REPORT OF THE STATE BUREAU OF MINES

DENVER, COLORADO, U. S. A.

HARRY A. LEE, COMMISSIONER

D. L. GRIFFIN,
P. H. CLIFFORD
MINE INSPECTORS

COLORADO

FOR THE YEARS 1899-1900

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LETTER OF TRANSMITTAL.

Office of the Bureau of Mines,
State of Colorado.

TO HIS EXCELLENCY,
CHARLES S. THOMAS,
GOVERNOR OF COLORADO.

Sir—I have the honor to transmit herewith the report of "The Bureau of Mines of the State of Colorado" for the fiscal years 1899 and 1900.

Respectfully submitted,

HARRY ALLEN LEE,
Commissioner of Mines.

Denver, Colo., December 20, 1900.

THE BUREAU OF MINES.

The closing year of the century has proven a very satisfactory one to Colorado. While the production balances for the year 1900 can not be accurately determined until all the various wealth producing items shall have been duly entered and collated, the general increased activity in nearly, if not all, sections of the state, presages a material increase over that of any former year. Colorado has gained an eminence among her sister states never before attained, and her citizens, encouraged by what has been accomplished in the past, better advised relative to the varied natural resources at hand, better equipped for operating, transporting and manufacturing, and still endowed with the energy and pluck that have ever characterized the West, look with confidence into the future with a knowledge that the zenith of possibility is yet far from attainment.

The phenomenal advance of Colorado is well illustrated by the fact that to-day, in nearly every section of the state, hale and hearty citizens reside who delight in recounting their experiences while "camping on the Platte before Denver was thought of," or similar incidents of other sections. What does this mean? Simply this: That within one generation the territory now embraced within Colorado has been transformed from a Western wilderness, with its Indians, trappers and wild game, to a commonwealth in the sisterhood of states that annually adds more wealth to the nation in proportion to population than any other state of the Union. To enter into historical detail, relating the trials, hardships and difficulties, and almost unsurmountable obstacles that confronted the sturdy pioneer, is but to illustrate the axiom demonstrated upon every page of American history, viz., occasion brings forth the man.

MINING AN AGENT OF CIVILIZATION.

History reveals the prospector in search of the precious metals at all times to be the advance agent of civilization. Following the indistinct trail of the trapper, he was rewarded by the discovery of gold in paying quantities in several localities of Colorado in the years 1858-59. The reports of his discoveries transmitted "across the plains" by word of mouth to the Eastern states, were heralded in exaggerated form and the tide of immigration was turned westward. Many who had lost their all in the financial panic of 1857, joined the van in the hope of retrieving their losses. Very few had any conception of the hardships undertaken beyond a long drive across the country, and possibility of Indian outrages. Equipped for these with fond hopes, brave hearts, and wagon covers emblazoned "Pike's Peak or Bust," the journey was undertaken and the caravan put in motion. Some failed to reach their proposed destination, finding homes of promise in the Middle states, but the more determined arrived only to realize that the golden pictures that had lured them from home had been too highly colored. With the realization that gold did not exist in quantities that would enable them to amass a fortune in a few days' or weeks' time, many reluctantly turned their faces eastward. The remainder were about equally divided, viz.: Those who were convinced of future possibilities and those who were financially unable to undertake the return journey, and compelled by circumstances to seek remuneration for labor in the placer beds. The areas bearing free gold being comparatively limited, and each crowded with men impatient to dig out fortunes, the interest excited by the realization of the heavy gains by a few subsided by degrees with the gradual decrease of earnings. Emigration to other fields followed, leaving the further development of the country to the few whose faith and pluck proved equal to the task.

A PERIOD OF REACTION.

In February, 1861, Colorado was organized as a territory with an estimated population of 65,000. At that time the civil war demanded about all the able bodied men who could be spared, and other gold discoveries in the farther West and North aided in depleting the population so that

the official census of 1870 showed little in excess of 37,000 people. During the period 1863-1870 little advance was made in mining beyond determining the permanency of the lodes. These had been attacked, and owing to the refractory form of the ores encountered, little profit accrued to the operator. The bases of supply were east of the Missouri river and all articles of commerce were transported by wagons across the plains at a cost of from ten to forty cents per pound. In addition, these supplies were shipped at purchasers' risk, and many caravans never reached their destination, but were destroyed or divided among the Indians, who were ever on the alert for rapine or gain. Under such conditions none but the bravest spirits, endowed with a faith born of conviction, remained, and so closed what may be termed the first period of Colorado's history.

In 1870 the first locomotive appeared in Colorado. In this connection it may be said that the "darkest hour was just before the dawn." The Union Pacific Railroad was originally projected via Denver, but was eventually constructed along the northern border, passing through Cheyenne. The result was a further depletion of population and a diverting of commerce to points in Wyoming and Utah. To counteract this exhaustive drain, the Denver Pacific Railway Company was organized by home capital and on June 22, 1870, completed, thereby connecting Denver and Cheyenne. At the present time such an enterprise would be undertaken without much thought, but when this line was constructed it was well nigh a hopeless endeavor and made in desperation by the Colorado property owners. The successful conclusion of this "desperate act" marks the initial step in the actual advancement of Colorado, and to these pioneers may be justly ascribed the credit.

A NEW ERA.

With transportation facilities, the tide of emigration was checked and changed to immigration. Capital was encouraged and sought investment both in the mines and the agricultural districts. New railroads sprang into existence and Colorado was again a much talked of country.

In 1874 the healthy condition of affairs was further invigorated by the discovery of lead-silver ores at Leadville. Up to this time gold had been the much sought for metal and

little value had been attached to the copper, silver and lead associated with the gold ores. The great yield of the next few years from the Leadville mines turned the eyes of the world toward Colorado. All lines of industry assumed broader planes of operation, and mining for precious metals received an impetus that has not only advanced the industry in this, but all other sections.

The cry of the prospector was for lead-silver ores and the gold pan of the pioneer was laid aside. New districts sprang into existence in all sections of the state, and the pioneers of each district were confident of having opened a "second Leadville." In 1880-81 the mining industry reached an unhealthy condition from over-excitement and boom methods. The result was a consequent reaction which gave time to the numerous owners of mining properties in outlying districts to consider what they really had, and return to a normal condition and resume business methods.

"BOOM" IN MINING.

While the so-called "booms" in the mining industry should be discouraged, there is no gainsaying the fact that they expedite development and consequently, production. No "boom" is instituted without some foundation of fact, and while this may be distorted beyond recognition, the excitement results in a vast amount of research that in normal conditions would not be equaled in a decade. In very few of the Colorado booms have the results not proven highly satisfactory to an interested few and added some producing mines to the list that may otherwise have remained unknown for many years.

The search for and mining of silver-lead ores continued in a more or less healthy condition until 1893, which may be said to end the second era in Colorado's welfare. Owing to the great financial depression of '93, legislation that appears iniquitous to the average Coloradan, and the consequent reduction in the market price of lead-silver ores, many of the silver producing properties were closed down temporarily and production practically ceased.

The great amounts invested in the mines, railroads and smelters compelled a readjustment of affairs to meet new conditions. After a short time new tariff sheets were prepared by the railroads, new schedules of treatment charges were agreed upon by the reduction works, and the miners

were called upon to contribute their quota by a reduction in wages until such time as the market price of silver-lead would justify the old wage scale, which was willingly acceded. Under these conditions the large and fortunately situated silver-lead producers resumed operations. There was, however, a large class of property owners in outlying districts that under favorable market conditions could operate at a profit, but so small was the margin that even under the new conditions operating expenses would exceed receipts. The result was that large numbers were possessors of property temporarily worthless and in addition were out of employment. Confident of the ultimate value of their holdings, and undaunted by conditions, they resumed the gold pan of the pioneers and began the search for gold. The result of this action has exceeded the expectations of the most sanguine. Two years ago Colorado assumed the lead among states as a gold producer.

In the foregoing short review of Colorado's history only the most salient features have been touched upon. Considerable detail relative to districts will be found under the chapters of counties following, which have been alphabetically arranged for convenient reference.

EVOLUTION IN MINING.

The evolution in Colorado mining is similar to that of all partially developed mining sections. In our early history gold was produced from the placers or surface washings along the gulches or stream beds. The area available was comparatively limited, and the more productive beds were soon abandoned as ground worked out, to be reworked by coming generations. This condition of affairs naturally led to a search for the source of the placer deposits and resulted in the partial development of many quartz veins. In this transition mining was greatly changed, and those remaining indulged in lode mining. Although gold in paying quantities was found in many places throughout the territory, its occurrence, with few exceptions, was in connection with other ores, making a refractory compound not susceptible to treatment in the sluice box and gold pan. Mills of all kinds and descriptions were in time introduced, and these were in the main promoted and erected upon the extravagant ideas of owners of properties. As a result many failures were recorded and mines abandoned. Ultimately the discovery was made that many failures were due to the men and not the mines.

ADVENT OF RAILROADS.

With the opening of Leadville and the advent of railroads and reduction works, prospectors entered all sections of the state and reported fabulous discoveries. Thousands rushed into the new fields, seemingly oblivious to the surroundings or economic conditions that are essential to paying mines. From all sections, however, the lucky few were able to transport their high grade ore to market at a profit, the remainder either abandoning their holdings or proceeding to patent them, and to await the advent of better transportation facilities. Railroads have been gradually extended, and each year added new producers to the list. While gold prospecting was not abandoned, it may be safely asserted that the search for silver-lead ores constituted the prospectors' work from 1876 to 1890. All sections made rapid progress, notwithstanding the almost constant falling market price of silver up to 1890. In 1893 the general financial depression and consequent decline in silver to 60 cents per ounce discouraged all and practically suspended the output of the small producers, a large proportion of which still remain idle. The large producers under readjustment of tariff rates by railroads and smelters, and of less expensive management, continued production and in some instances the regular profit.

MORE PRACTICAL MINING.

While the condition of affairs in 1893 is to be deplored from the standpoint of individuals, it has doubtless proven a blessing in disguise to mining as an industry. With years of prosperity mine operators had unconsciously, perhaps, grown into extravagant methods of operating, and little attention was given to detail. The so-called crash of '93 compelled a return to business methods, a departure from which endangers at all times the financial success of any industry. In order to operate at a profit all corners had to be cut, and this more conservative management led to the investigation of large bodies of low grade ores that heretofore had been left untouched for "the future." These ore bodies could only be made remunerative by the addition of mechanical appliances. Never in the history of the state have so many successful milling plants been added as during the past decade.

To Leadville may be justly ascribed the honor of placing Colorado mining on a large and firm foundation, but to Cripple Creek may be awarded the honor of starting a period of investigation that will ultimately bring many sections to the front as great precious metal producers.

Strange as it may appear, the prospectors prior to 1874 did all their work with a gold pan, and advocated or renounced any section or region the ore of which would or would not show the requisite number of "colors" by panning. From 1874 to 1890 the gold pan was almost entirely discarded by the prospector and he depended upon the returns given him by the assayer to determine the value or nonvalue of his find. So complete was the change that comparatively few ever engaged the assayer to determine more than the silver and lead contents, assuming gold not to be contained in the ore. Under the stimulus given the industry by Cripple Creek the ideas of the prospector have been modernized. He now enters the field with the gold pan, but failing to get satisfactory returns from it, has access to the assay furnace. Many of the old ideas of the occurrence of gold have likewise been discarded. The modern prospector is alive to the fact that almost any rock from the Archaen to the Cretaceous inclusive, may not only be gold bearing, but with advanced appliances and methods for treatment of low grade ores, gold may be found in quantities that will profit the operator.

ADVANCED IDEAS IN MINING.

Under present conditions old or abandoned properties are being made productive. Old dumps that were absolutely worthless at the time they were made, owing to economic conditions, are now being worked over at a profit. Energetic miners are procuring working leases in all sections and are adding their production to help swell the grand total. It may be confidently stated that the mining industry of the state is in a better condition to-day than at any time since its inception. While alleged mines are being sold and always will be, for fabulous considerations, based upon ridiculous expectations, the generally accepted value of mining property to-day is based upon a knowledge of what it *will* pay and not what it *may* pay, and a fair allowance for future possibilities. Modern appliances, intelligence and business management are gradually displacing the happy-go-easy, trust-to-luck methods of the past.

THE PROSPECTOR VS. THE "EXPERT."

One of the best evidences of the advance in mining is shown in the lessening of the antipathy of the prospector toward the so-called "expert." This antipathy has in the past proven a drawback to an advance in mining, and was doubtless born of the early days when brawn and muscle had gained a limited success and bred egotistical confidence. Another and perhaps a more potent reason is that the so-called "expert" has, in his professional capacity of mining engineer, in passing upon the value of a property for a proposed purchaser, been compelled to "turn down" numerous propositions, not deeming same, after examination, worth the price asked. By such action the so-called expert has been held personally responsible for the failure of the prospector to realize handsomely upon his property. To-day marks a great change. Although some few may, through social alliances or personal friendship, sell their holdings direct to purchasers upon their own statements, it is now almost the universal custom to employ a mining engineer to examine and pass upon the value of mining propositions. The inevitable is gradually being accepted more gracefully by the prospector as a foolish demand or custom of capital that must be complied with. This "foolish custom" exerts a restraining influence and is productive of more conservative statements regarding mining properties offered for sale than would be made were the same not to be investigated, and the transfer of property to be subject to the verification of representations made.

