the existence of scheelite deposits in the vicinity suggests the possibility of underlying scheelite or perhaps wolframite-bearing veins. —Author's Abstract.

Quicksilver Deposits of the Bottle Creek District, Humboldt County, Nevada, by Ralph J. Roberts. U. S. Geological Survey Bulletin 922-A, pp. 1-29, 4 maps, 1940.

The Bottle Creek district in Humboldt County, northwestern Nevada, produced 310 flasks of quicksilver between September 1938 and October 1939. Although under-ground work aggregates only about 2,000 feet, the outlook for the future production appears promising.

The rocks include an older pre-Tertiary group of complexly folded and faulted sedimentary and volcanic rocks and a later group probably of Tertiary age, that is also composed of volcanic and sedimentary rocks. The Tertiary group has been divided into five units. Three of these units—the lower tuffs, conglomerate and sandstone, the basalt, and the upper tuffs and clays—dip west and are in fault contact with the pre-Tertiary rocks. All are cut by diabase dikes and all are unconformably overlain by rhyolite flows that dip east.

There are two types of ore deposits: cinnabar-bearing faults and cinnabar-bearing diabase dikes. Prior to January 1940 all the production had come from the dikes, but recent development work has shown material of commercial grade in two fault zones. Ore shoots mined in the dikes are commonly small but of high grade and average about 30 pounds of quicksilver to the ton.

In the engineering sense there are no proved reserves, but in the light of past production the probable reserves in known dikes to a depth of 150 feet are estimated at about 3,000 flasks of quicksilver (a flask contains 76 pounds), which can be profitably mined so long as the price of quicksilver remains at $125 or more a flask. —Author's Abstract.

Quicksilver Resources of California, by A. L. Ransome and J. L. Kellogg. California Journal of Mines and Geology, vol. 35, No. 4, pp. 353-486, October 1939.

California, through a period of almost 90 years, has been the leader in the quicksilver mining industry in the United States; from 1850 to 1939 there has been produced in this State approximately 2,400,000 flasks of quicksilver having a total value in excess of $117,000,000.

The demand for quicksilver during the last decade (1929-1939) has reached a more nearly constant level than heretofore owing to increased usefulness of the metal where it is indispensable to many forms of modern mechanical, electrical, and chemical industry. Aside from general commercial uses, quicksilver is important in time of war and is listed by the National Government as a strategic mineral.

The average annual price received per flask has fluctuated over a wide range from below $30 to over $120 during the 90 year period from 1850 to 1939; but at the present time (1939) a minimum price of $65 to $70 is considered the least that can enable the larger quicksilver operators to mine profitably. Improved methods of mining and reduction have resulted in lower costs; but material and labor are above former standards. Most important of all, the general grade of mined ore is lower, from 5 to 10 pounds of quicksilver per ton.

The principal quicksilver ore deposits of California occur in the Coast Ranges within a belt about 400 miles long having a maximum width of 75 miles. Most of these deposits occur in the fracture planes of basic igneous rocks (especially serpentine) and their associated sediments belonging to the Jurassic Franciscan formation; the time of deposition of the ore minerals appears to be a late epoch—late Pliocene, Pleistocene, and Recent.

Quicksilver deposits are considered to be epithermal (deposition taking place near the surface of the earth's crust), occurring as impregnations, vein filling, and as fissure and breccia fillings usually associated with volcanic rocks and hydrothermal activity.

The association of quicksilver deposits with the Franciscan formation and especially the serpentine is probably structural, not genetic; fracturing afforded channel ways for the passage of ascending solutions to favorable zones of precipitation. These zones are in interstitial spaces of porous, or brecciated, rock masses underlying relatively impervious material.

Cinnabar, the most important ore-mineral of quicksilver, is commonly associated with marcasite and pyrite, and with calcite, barite, quartz, chalcedony, and opal, as gangue minerals. Cinnabar is deposited from hot alkaline solutions and the source of the contained metal is considered to be from a deep-seated rock magma, the existence and position of which is only a conjecture.

There is no method by which an accurate numerical determination can be made of the ore reserves of quicksilver. From the review of about 120 mines in 23 counties in California that have produced quicksilver, as well as many potentially productive prospects and claims in these as well as other counties, it is evident that quicksilver mineralization is widespread in the State.

There have been no new discoveries of quicksilver ore bodies of major importance in California for many years, and the principal mining activities have been confined to working the lower grade ores in the existing mines. Although the known ore reserves in California are diminishing, there is every reason to believe that unknown reserves remain, the development of which will prolong the life of quicksilver mining industry here for many years. —Author's Abstract.

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