It is not intended in the foregoing in any manner to charge the prospector with dishonesty or dishonest motives. Numerous investigations have satisfied the writer that with few exceptions prospectors actually believe their own statements. When, therefore, a person states what he actually believes to be a fact, no matter how much he may err as to the truth, he can not justly be charged with dishonesty. This paradox has been demonstrated time and time again. To illustrate: A prospector exhibits a fine piece of ore from a claim he owns, but has not seen it for a year or more. He describes the property in detail and asserts that he has one or two feet of ore similar to sample exposed, at the prospect. This assertion is followed by a desire to show it to you, and he insists that you go with him. After consenting and reach-

ing the prospect you often find no semblance of an ore body and only an occasional vugg or pocket, of which the sample first shown is larger and better than any that can be shown or found upon the dump. It does not stand to reason that a person will insist, and at considerable expense, conduct one to a place to demonstrate himself a falsifier. Yet he does this very thing, admits his overestimate and is as much surprised at conditions found as any one else. How such things may occur will not be entered into, but that they do, nearly everyone engaged in mining pursuits can verify.

The passing of many of the old beliefs and traditions of mining is another marked evidence of advance. It is now generally believed and accepted that ore bodies are concentrated by means of circulating waters, whether these waters fall from above, flow in from the sides, or rise from below; that ore deposits are of comparatively late geological formation, few dating back of the Tertiary; that ore deposits having commercial value may occur in almost any formation; and, with few exceptions, ore deposits are confined to a comparatively limited zone upon or near the surface of the earth's crust.

THE PROMOTER VS. THE INVESTOR.

Investigation discloses many misguided investments in so-called mines. Such investments are the result of overenthusiasm on the part of the promoter and the weakness or cupidity of capital in its almost ungovernable desire to obtain "something for nothing." Mining promoters are of two kinds. One, a man who knows practically nothing of the business of mining, but by a study of the reputed successes, becomes an enthusiast and confidently believes all prospects can be made paying mines. The other, a thorough business man, with enough mining experience to know that through a competent and reliable mining engineer the net value of ore in sight can be determined, the operating expenses and other economic questions learned, the probable future welfare of a mine be estimated, and the value of a property as an investment be demonstrated. Both classes of promoters follow the business for financial gain. One seeks prospects adjacent to or in the vicinity of paying mines. By an optimistic line of analogous reasoning, possibilities are soon merged into probabilities, and probabilities into a confident belief that certain acts, or certain sums of money ex-

pended in judicious development, will result in dividends comparable to the best mine of the region. His commission is usually commensurate with his optimistic beliefs. The enthusiasm of this class of promoters is unbounded and their optimism infectious. While the hard-headed business man, who has accumulated wealth by years of small profits, close attention to business and hard work, at first smiles derisively at the statements of these promoters, he will, in the majority of cases, if exposed long enough, become inoculated. He not only invests himself, but encourages his associates in business to do likewise. In this manner are many mining companies formed. In some instances the possibilities develop into realities, but in by far the greater number, failure is the result. Failure of a mining company does not, however, always demonstrate the property in question valueless. As a rule prospects so promoted have more or less merit and the possibilities of a future not beyond the range of reason. Failure is generally due to an over-estimate of dividends, and under-estimate of expense for development and operating, too much cash invested in purchase of property, the most of which is used to cover commissions, over-capitalization, the sale of all treasury stock, leaving no reserve fund to be drawn upon, and dependence upon property to yield sufficient profit to meet deferred payments of purchase as they become due. Failure, in short, caused by a radical departure from business methods. The promoter of the other class seeks developed mines, with a long record of production. He keeps himself within the bounds of reason, is satisfied with a comparatively small commission for his labor in presenting to capital a good investment. His commission is usually dependent upon the future probabilities of the mine, and may be properly compared to the so-called "good will," which is always a consideration in the purchase of an established mercantile or manufacturing business.

THE MINING ENGINEER.

As before stated, properties worked and eventually abandoned generally have some merit, and many such are taken up later by mining men and operated at a profit. In the present day there is no excuse for investors entering the mining field blindly. The same careful business consideration should be given an enterprise in mining that is extended to enterprises of manufacture or mercantile pursuits. All

men can not be all things. In manufacturing the advice of experience in the line under consideration is sought. In real estate transactions the advice of the attorney is sought; and in mining the advice of the mining engineer should be sought. The mining engineer may not be able "to see any further into the ground" than the miner or the promoter, but he will see all there is to see, state what he has seen and no more; determine the value of ore exposed, detail the surrounding economic conditions and demonstrate what a ton of ore so located will yield as profit to the operator. If the examination of the property include consideration and advice relative to the purchase price and proposition made by owner to proposed purchaser, the mining engineer will pass upon same and advise according to his convictions, having no interest in the transaction beyond his professional standing and the fee agreed upon for his services. Good advice may seem expensive, but it is far wiser to start right or not start at all.

MINES AND PROSPECTS.

The purchase of a mine in the full sense of the word, or a prospect, is an entirely different proposition. A mine is an established business. The engineer determines the amount of stock on hand, its gross and net value, and value of the plant as a whole. The difference between these determinations by the engineer and the price asked for the mine by the owner may be termed the price asked for the good will of the business. Fewer investments are safer than those judiciously made in developed mines. For this reason holders of large capital only seek mining investments of this character. The successful mining man, however, and especially the successful Colorado mining man, is constantly in the field for more mines or "holes in the ground" or prospects having promise. He does not anticipate that all of his enterprises in mining will prove remunerative, but by exercising care and judgment does expect that the final balance between the producers and non-producers will show a good profit. He does not pay a big price for a prospect, however promising. Its value can not be accurately determined until developed. Development costs money, and he absolutely refuses to pay out cash for the privilege of expending still more to determine whether or not he may have invested wisely. If the owner of a prospect will not afford the mining man ample time to develop the same, with the right to purchase for a stipulated price at the ex-

piration of an agreed time, during which time the same is to be developed, he generally holds his property and disposes of it elsewhere.

While the metalliferous deposits of Colorado are comparatively little developed, the achievements of the recent past have substituted knowledge where ignorance once existed, and given a reliability to mining that it at first did not possess.

OPPORTUNITIES IN MINING.

There is still some so-called luck in mining, but in the main success is attained by careful attention to mining business and mining methods. The mining of the earlier days was attended with great expense, and only the rich veins could be drawn upon with any possibility of profit. With the advent of railroads, county roads, reduction works and mills, ores valueless only a short time in the past are to-day valuable and yield a profit when managed with the same prudence and intelligence granted other industries. There are great numbers of prospects or undeveloped lodes throughout the several counties of the state. They are mainly owned by the original locators, who, for lack of means, are unable to develop them. The possibilities for capital in this direction are practically unlimited. It is but natural for the owner of a prospect when a sale is being considered to endeavor to obtain all he may, but he of all others appreciates his inability to develop his prospect into a mine, although he is thoroughly imbued with the belief that with development it will become a mine. He may therefore be easily induced to give capital an opportunity to develop it and take his chance of the prospect developing in accordance with his convictions. All prospects are more or less valuable and are subject to great possibilities. All mines were at one time prospects. Comparatively small investments may change a prospect to a mine. The percentage is so great when backed by judgment, ability and persistency, as to offer great inducement to capital. Every dollar injudiciously invested in mining is to a limited extent an injury to the industry. In general, a few hundreds of dollars invested in a prospect, with the expectation of developing a mine, is an injudicious investment. Those who follow mining as a business expect when taking hold of a promising prospect to systematically exploit it so as to enable them to determine whether or not the property may be developed into a mine by the expenditure of more money. With several such propositions,

some develop into mines, and the profits accruing, if only one mine is obtained, generally far exceed the outlay on the whole.

Nearly all sections of the state have good transportation facilities, and many factors that were in the past unfavorable to successful mining have been eliminated. The opportunity for judicious investment is almost unlimited.

THE MINING BUREAU.

The statute creating the department of the State Bureau of Mines is but a just recognition of the leading industry of the state. The statute also recognizes the necessity of subjecting mining operations to certain requirements, with the view of preventing the wanton destruction of human life by longer following customs that have proven far too disastrous. Like all new departments, its establishment met with strong opposition, and this opposition arose from sections that owe their existence to the development of industries through that of mining. Following the establishment of the Bureau of Mines, strenuous efforts were made to make the same inoperative. In this they were only partly successful, not by defeating the body of the bill, but by curtailing the equipment and maintenance of the department. It is not deemed essential at this time to enter into the causes of the opposition. That it exists is a well established fact, and that it is harbored by those who are at all times ready to oppose broad legislation for the benefit of the commonwealth as a whole, and favor legislation that may benefit certain localities is likewise well known. Suffice it, therefore, to say that under the decision of the Supreme Court of the state, the Bureau of Mines was established in pursuance of a constitutional mandate, is a constitutional office, and its abolishment can only be accomplished by amending the Constitution of the state in the regular manner.

An earnest endeavor has been made by the officers of the department to conduct the office upon the broad plane contemplated by the statute. Notoriety through the daily press has been studiously avoided, rather than sought. No department of state could, if it would, supply more news to the press than this bureau, and no set of officers could receive more free advertising were they to furnish the press representatives with the detail information that in the transaction of the business of the office comes to their knowledge. No such notoriety has been deemed wise or in accordance with the ac-

cepted construction of the statute. Under the statute the officers of the department are granted privileges and opportunities of gaining information not accorded to the general public, and for them to presume upon making this information public property would be as unbusinesslike as a bank examiner making public the debits and credits of the individuals patronizing the bank. While a different construction of the statute and the diffusion of knowledge gained might lend lustre and prominence to the bureau and its officers, such lustre would only be temporary, and would eventually prove just cause for the removal of the officers and the abolishment of the department.

While the foregoing construction of the statute may appear to some to be exactly *contra* to one of the main objects for which the department was created, viz., the diffusing of reliable information upon all minerals, localities, etc., that would tend to promote their welfare and indirectly the welfare of the whole state, a closer study of the statute will disclose how it was intended such information may be given to the public, and that personal property rights must at all times be observed and protected.

The department, while unable through lack of appropriations to publish bulletins on various subjects or districts, and unwilling to seek notoriety through the public press, has been and is constantly diffusing reliable and impartial information. The demands or requests made upon it are constantly increasing, both by mail and personal visitation, and the scope of queries propounded embraces nearly all subjects embraced in mining, metallurgy and allied industries. It has been the endeavor of the officers to treat all courteously, supply the information wanted, or put the inquirers in the way of ascertaining for themselves.

DETERMINATIONS.

It has been impossible to comply with all the requests made for determination of rocks and minerals. Many can be determined at sight, but others are more complex and require proper apparatus, microscopic slides or chemical analysis. The department not being equipped for such determinations, some samples have been returned undetermined, and others have been forwarded to various experts or educational institutions. Acknowledgment is here made of the many courtesies extended in this line by Dr. Wm. P. Headdon of the State Agricultural college at Fort Collins.

THE RECORDS.

The Mining Bureau furnishes an official source for information concerning the various mineral deposits of the the state, to which all may apply. The constantly increasing number of visitors and letters seeking information emphasizes the fact that the department is satisfying a long-felt need. While the greater portion of information sought relates to precious metal mines, no small part contemplates coal, building stone, lithographic stone, earths, paints, clays, cements, oil, gas, asphaltum, gypsum, lime, the rare metals, and mineral springs, with which the state abounds. To be able to supply this information has entailed no small amount of work in compiling and filing information upon all subjects mentioned and arranging same in form for ready-reference by counties and districts. In addition, a substantial and permanent set of record books is constantly being compiled. The ultimate value of these records can not be over-estimated. As now equipped, the department can meet nearly all demands for information.

THE MINERAL COLLECTION.

No more erroneous idea was ever entertained than that of considering a state mineral collection, to be for the sole purpose of supplying a place of interest to the idle curiosity seeker; or that the state mineral collection is nothing more or less than a "free show" maintained at the expense of the state. It is perhaps true that the mineral collection of this department has gained recognition as "one of the sights" of Denver. It is also perhaps true that the greater portion of the visitors examine the collection in search of novelty or to gratify idle curiosity. If expressions of pleasure and surprise indicate anything, even these are not disappointed. The real object of the collection is to supply and furnish information to those who are investigating the mineral resources of the state with a view to becoming financially interested in the mining industry of Colorado, and to demonstrate by an ocular display her great mineral diversity and wealth.

The collection has been carefully arranged, with a view of satisfying the desires of both the studious and the seeker after novelty. The central portion of the rooms is filled with flat oak show cases, in which are arranged the various minerals in regular order, duly numbered and catalogued to

conform to Dana's latest system of mineralogy. The walls are adorned with handsome oak wall cases, in which are arranged the ores and a few minerals from the several counties. Each wall case has been donated to the department by a county, and the ores and minerals of that county are thus segregated each into its own case.

Miners and prospectors avail themselves of the collection, and by comparison, are able to determine to their satisfaction whether or not they possess the particular ore or mineral under investigation. They also come or write the department, sending samples, asking for a classification of specimens, and to learn "what it is worth on the market per pound or per short ton." During the past two years many have had their fond hopes destroyed and many have been encouraged through the determinations made by the department.

Proposed purchasers of mining properties and mining engineers find much to benefit them by examining the case or cases containing the ores from counties in which they are about to invest or to pass upon the value of a mine in that particular section. By examining the ores and reading the records and reference works they become well informed as to what the conditions will be when they reach their destination. Mineralogists find much to interest them, and perhaps spend more time per person in the collection than any others. They are enthusiastic in their praises of the collection, and are best able to pass upon its merits and demerits.

During the past two years 2,720 specimens have been added to the "index" record of the collection. This does not constitute all the additions, for no small number has been substitutions, i. e.: When a better specimen is obtained than the one already on exhibition, it is substituted for the old one, and the old one added to the exchange shelf. By this means the standard of the collection is being not only maintained but gradually advanced.

THE EXHIBIT AT MILWAUKEE.

On June 15, 1900, and at the request of the mining exchanges of Colorado Springs, through Hon. B. F. Montgomery, twenty-five hundred choice specimens from the various districts of the state were boxed and shipped to Milwaukee, Wisconsin, to be placed upon exhibition at the International Mining Congress. The expense incident to transporting, in-

stalling, repacking and transporting, together with the expense and salary of a deputy in charge, was $500, which amount Col. Montgomery placed to the credit of the department. Mr. Harry C. Smith, M. E., was given charge of collection, and installed same in good shape at Milwaukee. The exhibit elicited no small amount of attention and advertising, and many from other sections of Colorado were pleased to find their camps well represented, through the broad-minded policy of the citizens of El Paso and Teller counties. While these two counties were probably best represented, all others had creditable showing and reaped corresponding benefit.

It is not contemplated that a state collection and a state department will be utilized for encouraging visitors into mining investments, but it is expected that all the ores and minerals upon exhibition in a state department shall be *bona fide* and that the information thus gained may be accepted as conservative and disinterested. It is expected when information regarding the character of ore, geological formation and general economic conditions is asked of a department that such information shall be authentic.

With the records, library and mineral collection, the department is now equipped so as to comply with nearly all the demands made upon it, and the number of those who accept and depend upon the statements of the bureau is constantly increasing.

OFTEN REPEATED QUESTIONS.

To attempt a review of the many questions propounded the department by visitors and through the mail would prove of little interest or value. A general statement of some answers made will not only give an idea of the practical value of the department, but also serve as a guide for others as to its general utility in these matters.

The office of the Bureau of Mines is a public office and the records are public records.

Certified copies of the records will be charged for at regular legal rate.

The state mineral collection is free to the public, and is open from 9 a. m. to 4 p. m., each day, Sundays and holidays excepted.

It is not within the province of the bureau to determine or pass upon the cash value of mining stock.

Officers of this department are prohibited by statute from making a report on a mining property with a view of aiding or abetting sale of same.

Upon request the bureau will report whether or not a designated company or property exists, and whether said property is a mine or prospect. The value of the property or the value of the stock must be determined elsewhere. This bureau can only make a statement of facts and conditions.

Determinations of ores or minerals will be made gratis upon application, provided said determination can be made without analysis or other expense to the bureau.

Samples sent for assay determinations will be delivered to reliable assayers when the fee for charges accompanies same. The bureau has no assay department.

Sampling works are independent enterprises, whose business it is to determine the mineral contents in ore. Their revenue is realized by charging a fixed amount per ton. As a further consideration they are expected to assist the owner of the ore in producing the highest price possible for the same. They may purchase ore from producers, but as a rule prefer to stand between the ore producer and ore buyer, and receive their compensation per tons handled.

Ore having value always commands a ready cash market. All reduction works charge a fixed rate per ton for handling. This charge is regulated by the character of the ore, and may be nothing or as high as twenty-five dollars per ton.

Mills should only be constructed after the most careful investigation. First, be certain of plenty of ore to justify the erection of a mill. Second, secure the best talent possible to determine the character of the mill required. Third, find some mill of character decided upon, in operation, and arrange for a practical test before construction. Many promising prospects are "killed" by erecting mills not adapted to the treatment of the ores, and all competent to advise will, if possible, insist upon a practical test, in a mill now operating, prior to advising construction of plant.

There is no statute in Colorado requiring a proficiency in mining knowledge to enable a person to work in or operate a metalliferous mine.

Metalliferous miners are not required to serve an apprenticeship "to learn the business" before being allowed to work underground.

Engineers on mines are not required to pass examination and obtain state or county certificates before being employed.

A "prospect" is a term generally applied to any territory that shows or may show evidence of mineral wealth. It may be good or bad, and may be wholly undeveloped, or exploited by extensive development.

A mine is a property competent to produce net, not only the purchase price, but to pay interest upon the investment during the time required to remove the ore and realize upon the investment.

An examination of title to mining property should embrace a verification by survey of the metes and bounds as described. A chain of title may be perfect on paper, and the stakes or monuments outlining the actual territory owned be at variance with the metes and bounds as stated in transfer deeds. It has been decided by the various courts that the stakes or monuments upon the territory in question govern the ownership. Much expensive litigation may be avoided by a proper examination of title.

The main cause of mining litigation is slip-shod or careless methods pursued in first obtaining title. A law suit does not add to the intrinsic value of a property, but law suits rarely occur until property in dispute is proven or supposed to be valuable.

It is better, but not absolutely essential, that a mine manager be a mining engineer. The careful exercise of business sagacity in employing the best talent to be had in the various lines, and depending upon their combined ability, will result successfully.

There is no economy in equipping a mine or mill with cheap machinery. A man may be a first-class miner, but have little mechanical knowledge. In all vocations a "little knowledge" of the subject under consideration is recognized as dangerous advice to follow.

"Ore in sight" is ore so developed or exposed by development that its length, breadth, thickness and value can be determined.

"Net ore in sight" is ore in sight, less all expense incident to mining, milling, transportation, reduction and management. Interest upon the investment, as a whole, may or may not be incorporated.

Buying mining stock is not mining. It is an investment that may prove good or bad.

New processes for ore reduction are dangerous. Laboratory tests, upon small quantities of ore, manipulated by an expert, may prove eminently successful, and mills erected to work the same process on a commercial scale, a complete failure. It is false economy to save several hundred dollars for competent advice and jeopardize thousands of dollars in mill construction as well as the welfare of the mine.

Typical specimens of ore or minerals are always acceptable and will be placed upon exhibition in the mineral collection, giving proper credit to the donor, mine and district.

A mine is not more valuable after it has produced largely than it was before. Every ton of ore taken from a mine leaves just that much less in it, and the end of production is just that much nearer. All things have a beginning and ending, likewise mines and fissure veins. It often happens that during the time of ore extraction, greater ore reserves are exposed by development than were known to exist, originally. In all well managed properties the ore reserves are kept well ahead of ore extraction. As a mine increases its production the ore reserves are usually increased in same ratio. Hence the oft-repeated statement.

Samples sent for analysis will be delivered to reliable chemists when fee for charges accompanies same. The bureau has no analytical department.

In Colorado mines, development and production have exploded the theory of "greater values in ore with greater depth." It may prove true, and has been demonstrated to be so in some cases, but in others the reverse has likewise been proven. The persistent value of ore in lode veins is dependent upon the source of the deposit, and mode of concentration by nature's forces.

The history of cross-cut tunnels for developing ore bodies is not favorable to that method of exploitation. In sections or districts where the persistence of ore bodies has been demonstrated by extensive development it may be advisable. In new districts, with comparatively little development, it is safer first to follow the ore down, and develop the strength of the ore shoots. With this done, the driving of a cross-cut tunnel resolves itself into an economic question. The custom of sinking a ten-foot hole on an ore body, and then starting a cross-cut tunnel several hundred feet long, is bad policy and should be discouraged. The miners' adage of "Stay with your ore if it goes up a tree," is founded upon experience and good judgment.

It is the duty of the officers of the bureau to do all things within their power to promote the welfare of the mining industry of the state. In the future, as in the past, parties desiring expert information will be referred to engineers competent to advise, in any capacity desired.

THE LIBRARY.

The library of the department consists of reports and works selected with special reference to giving information upon the geological formation, mineralogy and metallurgy of various sections of the country. In connection with the records it affords great assistance to the many who are constantly seeking authoritative information. The library is not by any means what it should be, but is gradually growing, and keeping pace with the advance and development of the mining industry.

Acknowledgment is here made of receipt of the following works, papers and periodicals, gratuitously furnished the department:

The Leadville Miner, The Herald Democrat, Victor Daily Times, The Morning Times, The Evening Telegraph, The Daily Mining Record, The Del Norte Daily Enquirer, The Evening Democrat, Victor Daily Record, Colorado Springs Gazette, The Rocky Mountain News, The Denver Republican, The Denver Times, The Evening Post, Granite Pay Streak, Weekly Register-Call, The Gilpin Observer, The Idaho Springs News, Mining Gazette, Georgetown Courier, The Silver Standard, Fort Collins Express, The Weekly Courier, Loveland Reporter, Loveland Register, The Alamosa Independent Journal, San Luis Valley Courier, Silver Cliff Rustler, The Aspen Tribune, The Pitkin Miner, Summit County Journal, Eagle County Blade, The Eldora Miner, The Boulder Tribune, The Boulder News, The Searchlight, The Mining Gazette, The Canon City Record, Rio Grande Sentinel, Colorado Transcript, The Western Miner and Financier, The Como Record, The Steamboat Pilot, Coal and Coke, Western Mining World, The Coal Trade Journal, Mining and Engineering Review, American Manufacturer and Iron Worker, Mining and Scientific Press, The Engineering and Mining Journal, The American Inventor, The Mining Investor, Mining Reporter, The Marble City Times, The Gunnison Tribune, The Gunnison News, The Creede Miner, The Lake City Times, The Lake City Phonograph, The Delta In-

dependent, The Ouray Herald, The Silvenite Plaindealer, The Telluride Journal, The Telluride-San Miguel Examiner, The Ophir Mail, The Rico Sun, Mancos Times, La Plata Miner, The Durango Wage Earner, Silverton Standard, Silverton Weekly Miner, The Altman Champion, The Examiner, The Manitou Springs Journal, The Gillett Forum, Canon City Clipper, The Salida Mail, The Whitehorn News, The New Zealand Mine Record, Mineral Collector, The Anglo-Colorado M. & M. Guide, Modern Machinery, Ores and Metals, Mines and Minerals, The Journal Franklin Institute, San Juan Miner, Copper, Zinc and Lead Review, Stone, Mining Journal of Northwest Mining Association, Bulletin of South Dakota School of Mines, The Platform Library, Regulations—Gold Fields in Western Australia, General Report Mines and Quarries from England, Report Carnegie Library, Report Field Museum, Report Philadelphia Museum, Report California State Bureau of Mines, Report of Bureau of Mines of Pennsylvania, Iowa Geological Survey, Geological Survey of Michigan, Missouri Geological Survey and Report, Report of Bureau of Mines of Ontario, Report of the Bureau of Statistics of Indiana, Resources of North Carolina, Geological Survey of Georgia, Coal Report of Illinois, Mineral Resources of Kansas, Report of Inspector of Mines of Montana, Report of Inspector of Mines of Ohio, The Resources of Oregon, South Dakota Geological Survey, Reports of Wyoming, Canada Mining Institute, Building Stone of Maryland, Report of Inspector of Mines of New Mexico, Mining in British Columbia, Department of Mines of Nova Scotia, Mine Report for United Kingdom, The Mineral Industry, and Works of the United States Geological Survey.

ACCIDENTS.

It is a deplorable fact that accidents which cause the death of one or two persons are of such common occurrence as to attract little attention from the general public. The daily press teems with fatal accidents, but even the usual short description published is barely read beyond the head lines. In the event that the accident assumes alarming proportions, so that many instead of a few human lives are destroyed, public interest and sympathy is temporarily aroused. The cause of accidents and their prevention have received much careful consideration at the hands of experts in nearly all vocations. Mining statistics have been compiled and some

good accomplished. The field for improvement is, however, still great. Greater than it should be when human life pays the penalty. In all vocations or walks in life accidents are liable to occur. Some vocations are shown by statistics to be more dangerous than others, and expert statisticians have attempted to classify the various occupations of man in tables of so-called "risks." No doubt is entertained as to the accuracy of these tables or that they form a safe basis upon which insurance companies calculate "human risks." A mathematical demonstration calculated with a view of determining safety, corporate or individual, in the purchase of "human risks," is a different proposition from endeavoring to save human life for humanity's sake. These statistical tables doubtless demonstrate the risks assumed in various vocations and may do some good, but do they not also carry with them an object lesson in fatalism, a belief in the inevitable, and a meek submission to the forces of nature so long as the death rate of alleged risks assumed falls under the stipulated rate per one thousand men employed, as shown by the tables? If these tables of statistics do encourage this character of fatalism, and careful investigation of accidents for several years leads the writer to assert that they do, then comparatively little advance in the prevention of accidents can be hoped for until legislative enactments, with fixed severe penalties, become laws.

Metalliferous mining has been and is considered a hazardous and dangerous occupation. If comparative statistical tables are to be taken as a guide, then the belief is well founded. If the number of men killed annually in the Colorado mines be unavoidable, then no advance in the saving of the lives of the miners may be hoped for. To acknowledge such fatalistic doctrine is but to deny the intelligence of man to exploit the precious metalliferous deposits of nature without human sacrifice.

Wherein lies the cause of mining accidents? Why are more men killed in mining than in any other industrial pursuit of the state? Why does Colorado proportionately lead the list of fatal accidents as compared with all other states or provinces? These questions are of vital importance and are worthy of careful consideration. The writer asserts that metalliferous mining *can* be conducted in such manner as to eliminate almost entirely the elements of risk or danger to human life. It does not follow that mining so conducted will yield as great a profit as it does under methods now in vogue.

This gives rise to the question, how far should an industry be permitted to advance its material welfare at the expense of human life?

Systematic investigation of the mining accidents that have occurred during the past five years, and careful consideration of the conditions and mining methods that caused them, have convinced the writer that the fundamental causes may be generalized as follows:

Incompetent management.

Incompetent miners.

Lack of rigid discipline.

Carelessness.

INCOMPETENT MANAGEMENT.

There is no law in this state prohibiting anyone from assuming control or management of a metalliferous mine or prospect. Any person may prospect. Any person may mine, or hire others to mine, practically without restriction. Mines are the outgrowth of prospects, and mining managers as a rule the outgrowth of prospectors. The only knowledge they possess of mining is that obtained by aiding in the work of a few assessment holes, or turning a windlass to remove rock broken by the miners employed. This is the best possible way to acquire knowledge if pursued far enough. Investigation shows, however, that after one or possibly two seasons, they think they have acquired sufficient knowledge to assume control themselves, and that they need no longer depend upon the more mature judgment of others. The result is that the greater number of the metalliferous properties operating in the state are managed by those whose mining experience is extremely limited. In nearly all vocations a little knowledge is considered dangerous. It is also generally conceded that all men believe they know more about a new business, soon after undertaking it, than they ever do again. In the so-called "trades" it has long been a standing joke to ask the apprentice after a day or two if "he is not sorry he learned the business." A very common expression in all walks of life is "if I only knew as much about this business as I thought I did when I first started, my success would probably be better." Not only is the greater number of metalliferous properties operated in the state managed by men who practically know nothing of the business, but in the aggregate

they employ the greatest number of men engaged in mining in the state. Such men usually conduct their correspondence upon stationery displaying not only the name of the company, but also the name of the "general manager" in a conspicuous corner. They are dangerous not so much for that which they do not know about mining, but for that which they assume to know. Men are employed and put to work in places that to them appear dangerous. The manager, however, has "examined it and declared it safe." The men, upon this assurance, do not investigate, but accept the opinion of one not competent to pass judgment, and eventually an accident is the result.

INCOMPETENT MINERS.

There is no statutory definition of a miner, neither has custom established a standard of mining knowledge and experience that entitles a person to call himself a "hard rock miner." He is a miner, and accepted as such by his own declaration, and his ability to "hold a job." He is not compelled to serve an apprenticeship and learn the art or science of mining. If he can assist in driving a few open-cuts, learn how blasts are put in place and become so skilled that he may "hit a drill," he feels and believes himself a miner, and is too often soon found employed upon a property as a full fledged miner. What he lacks in skill he endeavors to equalize by strength and willingness to work. In this way he may be able to accomplish a fair day's work, but placed underground with other men, he is a menace to the safety not only of himself, but that of his fellow miners.

If an unskilled man should succeed in obtaining employment as a miner on a plant managed by one who has no actual knowledge of mining beyond presumption, the result from the standpoint of safety is obvious. Of the two, the unskilled manager is the more dangerous for the reason that in the unskilled miner caution has not been entirely lost to egotism.

In the large mines of the state the safety of employes receives more attention. Not that the management of the larger mines is more humane, but because the economical operation of a large plant demands more systematic co-operation in all parts of the mine, and accidents not only cause delays and consequent loss of time, but many result in the

trouble, annoyance and expense of a suit for damages. The safety of employes is therefore largely an economical question and one that materially affects the financial results desired to be obtained. The investigation of accidents upon large plants which are usually incorporated companies, demonstrates the truth of the saying, "Corporations are without soul." It is true that the individuals composing the management of a large plant express their sorrow and regret when a fatal accident occurs, but no one officer can be found who assumes or feels any responsibility for the casualty. The stockholder feels absolved by placing the management in the hands of a board of direction. The board of directors has warned the general manager and this warning has been passed down through the superintendent, foreman and shift boss to the employe. All appear satisfied that they have discharged their duty in this respect, and that they are all absolutely blameless, and some go so far as to say powerless to prevent accidents. The fact remains, however, that there is work for the coroner and undertaker. The cause of these finding so much employment will be reached in a later paragraph.

DISCIPLINE.

It is very questionable if lack of rigid discipline should not be accredited the first place, as the primary cause of accidents. In prospecting work the men are relied upon to use their own judgment; as the prospecting may develop, the men are still permitted largely to exercise their own judgment. The whole work is conducted upon a happy-go-easy, do-as-you-think-best system. Either the person actually directing the work is incompetent to advise or has fallen into the custom of permitting the men to decide the safety of conditions for themselves. Nearly all matters connected with the operation of a mine are governed by established customs. There are comparatively few mines that are managed by mandatory orders. All should be. A person about to be employed should be required to give satisfactory evidence that he is entitled to be called a miner. He should then be made conversant with the standing orders by which the mine is governed, and his unqualified assent be obtained to abide by same, before his name is placed upon the pay roll. He should assume his work with a full knowledge of the duties he has to perform and that failure upon his part means disciplining

by a temporary "lay off" or dismissal from service. The same iron-clad policy should govern every department about the mine. These rigid demands of the employe should be balanced by the employer in prompt payment for services rendered, ample safety mechanical appliances, safe timbering, good ventilation and comfortable "rooms for changing."

Investigation discloses that the greatest number of accidents is caused by conditional orders not complied with, or from ignorance relative to the systems employed in the mine. A man is employed upon his declaration that he is a miner. He is sent to work with the assumption that he is fully conversant with the laws, customs or systems of work that prevail in the mine. In the event that the new employe is neither a miner nor conversant with the prevailing customs of the mine, both the employer and employe are or should be held culpable for exposing the other employes to this unknown danger, but the burden of crime should rest upon the employer. He is expected to look after the safety of his employes and the welfare of his property, but through carelessness does neither.

CONDITIONAL ORDERS.

By conditional orders is meant, orders like the following: "That ground above you is not safe and I think you had better not work there until some timbers are put in;" or, "Men riding on the bucket do so at their own risk," etc. In the first instance the order should be: "Remove your tools and do no more work there until timbered up." If the ground be unsafe, in the opinion of the person in charge of work, it should be a mandatory duty to order the employe away, and it should also devolve upon him to see that his order is immediately executed. The same kind of orders may be shown by almost innumerable illustrations, but are deemed unnecessary. The idea to be conveyed is, that the conditions constantly arising about a mine are safe or unsafe, and the decision rests upon the person representing the employer, that he should or should not issue an order, or should not attempt to divide the responsibility with the employe.

Orders of the character of the second example, viz.: "Men riding upon the bucket, do so at their own risk and the company will not be responsible for any accidents," are not only useless but in a sense contemptible. These orders are often found posted near the top of the shaft. Such no-

tices are a presumption upon the ignorance of the employe, and in nearly all instances are posted with a full knowledge that the same in no manner lessen the responsibility of the employer. "Riding on the bucket," should be adjudged safe or unsafe, and be permitted or prohibited. Such orders indicate a willingness on the part of the management to permit practices which they consider dangerous, provided they may unload the responsibility of the risk. They also indicate a willingness on the part of the management to permit any practice so long as accident does not occur and thereby encourage the overthrow of all discipline. The safety of employes on metalliferous mines is more dependent upon enforced discipline than upon any other one factor.

CARELESSNESS.

Carelessness is but the natural outgrowth of slipshod methods or want of discipline. Oft-repeated or constant exposure to danger may cause the person to forget the actual risk assumed, or to become so accustomed to danger that dread of accident loses its force. In some instances carelessness is the natural outgrowth of a fatalistic belief, quite common to underground miners, that they are born to be killed or not to be killed in a mine, and the exercise of care on their part is useless. Whatever the actual cause, many accidents, both fatal and non-fatal, occur from overt or careless acts on the part of the person injured or killed. Investigation discloses that more accidents from this cause occur on properties where the least discipline prevails, and the writer is fully convinced that the enforcement of rigid discipline will do more to prevent casualties of this character than anything else.

NEED OF LEGISLATION.

The work of this department during the past two years, in correcting wrong methods, and doing all things within its power to prevent accidents, has been very gratifying. The result of this labor cannot be measured by number of accidents prevented or by number of lives saved. There is no room for doubt, however, that by constantly correcting wrong practices, establishing proper methods, and advocating appliances known to have merit, that many accidents and deaths that would have otherwise occurred have been

prevented. The field for work is much greater than is possible for the department to properly cover with its present force. Never in the history of the state have so many inexperienced persons engaged in mining as during the past few years, and the demand and necessity for state supervision is constantly increasing.

It is the duty of the legislature to aid the department by enacting measures that will reduce the number of casualties in mining. If the working force of the bureau cannot be increased, a law providing a standard of experience, skill and educational qualifications for all who operate metalliferous mines will do much to overcome the present death rate. The mining industry of the state has now advanced to a point where the farmers, doctors, lawyers, ministers, merchants, clerks and men of all other professions should be permitted to return to their own work, and turn the work of mining, which they are trying to manage, over to mining engineers. With men in control of properties, compelled by legislative enactment to be competent, the death rate from accidents would be greatly reduced. The legislative assembly that enacts laws which will result in saving the lives of fifty to seventy-five men per annum, will have accomplished much.

STATISTICS.

The compilation of accurate statistics relative to the mining industry is at best somewhat unsatisfactory. The Twelfth General Assembly, in its wisdom, amended the statute relative to men engaged in mining, so as to read as follows:

"Twenty-second—Any person or persons operating any metalliferous mine or mill and employing five or more men shall report the same to the Bureau of Mines. * * *."

A large proportion of the mining operations of the state are conducted by individuals and corporate companies employing less than five men. The statute, as amended, relieves all of this class from reporting, and in order to obtain the number of men employed, temporarily or regularly, the bureau is, to a great extent, dependent upon the good will and patriotism of the operators. The intent of the amendment was to increase the efficiency of the bureau in obtaining reliable information, but the effect has proven to be the re-

verse. Thousands of blank forms and requests asking co-operation are sent out, at no small expense. Many comply promptly, but others are less prompt and must be systematically pursued, either by actual visitation or by subsequent requests by mail. From the very best information obtainable under present conditions, the following table shows the number of men engaged in actual mining and milling, by counties, during the fiscal years 1899 and 1900:

NUMBER OF MEN EMPLOYED.

County.	1899.	1900.
Arapahoe	2,032	2,092
Archuleta	10	6
Boulder	1,539	1,597
Chaffee	938	944
Clear Creek	1,981	2,012
Conejos	35	15
Costilla	62	44
Custer	340	419
Dolores	485	497
Douglas	43	5
Eagle	316	302
El Paso	....	85
Fremont	410	495
Garfield	10	6
Gilpin	3,017	3,124
Grand	24	35
Gunnison	560	585
Hinsdale	576	538
Huerfano	8	37
Jefferson	57	45
Lake	6,736	7,470
La Plata	360	307
Larimer	110	86
Las Animas	12	10
Mineral	1,040	992
Montrose	162	115
Mesa	55	28
Montezuma	125	109
Ouray	1,878	1,897
Pueblo	2,054	2,084

NUMBER OF MEN EMPLOYED—CONCLUDED.

County.	1899.	1900.
Park	448	374
Pitkin	1,635	1,560
Rio Blanco	5	6
Rio Grande	186	75
Routt	191	115
Saguache	315	378
San Juan	1,347	1,405
San Miguel	1,612	1,723
Summit	568	574
Teller	7,928	7,920
Total	39,210	40,111

To divide accurately the number of men into "number employed above ground" and "number employed underground" is practically impossible, for the reason that no small proportion employed work both above and below ground each day worked. That is to say: On small properties the labor above ground is usually divided among the employes. All work underground while the holes for blasts are being drilled, and after blasting, one or two do the "top work" one day, necessary to remove the broken rock, sharpen tools, etc., and the others do the top work next day. From best information obtainable the following is an equitable division and practically correct.

Number of men employed in mining and milling, 1899.....39,210
Number of men employed above ground, 1899.....15,684
Number of men employed under ground, 1899.....23,526
Number of men employed in mining and milling, 1900.....40,111
Number of men employed above ground, 1900.....16,040
Number of men employed under ground, 1900.....24,071

ACCIDENTS.

During the fiscal years 1899 and 1900, 1,217 accidents have been investigated, of which 210 were fatal and 1,007 non-fatal. Many of the non-fatal accidents are trivial in character, but come under the definition of an accident as defined in statute, viz.:

"* * * accident serious enough in character to cause the injured party to stop work for two consecutive days. * * *."

The largest proportion of the slight accidents are reported from properties carrying insurance policies with casualty companies.

CAUSE OF ACCIDENTS.

ABOVE GROUND—	Fatal.	Non-Fatal.	Total.
Machinery accidents	7	30	37
Mill and smelter accidents	7	187	194
Overwinding cage or bucket	0	2	2
Falling down shaft from surface	5	4	9
Falling from ore wagon	2	2	4
Falling from gallows frame	1	2	3
Material falling down shaft from surface	7	20	27
Gravity tramway	1	6	7
Tramming or dumping cars	0	18	18
Injured by windlass	0	2	2
Falling into uncovered prospect holes	0	2	2
Miscellaneous	0	31	31
Total	30	306	336

SHAFT ACCIDENTS—			
Getting on or off cage or bucket in motion	5	5	10
Material falling from levels or sides of shafts	9	37	46
Material falling from overloaded bucket	2	5	7
Broken or detached cable	1	7	8
Struck by descending cage or bucket	3	16	19
Falls from bucket or cage while being hoisted or lowered	11	21	32
Falls from ladder	4	10	14
Pushing car into open shaft, going down with same	2	1	3
Total	37	102	139

CAUSE OF ACCIDENTS—CONCLUDED.

UNDER GROUND—	Fatal.	Non-Fatal.	Total.
Falls of rock	41	227	268
Falls from overloaded staging	3	39	42
Falls from ladder	5	35	40
Falls in chute, winze, upraise or manway	10	33	43
Caught in ore chute with running ore	5	35	40
Injured by tram car	0	49	49
Injured by flying rock or steel	0	32	32
Suffocation, burning shaft house	3	0	3
Suffocation, bad air, abandoned mine	3	0	3
Suffocation, powder smoke	5	6	11
Operating machine drill	0	20	20
Miscellaneous	0	26	26
Total	75	502	577

EXPLOSIVES—			
Thawing powder over candle, in hot sand or water	4	8	12
"Picking out missed shot"	11	13	24
Drilling into hole that missed fire	17	24	41
Blast exploded while loading	11	10	21
Powder and caps exploded while preparing charge	5	12	17
Remained too long after lighting fuse	6	12	18
Returned before blast exploded	6	16	22
Handling caps	1	0	1
Explosion of caps and powder on cage	3	0	3
Explosion of dryer caused by frozen pipe	1	0	1
Explosion, cause unknown	3	2	5
Total	68	97	165
Grand total	210	1,007	1,217

RATE OF ACCIDENT PER 1,000 MEN EMPLOYED.

Number of men employed in 1899 and 1900	79,321
Number of men above ground, 1899 and 1900	31,724
Number of men under ground, 1899 and 1900	47,597
Number of non-fatal accidents investigated	1,007
Number of fatal accidents investigated	210
Number of accidents investigated	1,217
Number of non-fatal accidents above ground	306
Number of fatal accidents above ground	30
Number of non-fatal accidents under ground	701
Number of fatal accidents under ground	180
Per cent. of fatal accidents per 1,000 employed	2.64
Per cent. of non-fatal accidents per 1,000 employed	12.68
Per cent. of accidents per 1,000 employed	15.32
Per cent. of fatal accidents per 1,000 employed, above ground	0.94
Per cent. of non-fatal accidents per 1,000 employed, above ground	9.64
Per cent. of accidents per 1,000 employed, above ground	10.58
Per cent. of fatal accidents per 1,000 employed, under ground	3.78
Per cent. of non-fatal accidents per 1,000 employed, under ground	14.73
Per cent. of accidents per 1,000 employed, under ground	18.51

REDUCTION IN NUMBER OF FATAL ACCIDENTS.

In proportion to men employed there have been fewer fatal accidents in the metalliferous mines during the past two years than during the years previous to that time. That the Bureau of Mines has been the means through which this much desired result has been accomplished there can be no doubt. Beyond that of being the agency through which the wisdom of the General Assemblies has been exemplified by the enactment of laws contemplated to prevent accidents and prescribing the duties of its officers, the bureau is entitled to no credit. From the report of the bureau for the year 1896, the following is quoted:

Number of fatal accidents per annum per 1,000 men employed above ground...0.32
Number of fatal accidents per annum per 1,000 men employed under ground...5.96

From the table preceding, for the years 1899 and 1900, the rate was as follows:

Number of fatal accidents per annum per 1,000 men employed above ground...0.94
Number of fatal accidents per annum per 1,000 men employed under ground...3.78

This comparison shows an increased fatality per annum per 1,000 men employed above ground of 0.62, and a decrease of 2.16 per annum per 1,000 men employed under ground.

Average number employed, 1896	25,545
Average number employed, 1899 and 1900	39,660
Average number employed above ground, 1896	9,621
Average number employed above ground, 1899 and 1900	15,862
Average number employed under ground, 1896	15,924
Average number employed under ground, 1899 and 1900	23,798
Number of fatal accidents, 1896	103
Number of fatal accidents, 1899-1900 (average per annum)	105

The non-fatal accidents for 1899 and 1900 show a marked increase over 1896, both above and under ground. This is due to the law enacted by the Twelfth General Assembly, defining an accident requiring a report to be an * * * "accident serious enough in character to cause the injured party to stop work two consecutive days. * * *" Prior to the enactment of this definition, minor accidents were not taken into consideration.

While the rate of fatalities is considerably reduced, as above shown, the accident rate of the metalliferous mines is still much in excess of what it should be, and may be still further reduced. To compare favorably with other mining sections, where more rigid laws are enforced, the rate must be largely reduced.

RATE OF ACCIDENTS NOT OVERESTIMATED.

The alarming accident rate in the metalliferous mines, as shown in the above tables, is believed to be under, and not over, the actual rate. The various statistical reports received from the mines appear to calculate the average number of men employed from the average number of men on pay roll. A pay roll may show an average of 100 men for twelve months, but it does not follow that these 100 men each worked three hundred days in the year, or that 360,000 days' work was done during the year. Every effort to obtain correct reports and deductions has been made, but all requests have not received the careful consideration desired. Neither has it been possible to determine an equitable and proper deduction to be made by this department. Upon some mines the employes apparently work when they please and "lay off"

when they so desire. On other mines the discipline is more rigid. The number of men, therefore, actually exposed to accidents three hundred days per annum is believed to be less than number shown in above tables. If this be true, then the accident rate per thousand men employed three hundred days per annum is lower than it should be and the actual risk incurred is not actually determined.

An endeavor has been made to secure the co-operation of all mine managers so that the accident rate could be accurately determined, but with only partial success. The following mines have responded to requests made and reported the actual number of days' work, above ground, under ground, and the number of fatal accidents, for a period of twelve months: Independence, Victor, Portland, Strong, Golden Cycle and Granite of Cripple Creek; Ibex (Little Jonny), Moyer, Comstock, Chippewa, Rialto, Revenue Lease, of Leadville; Tom Boy, Bessie, Smuggler-Union, of Telluride; Revenue, of Ouray; Smuggler, Argentum-Juanita, and Mollie Gibson, of Aspen; Iron Mask and Ground Hog, of Gilman; Jessie and Eldorado, of Breckenridge; Mary Murphy, of Romley; Lamartine and Mendota, Idaho Springs; Bachelor, of Creede; Silver Lake, of Silverton; and Fisk, of Central City.

The reports aggregate as follows:

Total days work above ground	312,689
Total days work under ground	846,385
Total days work	1,159,074
Total number of fatal accidents above ground	0
Total number of fatal accidents under ground	16
Total number of fatal accidents	16
Number of days actual work to each fatal accident	52,899
or	
Number of fatal accidents per annum (300 days) per 1,000 men employed	5.69

The writer believes that the fatal accident rate of 5.69 to every 1,000 men actually exposed to danger 300 days per annum in the metalliferous mines is nearer correct than that of 1899 and 1900, as shown in previous table. Had all the mining managers requested responded and furnished the bureau with the actual days worked, the result would have been far more satisfactory. It is not safe to assume that the

rate of 5.69 would hold good if the total number of days worked in all the mining operations of the state was calculated upon same basis. The rate may be above, or it may be below. Neither is it safe to assume that the accidents of one year will hold good for all years past or to follow. The actual risk can only be determined by comparative tables for a number of years. The comparison of tables prepared in 1896 with those of 1899 and 1900, show a marked decrease in fatal accident rate. The comparison is correct, for the reason that both sets of tables are prepared in the same manner, but it is believed that both are below the actual death rate per 1,000 men employed. From a careful perusal of a number of statistical reports demonstrating the risk assumed in the various vocations, and of mining in particular, it is impossible to determine whether the same are based upon number of men on pay rolls, or number of men actually exposed to the dangers incident to their vocation three hundred days per annum. The proper method of demonstrating the real risks assumed is obvious, and it is hoped that calling attention to the possible difference will result in an expression from other departments as to the manner in which their vital statistics are prepared.

The following interesting detail may be gleaned from the sixteen fatal accidents shown above by reference to the records of the bureau.

CAUSE OF ACCIDENT—	Nationality.	Experience in Mining.
Fall of rock	Finlander	10 years
Fall of rock	American	14 years
Fall of rock	American	6 years
Fall of rock	Austrian	3 years
Fall of rock	Irishman	4 years
Returned before blast exploded	Irishman	25 years
Remained too long after lighting fuse	American	8 years
Remained too long after lighting fuse	Austrian	11 years
Drilled into missed hole	American	6 years
Drilled into missed hole	American	5 years
Thawing powder	American	3 months
Explosion from tamping	American	5 years
Being hoisted with tools on cage	Englishman	3 years
Getting on cage while in motion	Irishman	12 years
Slipped and fell from ladder	Englishman	15 years
Falling off bucket while being lowered	German	15 years

GENERAL REVIEW OF ACCIDENTS.

In the table showing cause of accidents for the years 1899 and 1900 the casualties are so grouped and designated that nothing beyond a careful perusal of same is necessary to determine where remedies are most needed. Each accident reported is a matter of record in the bureau, and may be examined in detail by any person so desiring.

Machinery, Mill and Smelter Accidents—While the number of casualties is small as compared with the number of men employed, the result is 14 fatal and 217 non-fatal accidents. The fatal accidents are caused by employes being caught in moving machinery, becoming entangled in line shafting while attempting to "put on belts" with pulleys in motion, or in moving or placing heavy machinery. The non-fatal accidents are from same causes with addition of many minor ones that naturally arise in the prosecution of the work. The accident rate may be greatly diminished by the more careful housing of large pieces of machinery, more rigid discipline in regard to "putting on belts," and not permitting same to be tried until line shaft has stopped revolving, and more competency in men having charge of the loading, unloading and placing of heavy machinery. Non-fatal accidents may be largely reduced by the employes giving their minds, as well as their hands, to the discharge of their duties. Bruises and burns are largely the results of thoughtlessness or the carelessness of their co-workers.

Overwinding Cage or Bucket—No fatal accident has occurred during the past two years through the fault of overwinding. All mechanical hoisting plants must now be equipped with an indicator, positive in character. This shows the engineer exactly where his load is in reference to shaft or incline at all times. Only through faulty construction of indicator or carelessness of the engineer may the cage or bucket be hoisted into the sheave wheel. While the indicator, properly constructed and adjusted, is a great safeguard, it does not furnish absolute protection against overwinding, or fatal accidents. In many mining countries, absolute protection is provided by statute requiring the addition of a safety attachment, generally designated as an "overwinding hook." This hook is attached to the end of the cable and so adjusted that in the event of the failure of the indicator to perform its function, or of the engineer to

perform his, the cage is freed from the cable at a point below the sheave wheel, securely caught and held in suspense and the cable alone is carried up to or over the sheave wheel. The device is certainly a good one and should be used upon the large mines, where a high rate of speed in hoisting and lowering is attained.

Falling Down Shaft—Accidents from this cause indicate that the shaft collar is not properly housed in, or that the doors have been left open so that employes may fall down shaft. One is a failure to comply with the law; the other is an act of carelessness, or failure to comply with the spirit of the law.

Material Falling Down Shaft From Surface.—The main source of accident from this cause is either the failure of the top man to carefully close the top doors, or after dumping bucket, failure to remove all loose rock that may have fallen or lodged upon the doors. Another source is the custom of lowering the bucket inside of the housing of the shaft, with top of bucket level with the floor, and then loading bucket with tools, timbers, or any required articles. With men working in the shaft the chance of fatal accident is great, in the event that any of these articles slip or fall into shaft instead of bucket. The belief is somewhat general that any person possessing the necessary physical ability to push cars, unload buckets, and handle timbers, is competent to act as "top-man." This is a great mistake. The safety of the men below ground is nearly as much dependent upon the top man as upon the engineer. A topman should possess a cool head, have good judgment, and above all, fully appreciate that the lives of his brother workmen are largely dependent upon his caution and forethought.

Getting on or Off Cage or Bucket in Motion.—Each year records fatal and non-fatal accidents from this cause. No mine has yet been visited where this act is not prohibited, but results show that this rule is not obeyed. For the past two years five fatal and five non-fatal accidents is the record. Many men doubtless successfully perform this feat of daredeviltry many times. There is no reason for assuming such risks and upon mines well managed the practice will not be permitted.

Material Falling From Levels or Side of Shaft.—The same line of reasoning applied to material falling down shaft from surface applies to material falling from levels. If

any different, more care is required at the levels than on surface, for the reason that there is no housing or protection around shaft at floor of level and foreign matter is more easily pushed into shaft. Material falling from sides of shaft is caused from lack of proper timbering. The record under this head for the past two years is nine fatal and thirty-seven non-fatal accidents.

Material Falling From Overloaded Bucket.—The record from this cause is two fatal and five non-fatal accidents. Such accidents are due to carelessness of men in overloading bucket, or loading same in such a manner that while being hoisted rock may be jarred over the sides of the bucket.

Struck by Descending Cage or Bucket.—Accidents of this character are caused by men crossing over the working compartment of a shaft while the bucket or cage is above, or by looking up shaft to determine if cage or bucket is "in sight," or by engineers lowering cage or bucket upon men, while working in shaft. Crossing over the working compartment of a shaft is forbidden by statute. Looking up a shaft is a foolish practice, and demonstrated to be such by the fact that men cannot see the cage or bucket until quite near, and if moving rapidly are struck before they can get back out of the way. Lowering a cage or bucket to the bottom of a shaft wherein men are employed is forbidden only by custom. The custom of stopping the cage or bucket far enough above the men to not discommode or endanger them, and to lower same from that point to bottom only upon signal, is generally practiced. The exceptions to the rule are responsible for the accidents from this cause. Three fatal and sixteen non-fatal accidents is the record for the past two years from these causes.

Falls From Bucket.—The result of falls from buckets while being hoisted or lowered during the past two years is six fatal and one non-fatal accidents. This is not much, if any, above the average fatality from accidents of this kind. It fully demonstrates the practice of riding in a bucket to be very hazardous, and that the practice of same should not be longer permitted. An attempt was made at the last session of the legislature to enact a provision that would stop this custom. The only unanimity of opinion came from representatives from districts where no mining operations were conducted. They favored the provision. The representatives of mining sections were about equally divided in the opinion

that such a provision would work a hardship on the mine owner by causing him to make a great outlay in the construction of suitable manways, or it would work a great hardship upon the miner by compelling him to ascend long and tedious ladders before and after his day's work. The bureau still maintains the practice should be stopped and still entertains the hope that the consideration of expense and comfort may not continue to overbalance the value of human lives.

Pushing Car Into Open Shaft.—Accidents of this character are the result of carelessness upon the part of the trammer. He fails or forgets to drop the guard rail in place across the shaft and is only aroused to the condition when he appreciates he has pushed the car into the shaft. A realization of the fact usually results in an almost superhuman effort upon the part of the trammer to stop or hold the car. The general result is that he follows the car into the shaft and is killed. Employment of more cautious men and enforcement of more rigid discipline is the only manner in which this kind of accidents may be avoided.

Falls of Rock.—The greatest danger to which the metalliferous miner is exposed is the falling, slipping or caving of rock or rock masses. The safety and avoidance of accidents from falls of rock is dependent upon the caution and judgment of the miner and like qualities in the man who directs him in his work. The miner is largely responsible for the slight or non-fatal accidents. It is not possible for the manager to visit every place in a mine immediately following each blast. The miner therefore must provide for his own safety to the extent of removing all the hanging or loose rock found after blasting. He also should carefully examine the conditions as a whole, and if they appear to him to be dangerous, stop work or at least cease work until a report of same can be made to the person in charge of the mine. The person in charge of a mine is responsible, or should be, for the timbering of a mine. The supporting of bad or loose ground with timbers or timbering is one of the great expenses in metalliferous mining. The less money there is expended in timbering, the more there will be left for profits. The financial success of the mine is always a matter of consideration by the man in charge, and he is naturally led into that method of timbering which in his judgment will entail the least expense and yet establish safety. Investigation shows that the factor of safety in timbering is in nearly all

cases gradually reduced, and more and more dependence is placed upon the ground being exploited. This is especially true if the miners appear satisfied and fail to demand more timber. That both miners and managers are negligent or careless is demonstrated by the record of the past two years, which shows forty-one fatal and two hundred and twenty-seven non-fatal accidents from falls of rock. The question of protection against falls of rock is a hard one to meet. A law applicable to one mine would not apply to another. A law that would be equitable in one district would be unjust in another. The conditions arising under the operations as conducted in metalliferous mining are so variable that legislation to the end of establishing a standard of safety in timbering is not tenable.

In some instances accidents occur from falls of rock on account of the management refusing to furnish or put in place the required amount of timber. Such instances are found to be the exception and not the rule. Generally speaking, the mines keep on hand a good supply of timbers, the same being framed and ready to put in place when deemed necessary. In some instances miners demand additional timbers when the same are unnecessary. Such instances are, however, the exception and not the rule. The actual condition that results in so many accidents from this cause appears to be carelessness upon the part of the management and recklessness upon the part of the miner. The only cure is to be found in the suggestions of chapters preceding this, entitled "Incompetent Management," "Incompetent Miners," "Discipline," "Conditional Orders" and "Carelessness."

Falls.—Falls in the various parts of the metalliferous mines are quite common and do not receive the attention they should. The placing of staging to stand upon is one source of accidents. The stages are generally put in firm enough for the purposes originally intended, but a stage that is amply secure for one or two men and their tools is unsafe for the additional weight of several tons of ore or rock. This is the main cause for accidents from falling staging. Others are caused by insecure staging, but generally by the platform upon the stull timbers being too long, and a miner stepping upon the end of a plank, the same is tipped up and the miner falls and lands upon the level below.

Falls in manways, upraises and like places are mainly due to lack of proper appliances for safety. The men work-

ing in such places are accustomed to the surrounding conditions. As development or ore extraction progresses the increased risk in traversing the roadways established is unnoticed. When an accident occurs the proper means for employees to ascend and descend from their work is provided. Accidents from such causes do not seem to be anticipated and provided against only after one or more have occurred. Many places are found where the miners apparently go up or down with perfect ease. The reason is they are fully familiar with the excavation and know just where it is necessary to place each foot and each hand. Let a stranger to the workings endeavor to make the same journey, and it is accomplished with great difficulty and at great personal risk. Exceptions to the above are sometimes found, but even the best equipped mines underground generally have some places that only those well acquainted with conditions can proceed with apparent ease and security.

Caught in Ore Chute.—It hardly seems credible that men will get inside of an ore chute that is constructed for ore to slide in and start the mass of ore above them, yet such is the fact. Some only get in with head and shoulders, some only insert their arms and with bars jar the ore loose. Strange to say, some escape without injury. In very few if any chutes does the ore always slide freely. In well constructed chutes this fact is recognized and a means provided for starting the ore when it clogs or ceases to slide.

Explosives.—The record for explosives during the past two years is 68 fatal and 97 non-fatal accidents. All of the fatal accidents did not result in instant death. Neither did those not fatally injured entirely recover. In fact, many are so maimed that they will remain crippled for life. Accidents caused by explosives are generally given considerable prominence in the daily press, and it would be but natural for the oft-repeated story to have some effect and cause those handling explosives to exercise more care. Such, however, does not appear to be the result. Miners comment upon the unfortunate accidents to their brothers and then proceed to do the very same thing themselves. Ignorance of the dangers really incurred may be designated as the main cause of accidents from explosives. This ignorance is emphasized by arguments to the effect that certain practices have been followed for five, ten or twenty years without accident. Therefore the practice is a safe one.

Thawing Powder.—The record of four fatal and eight non-fatal accidents evidences the fact that not all engaged in mining and the use of explosives have complied with the statute and procured powder warmers. Many powder warmers have been installed and the percentage of accidents from improper thawing of powder shows some reduction over former years. Nitro-powders, dynamite, or the commercial powder of the metalliferous miner freeze at 40° to 44° F., explode when confined at from 320° to 360° F. From a quick application of heat powder is liable to explode at 120° F. The lack of knowledge, lack of appreciation or failure to believe that powder will or may explode at 120° F. if the temperature be quickly raised, is the cause of so many accidents from thawing powder. That such declaration is well founded is demonstrated far too often annually. Powder placed before a hot fire, in the oven of a stove, buried in hot sand, or the hot ashes upon a blacksmith forge, plunged into hot water, or heated over the flame of a burning candle, are some of the practices that have been and are even now being followed. That fatal results are not even more common as the result of such practice is a matter of great surprise and satisfaction.

The improper thawing and imperfect thawing of powder is one of the main sources of accidents by explosion. Improper thawing may result in an immediate explosion. Imperfect thawing may be the primary cause of an accident when the powder is used in the mine. Powder may be exploded in a powder warmer constructed for the purpose of thawing powder. Too much emphasis can not be put upon the proper method of thawing powder, and the great danger incurred by the quick application of heat. Powder to be thawed safely must have the heat applied slowly. If a powder warmer is used, of the pattern using water, the water should be cold when placed in the warmer, then the temperature raised slowly. To fill the warmer with powder and then pour in boiling water is unsafe. While the powder does not come in direct contact with the water, it is only separated by a thin sheet of metal, and is little better than plunging the powder into boiling water direct. Such a procedure is simply a quick application of heat, and is liable to produce an explosion. Upon large mines the powder is generally placed in charge of a trustworthy employee, whose duty it is to attend to the thawing and delivery of powder to places required. The most danger is generally incurred upon mines working small

forces. There is no excuse for any risk to be assumed in the thawing of powder even upon a small property. If a powder warmer of the prescribed pattern can not be procured, two tin buckets or cans of different size will suffice. Place the smaller can in the larger and let it rest upon a few angular pieces of rock previously placed in the large can. Place the powder in the inner vessel, and surround the inner vessel with water. Then place the big can on some angular pieces of rock high enough to permit one or two short candles to be lighted and placed underneath. This can be done in the morning and at noon prior to beginning work. By ten o'clock a. m. and four o'clock p. m. the powder will be thoroughly and safely thawed and ready for use. Should this be earlier than needed the heat contained in the water surrounding the can will be found sufficient to keep powder in proper condition for considerable length of time.

Picking Out Missed Shots—This is another great source of accident in the use of explosives. The record for the past two years is eleven fatal and seventeen non-fatal accidents. In a former report the writer gave expression to the belief, founded upon careful investigation, that more accidents occurred from supposed missed shots than from shots that had actually missed fire. Or, in other words, that many blasts supposed to have failed to explode by the failure of the fuse to ignite charge, would, if left alone long enough, have exploded. More extended investigation has served to strengthen this belief, rather than diminish it. Some shots may and do miss fire, but the fuse used in igniting or exploding the cap, which in turn exploded the powder, is so constructed that when the central punk or filling is once thoroughly ignited, it is hard to extinguish. Its speed in burning may be retarded, but if left alone for a long enough period, it will in most cases eventually burn through. It would seem more proper to designate the cause of such accidents as the result of slow burning fuse, than to use the term "missed shots." The latter, however, is the common term and belief of the cause of the accidents. The belief is general that the miner, in picking out a missed hole, explodes the same by concussion, or, in other words, by striking the cap with his spoon. Investigation shows that all miners imbed the cap in a piece of the powder. The wrapper surrounding the powder is very tough and can only be torn with difficulty. In addition, this portion of the charge, when placed

on top of the powder in the bottom of the hole, is covered with fine tamping, and this indicates where the spoon is in regard to the charge when a hole is being picked out. In no case yet investigated has the injured party been able to state positively that he had reached the "fine tamping" in picking out a hole, when the explosion occurred. In every case the declaration was made that from three to six inches of fine tamping was placed in the hole directly above the charge. In every case it has been learned that the miner was a firm believer in the necessity of a hole being solidly tamped, in order that the blast might yield good results. For the foregoing reasons the writer is satisfied that the picking out of the tamping simply relieved the pressure that was retarding the burning of the fuse, and, when relieved, an explosion was but the natural result.

Blast Exploded While Loading—The record from this cause is eleven fatal and ten non-fatal accidents. To ascertain the real cause of explosions of this character is in a sense theoretical. From investigations made, however, it is believed to be the result of concussion, or tight tamping. Many miners, especially of the old school, or those who originally used black powder, are firm in their belief that a charge of powder can only do good work when deeply bedded, and solidly tamped. That if the tamping could be made as solid as the rock was originally, the charge would do the best execution possible. That the effectiveness of a blast was in proportion to the perfection of tamping. So far as investigated, miners who have been injured by blasts exploding while being loaded, are of this faith. The evidence taken strongly favors the view of explosion from concussion if it is not conclusive.

The statement to the average miner that a charge of nitro powder loosely tamped, or tamped only sufficiently to hold the charge in place and exclude the air, will give as good results as a charge tamped solidly, is not believed. The person making such statement is also apt to lose the esteem of the miner so addressed. The truth of the statement, however, has been verified by an extensive and exhaustive line of tests by skilled men. Both methods have been thoroughly tested, for the express purpose of determining which of the two gave the better results, and the execution of each was found practically equal. Some of these experiments indicate that the best results are obtained by placing enough tamping di-

rectly upon the charge to exclude the air, and then near or over the collar of the whole place enough more tamping (clay or talc) to exclude the air and form an air cushion between the two tampons. No doubt is entertained as to what the result will be when a shotgun is loaded properly and then a wad placed in or near the muzzle of the gun. The gun barrel is burst. Like results are claimed by the experimenters with nitro powder in rock, and with same show of reason.

Certainly scientific pursuit is worthy of careful consideration and has been set forth with the hope that it will result in lessening the practice of tight tamping. Loose tamping, as above set forth, has many advantages. The burning of the fuse is not retarded, and fewer "missed shots" are liable to occur. In the event that a blast does miss fire, the cap can be pulled out with the fuse and the danger of explosion from concussion practically removed. The difference in time consumed in pulling out a cap and picking out a hole is no small item, and it is therefore an economical method. Above all, fewer explosions and consequently less loss of life will be the result. A number of the large mines are now using this method and they claim the results to be equal to tight tamping, with the above named favorable features in addition.

Drilling Into Hole That Had Missed Fire—The record from this class of accidents exceeds all others from explosions. It shows, for the past two years, seventeen fatal and twenty-four non-fatal accidents. If the ground under the caption of "Blast Exploded While Loading" be well taken, then no stronger or more forceful argument can be made or better method advised than therein set forth. There is little room for doubt that explosions under the present heading are caused by concussion, and that concussion first explodes the cap, and the cap the powder. If, by employing loose tamping, the cap can be easily removed, the danger of explosion is largely diminished, or removed. The casualties from drilling into holes that have missed fire are not generally caused by drilling the tamping out of the old hole, but by drilling so close to it that the old charge is exploded either by concussion or by the heat generated in cutting the new hole. In some instances it is doubtless due to concussion, and the actual breaking into the old hole with the new. In one instance of record the old hole had, to all appearances, exploded, and performed its function, but had not broken

the rock to the bottom. Later development showed that all the powder in the old hole had not exploded. A machine drill hole was pointed or started so as just to miss the bottom of the old hole. When the drill had reached a point several inches from the supposed bottom of the old hole and a few inches to one side of it, an explosion occurred. It was at first supposed by those in charge of the work that the explosion was caused by gas, but investigation demonstrated to the satisfaction of the bureau that the explosion was caused by powder. Investigation further disclosed that the method of thawing the powder was not satisfactory and that it was not uncommon for the person loading the holes to use imperfectly thawed powder. When only partially thawed the lumps or hard portions were rubbed or kneaded so that they could be inserted and packed down in the bottom of the hole. There seems to be little room for doubt that all the powder did not burn or explode, and that some of the charge remained practically intact in the bottom of the hole. Later, that an explosion was caused by drilling near the powder thus bedded and the same was exploded either by concussion or by heat generated in cutting the extremely hard rock or by a combination of the two. That this was the cause of the explosion can not be stated with absolute certainty, but it appears to be the only probable cause that could produce the results effected. Such an accident should at least serve as a warning against the use of powder not thoroughly thawed.

Explosion of Powder and Caps While Preparing Charge.—This heading should read the "explosion of caps and powder while preparing charge," for the reason that the caps were the primary cause of the explosions. Five fatal and twelve non-fatal accidents are of record for this character of explosions. The real danger incurred in the handling of caps or exploders used for exploding nitro-powder is little appreciated. They are charged with different quantities of fulminate of mercury which is recognized as one of the most unstable chemical compounds known. The least jar or smallest amount of friction may cause an explosion. Miners who carry these exploders loose in their pockets, with matches and what not, rap them against rocks to remove any dirt that may have gotten inside, or crimp them on the fuse by laying them on a flat rock and sticking a knife through the shell of the exploder, or place them between their teeth and thus crimp them on the fuse, are simply tempting provi-

dence. That many do these rash acts and escape injury is a surprising fact. The force that each exploder or cap exerts when exploded is governed by the charge of fulminate of mercury contained. They are made in several grades, and are usually designated by X, XX, XXX, XXXX, and so on. While the actual force of the explosion of one of the caps in general use is not known, it can be approximately estimated by standing it on end on a piece of steel or iron boiler plate. It will readily break through an iron or steel plate one-fourth of an inch thick. The explosion of caps and powder while preparing charges is a double explosion. The caps are, through some overt act, exploded and they in turn explode the powder.

Remaining Too Long After Lighting Fuse.—Six fatal and twelve non-fatal accidents is the record for the past two years from this cause. Such accidents are usually the result of trying to light the fuse upon too many blasts at one time, or the use of too short fuse for the number of blasts to be lighted. Much care is generally taken by the miner in splitting the end of his fuses and putting them in the best possible shape to light or "spit" quickly. It often happens that in lighting the first one the spitting of same extinguishes the miner's candle. He then endeavors to relight his candle and then his fuse. Notwithstanding this loss of time this feat is often accomplished, and the miner escapes before an explosion occurs. The record, however, evidences that some do not escape. Safety lies in the use of longer fuses, the attempted lighting of a less number at one time, or the use of an electric battery.

Returned Before Blast Exploded.—Fatal accidents, six; non-fatal, sixteen, is the record for past two years. These accidents are simply the result of slow fuse, or fuse retarded in burning by tight tamping. The fuse is lighted; the miner retires and awaits the explosion. After waiting the length of time that to him seems necessary, if no explosion occur, he concludes he has a missed shot and returns to the place where he has planted blasts. Many accidents are narrowly avoided by explosions occurring before the miner approaches near enough to receive the effects of the blast, but others reach their place of work just in time to receive the full force of same, and a fatal or serious accident is the result. Accidents from this cause are strong arguments against tight tamping or the use of poorly manufactured or cheap fuse.

The length of time a miner has used explosives seems to have little bearing upon these accidents. One of the fatal accidents recorded under this heading claimed as its victim Senator Jos. Gallagher, of Clear Creek county, who had followed mining for a period of over twenty-five years. While serving the state in the official capacity of state senator he was a strong supporter of this bureau, and appeared especially interested in evolving some method by which the hard rock miners could be made to appreciate the great risks incurred by the careless manipulation and use of explosives. He was thoroughly conversant himself with all the details, and yet it becomes necessary to report his death as the result of lack of caution where he well knew great care should be exercised.

Explosion: Cause Unknown.—Each year records some explosions under this heading. Men work alone in their own properties and failure to return in time leads to an investigation. That explosion has been the cause of death is easily determined, but what the primary cause was cannot be ascertained with any degree of certainty. The only witness of the disaster is found silent, and the real cause must be left to conjecture.

The nitro-compounds, commonly designated as "powder" by the hard rock miner, are not dangerous if properly handled. Comparatively few consumers take the time or trouble to investigate what has been determined by those best qualified to pass an opinion, to be safe and what to be unsafe methods of handling these so-called powders. This is the main cause of so many accidents from explosives. To charge the consumers of nitro-powder compounds with ignorance in reference to powder is strongly resented. It is, however, a fact, with comparatively few exceptions. Messrs. A., B., C. and D. have used powder and followed certain practices for five, ten or fifteen years, or even a longer period of time, and without an accident. Their experience and methods are accepted as having practically demonstrated what can and what cannot be done with powder. In many instances some of the customs followed by A., B., C. and D. are specifically designated as dangerous by those who manufacture and employ the best talent possible to determine what is and what is not safe. Call the attention of the consumer to these facts and he replies: "What do I care what these powder experts say? They know nothing of its practical use and ought to

come out and learn something. A man who claims a custom unsafe that has been demonstrated by twenty years of practical application to be safe, does not know what he is talking about." Certain customs in reference to handling powder may be followed for twenty years without accident, but on the other hand an explosion *may* occur the first day or first time the custom is put in practice. A powder expert reaches his conclusions through a long and carefully conducted series of experiments. In these tests some explosions occur, but in the great majority of trials explosions do not occur. He can, therefore, only state that certain practices *may* cause an explosion, not that it will cause an explosion. If he errs at all in his conclusions, error is committed on the side of safety and with a view of saving human life. The principal abuses practiced in regard to explosives are set forth in the preceding chapters, and it is hoped that emphasized as they are by an alarming death and serious accident rate for the two years last past, that they my receive more than passing notice. If the so-called theories of powder experts may not be deemed worthy of consideration on account of unjust prejudice, then may the accidents herein recounted serve to attract the careful attention of the results of so-called "practical application."

Broken or Detached Cables.—The record for broken or detached cables for the past two years is one fatal and seven non-fatal accidents.

The life of a wire cable is largely dependent upon the diameter of the drum, the diameter of the sheave, weight of load, speed at which it is run, friction on roller or sides of shafts sunk on an incline and the lubricant used. As a general rule, in the cables used upon the metalliferous mines, the factor of safety is high, or, in other words, the load is far below the breaking test of the cable. In the smaller plants, however, the past two years has demonstrated an inclination to reduce the size of the cable to a point that safety can only be insured by frequent changes. In the majority of the mines the water is more or less acid and oxidation is very rapid unless a good lubricant is often applied, which is too often neglected. The actual effect of rust on the strength of steel-wire cables is hard to estimate, and it may be a much less factor than is generally supposed. Several examinations have been made of cables running in incline shafts where the exterior wear upon the cable was great. While doubtless

weakened in proportion to the actual wear, the remainder of the cable sections examined were to all appearances found as good as the unused sections. These examinations were of course superficial, and consisted in separating the strands and comparing the toughness by bending back and forth until the wires would break. These comparisons would indicate little difference between the old and the new, and that with the avoidance of short bends or kinks and sudden shocks the cables were safe for the loads handled. The only proper way to make cable tests is by a machine constructed for the purpose which is not at the command of the bureau. The danger incurred from defective cables is by no means small, and where buckets are used and employes are hoisted and lowered there is little hope for escape in the event of a cable breaking. While great improvement has been made in restricting the number of men that may or may not ride at one time, there is still too little attention paid to this important matter.

TIMBERING.—One of the most fruitful sources of accidents in mines is falls or slips of rocks from roof or sides. Falling or slipping rock is the greatest risk assumed by the miners working in metalliferous mines. As a rule miners soon "know their ground," or think they do, until a fall or slip of rock occurs to change their views. Ordinarily and almost universally the exercise of proper care can determine the safe or non-safe condition of territory being exploited. The exceptions mark the real danger incurred underground.

Investigation shows that nearly all the mines are amply supplied with suitable timber ready for use. That mine superintendents are too much inclined to permit their employes to "use their own judgment," or to say, "I do not believe that ground is very safe and think you had better timber up closer, but you can do as you please;" that acting upon such instructions, the miner often delays too long and an accident occurs.

The mine superintendent should not, in cases of timbering, instruct by suggestion, but should order in all timber which in his judgment is deemed necessary, and further, see to it that any instructions given for security of men and workings are actually carried out. While the miner should be allowed the right to demand proper timbers and make the place safe in his judgment, it is a curious fact that the miner's estimate of the safety of ground in which he is at work is in-

variably below and not above the standard of safety. He studies his ground carefully, with a view of breaking the most possible with the least exertion, "knows his ground" thoroughly, or thinks he does, until an accident occurs. For these reasons the miner should have no discretion in omitting the proper amount of timber deemed essential by the superintendent or foreman in charge of work.

Many more or less serious, but not fatal, accidents are caused by failure of miners to examine, carefully, surroundings after blasting. Investigation shows an almost universal interest upon the part of the miner to ascertain the results of his blasts as quickly as possible after re-entering to his work. He accordingly "sounds" the ground immediately around the places where the blasts were bedded, begins picking down some of the shattered rock and forgets to ascertain the condition of the ground immediately back of the blasts, and under which he is working. The result is that with a very slight jar rocks that have been loosened and are just barely hanging in place, drop, and a more or less serious accident from falling rock is the result. In this connection it may be stated that the greater number of accidents of this character occur to miners of many years of experience.

The most dangerous work upon a metalliferous mine is that of timbering. In all well regulated mines this work is performed by men employed for that purpose alone. Timbermen usually work in pairs or gangs and repair from place to place under the direction of the superintendent or foreman. If working in single pairs the work is in charge of one who has had large experience and is known to have good judgment. His associate is usually a younger and less experienced man, chosen for his agility, strength and tact and for seeing what is necessary to be done without explicit instructions. It often happens that the caution and judgment of the older in the method of placing timbers is overcome by the zeal of the younger to make time and save work, and the result is a serious or fatal accident to one, both or more.

There are few callings that demand as much sound judgment and skill as that of the timberman. Metalliferous mines are exploited along general lines and generally well known and established systems of timbering are employed, but unexpected and unforeseen conditions are constantly arising and must be met. Safety is the point to be gained, and the question is, how can safety be attained with the least expenditure

of labor and material. Timbering is one of the great expenses in mining and but for this expense many properties would to-day be working at a profit that are now idle. To use enough timber to insure safety, no more than is essential, and to do the work in a safe manner and with no more expenditure of labor than is necessary are questions that constantly confront the superintendent and timberman, and the result of their conclusions and labor is an important factor in the financial welfare of the property.

So varied are the conditions arising demanding timber that they must be met as encountered, and no established system or rules can be laid down. Not only must the weight to be sustained be considered, but the character of the ground also. Some rock exposed to the air passing through a drift or shaft may remain normal and unchanged. Again it may decompose upon exposure to air current and "swell." In the former, timber must be sufficient to sustain the weight, keep in place and avoid a sudden drop or fall. In the latter, timber of any size or description is apparently of no avail, but is slowly but surely crushed to a pulp. In an ordinary drift the usual "drift set" with eight to ten inch legs and ten to twelve inch cap set three to four feet apart, will sustain the ground for a number of years. In some of the mines at Leadville, notably the drift from shaft on the R. A. M., drift sets of green timber placed solidly side by side, with sixteen to twenty inch mud sills, fourteen to eighteen inch legs, and eighteen to thirty inch caps are insufficient. This drift in the R. A. M. is less than 100 feet long, and requires the constant services of a corps of timbermen. No sooner is it timbered throughout when the finished end is left and work begun again on the other end.

Careful investigation of the timbering in the various mines discloses some curious results. The best timbered mines are found to be those situated above timberline, or at places where all timber has been cut from the surrounding surface. The poorest timbered mines are found to be those located in heavy growing timber. So it may be stated: The best timbered mines are those most remote from timber supply. The poorest timbered mines are those located in growing timber. The reason for this is found to be that the first cost of timber to the mine located in a forest is small, anything at hand is good enough, and "after while we will put in good timbers throughout." This "after while" is like to-mor-

row—never reached. At the mines remote from timber the cost is usually governed by the size or weight. Good timber of a given size weighs no more than poor, and therefore nothing but the best is transported, accepted, or used.

Great variation is noticeable in the methods of timbering in the same district, and in properties having the same general characteristics. In some cases the expenditure of labor and material in timbering may be termed extravagant, in others quite penurious. Investigation shows that extravagance along safety lines is most common among young superintendents, and penuriousness in use of timber is chargeable to the superintendents of many years' experience. There is no doubt that the latter's judgment is the better of the two, neither is there any doubt of the truth of the adage "familiarity breeds contempt."

The most neglected openings in mines have been found to be those that are operated by lessees, and especially those in which the work is actually performed by the lessees themselves. As a rule, these men are old miners, have had varied experience underground, and are well aware of the risks they are assuming. In most cases they resent the orders of the mine inspectors, and consider same an unwarranted official interference with their personal affairs, and a desire upon the part of an official to put them to so much expense that no profit for their labor will accrue to them. When asked if they would work for day's pay in such a place for a corporation, they will answer: "Not a minute, but a corporation can afford to timber; we cannot." This answer clearly demonstrates one of the reasons why ore bodies that cannot be worked to a profit by the owners will yield a profit to both themselves and the lessees, when worked under lease.

MINE INSPECTION.

During the past two years mine inspection has been diligently prosecuted by the inspectors. Their instructions are to perform their duty in accordance with the statute; to do so without any vulgar display of authority, and in a manner best calculated to establish the elements of safety; to encourage rigid discipline on all the mines; to in no manner retard the working of mine more than is absolutely necessary; to have no favorite; and to permit no practice about a mine, by them considered dangerous to the health, comfort and safety

of the miners, whether the same be covered by statute or not, without giving an order or a suggestion that the practice be discontinued.

That these duties have been creditably performed is evidenced by the records of the department. There is no way, however, of determining the number of accidents that are avoided through the work of the department. Accidents occur, and occur through a cause. These causes are generalized, and the inspectors are constantly stopping practices that are known to be dangerous and cause accidents. It may be asserted, however, that many lives are saved annually by the work of this department. That the officers of the department are doing good work is in part demonstrated by their unpopularity with both the mine owner and the miner. This result is inevitable, for the reason that they occupy neutral ground—stand between the employer and the employed—and are, therefore, targets for both labor and capital. Differences are constantly arising, and as a rule selfish interest or prejudice carries both sides of the controversy beyond the pale of justice or right. Both sides to the controversy must be heard, but the inspector must act in accordance with the conditions as found by him to exist, and his sympathy for one side or the other must be laid aside. He occupies the unenviable position of both judge and jury. He cannot temporize or arbitrate in a manner to please both sides. The practice or custom being investigated is either safe or unsafe and must be so adjudged. Although many differences of opinion have arisen between the department and mine owners, it is gratifying to be able to report that, without exception, the officers have been shown every courtesy by the mine owners, and with few exceptions the orders of the department have been complied with promptly. During the fiscal years of 1899 and 1900 the following orders have been issued by the department and have been complied with:

RECOMMENDATIONS.

Regarding timbers and timbering	33
Regarding explosives	144
Regulating the amount of powder kept in stores	33
Storing oil and inflammable material	26
Use of steel or iron tamping bar	74
Removing old timbers from the mine	15
Regarding employment of hoisting engineer	6

Regarding indicator on hoisting machinery	99
Employing cage tender	7
Posting uniform code of signals	129
Regarding fire protection	80
Prohibit riding upon loaded cage, skip or bucket	17
Giving false signals	5
Partitioning shaft for ladderway and repairing ladder	94
Making exit to surface	12
Provide tunnel or adit with connection to surface with suitable ladders	20
Provide chain ladder in shaft or incline while sinking	51
Providing shaft collar with cover or bonnet, and cage equipped with safety clutches and steel hood or bonnet	27
Making passageway around shaft and providing guard rails	56
Leave pillar of ground standing on side of shaft	6
Cover or fence abandoned mine shafts	127
Penalty for removing shaft coverings	14
Shall report to the Bureau of Mines	135
Notice of number of men permitted to ride upon cage, skip or bucket	26

As in the past, systematic mine inspection has not been possible with the force at command and the immense territory to cover. By systematic inspection is meant taking up a mining camp and inspecting all the mines *seriatim* until all are inspected. Under present conditions, which demand the investigation of the cause of accidents, as much time is consumed in travel from camp to camp as in systematic field work. Both inspection to prevent accidents, by enforcing rules of safety, and investigation to determine the cause of accidents are essential, but the present force of the department is not sufficient to do both or do full justice to either.

The statute, as it now stands, permits the Commissioner of Mines to appoint special deputies for stated purposes, but the general appropriation bill failed to provide for such action upon the part of the commissioner. When the amended bill was under consideration it was demonstrated to the mines and mining committee of both the house and senate that it would greatly enhance the value of the department if the inspectors could go to a county and inspect all the mines before leaving it, and that this could be done and would be more economical, provided the commissioner would appoint deputies near the place where the accident occurred to investigate and report on same, thereby relieving the inspectors

of this work, and permitting them to finish the counties one after the other. As before stated, the statute was so enacted, but provision to pay these special agents for specific acts was withheld, and thereby was made inoperative.

PRODUCTION OF PRECIOUS METALS.

To ascertain with any degree of certainty the total precious metal production of Colorado has proven much more of a task than was at first anticipated. Prior to 1870 the production having value was gold. A careful perusal of all data obtainable shows great variation in the estimates of gold production by the various authorities. "Gold dust" at this time was largely used as a medium of exchange, and, with some compilers, it appears that all "gold dust" available at the beginning of each year was erroneously estimated as the gold production of the year previous. Such compilations are manifestly unjust, and were therefore discarded.

In the following table the production prior to 1870 was estimated from the most reliable data obtainable, a visit to the various gold beds, and through pioneers, who furnished information as to the average number of men employed, the length of time the beds operated, and what was considered a fair "clean up" for labor expended, value of gold per ounce, etc. At best, the precious metal production prior to 1870 is but an estimate, but the following may be considered safe and conservative:

TOTAL PRODUCTION OF PRECIOUS METALS IN COLORADO.

	Value of Gold.	Value of Silver.	Value of Lead.	Value of Copper.	Total Value.
Previous to 1870..	$ 27,213,081 00	$ 330,000 00	.....	$ 40,000 00	$ 27,583,081 00
1870	3,015,000 00	660,000 00	.....	20,000 00	3,695,000 00
1871	3,633,951 00	1,029,058 00	.....	30,000 00	4,693,009 00
1872	2,646,463 00	2,015,001 00	5,000 00	45,000 00	4,711,464 00
1873	1,835,248 00	2,185,014 00	7,078 40	65,000 00	4,092,340 40
1874	2,065,595 00	3,086,926 00	37,502 40	90,197 00	5,280,220 40
1875	2,321,055 00	2,873,591 00	95,706 00	90,000 00	5,380,352 00
1876	2,726,311 00	2,950,256 00	81,774 20	70,000 00	5,828,341 20
1877	3,000,000 00	4,180,138 00	98,490 60	93,796 64	7,372,425 24
1878	3,366,404 00	4,807,001 00	481,501 80	89,000 00	8,743,906 80
1879	3,225,000 00	10,162,503 00	1,960,207 20	131,000 00	15,478,710 20
1880	3,200,000 00	15,055,302 00	3,595,939 20	184,000 00	22,035,241 20
1881	3,300,000 00	15,104,092 00	3,900,621 40	161,000 00	22,465,713 40
1882	3,360,000 00	14,436,136 00	5,401,000 00	276,390 00	23,473,526 00
1883	4,100,000 00	14,912,756 00	6,096,124 80	182,750 50	25,291,631 30
1884	4,250,000 00	13,984,066 00	4,724,742 00	278,800 50	23,237,608 50
1885	4,200,000 00	13,014,927 00	4,345,000 00	127,435 20	21,687,362 20
1886	4,450,000 00	12,313,404 00	5,463,400 00	44,990 00	22,271,794 00
1887	4,000,000 00	11,345,608 00	5,670,000 00	226,350 00	21,241,958 00
1888	3,758,000 00	13,813,906 00	5,790,200 00	270,058 60	23,632,164 60
1889	3,883,859 00	17,199,486 00	5,423,400 00	426,250 00	26,932,995 00
1890	4,150,000 00	19,665,245 00	4,883,200 00	945,000 00	29,643,445 00
1891	4,600,000 00	20,906,554 00	5,568,000 00	883,400 00	31,957,954 00
1892	5,300,000 00	23,682,600 00	5,030,700 00	837,375 00	34,250,675 00
1893	7,527,000 00	20,205,785 00	3,147,970 80	765,535 13	31,646,290 93
1894	9,549,731 00	14,638,696 00	3,200,000 00	624,097 26	28,012,524 26
1895	13,559,954 00	11,683,232 00	2,954,714 00	659,050 00	28,856,950 00
1896	15,267,234 00	14,458,536 00	2,321,109 40	820,269 86	32,867,149 26
1897	19,579,637 00	12,692,448 00	2,731,032 49	960,917 13	35,964,034 62
1898	23,534,531 28	13,690,265 15	4,117,043 24	1,304,504 28	42,646,343 95
1899	26,508,675 57	13,771,731 10	6,170,765 53	1,869,169 78	48,320,341 98
Total	$223,126,729 85	$340,254,263 25	$93,302,223 46	$12,611,336 88	$669,294,553 44

Note—In the above table the calculation is on the average market price of the metal for each year.

MARKET VALUE OF METALS.

YEAR.	Gold. Price per Ounce.	Silver. Price per Ounce.	Lead. Price per Pound.	Copper. Price per Pound.
Previous to 1870	$20.67	$1.32	.....	$0.20
1870	20.67	1.32	.....	.206
1871	20.67	1.32	.....	.33
1872	20.67	1.322	$0.0625	.29
1873	20.67	1.298	.0632	.232
1874	20.67	1.278	.0601	.225
1875	20.67	1.246	.0585	.21
1876	20.67	1.156	.0613	.186
1877	20.67	1.201	.0549	.186
1878	20.67	1.152	.0361	.165
1879	20.67	1.123	.0414	.171
1880	20.67	1.145	.0504	.201
1881	20.67	1.138	.0481	.181
1882	20.67	1.136	.0491	.185
1883	20.67	1.11	.0432	.1585
1884	20.67	1.13	.0374	.1385
1885	20.67	1.065	.0395	.1112
1886	20.67	.995	.0463	.11
1887	20.67	.978	.0450	.1125
1888	20.67	.94	.0442	.1666
1889	20.67	.936	.0393	.1375
1890	20.67	1.046	.0448	.1575
1891	20.67	.988	.0435	.1262
1892	20.67	.876	.0409	.1155
1893	20.67	.782	.0373	.1075
1894	20.67	.63	.0329	.0956
1895	20.67	.653	.0323	.1076
1896	20.67	.671	.0283	.1088
1897	20.67	.5965	.0338	.105
1898	20.67	.5825	.0363	.12
1899	20.67	.5958	.0447	.1761
1900	20.67	.6141	.0473	.1652

The above table shows a precious metal production of $669,294,553.44 prior to January 1, 1900, produced by a people numbering less than 37,000 in 1870 and 539,700 in 1900. A record that is second to none other, so far as investigations have disclosed.

The fact that the annual precious metal production, as given by this department, has at all times been below the estimates of the newspapers in their New Year's editions has given rise to considerable inquiry and some criticism. It may be said in this connection that to those thoroughly conversant with the detail work necessary to compile the annual production, the newspapers deserve great credit for getting as near to facts as they do. At the time the papers publish their estimates only the grand totals, with a few minor exceptions, are obtainable. These totals from the various reduction works and United States mints are, however, only the beginning and not the end of the compilation. To illustrate, some reduction works only produce a "matte," which is in turn sold to another plant. So that an estimate from the totals given by each plant duplicates or doubles this particular product, and accuracy demands a deduction. Again, one plant may buy a large consignment of ore and in turn consign all or part of same to another plant, and thereby again duplicate the actual product when compiled from the general statement of each plant. These illustrations could be multiplied, but are deemed unnecessary, and are mentioned simply to call attention that accuracy in compilation requires both time and care to avoid duplication and at same time get all the product.

The mineral production is compiled from the finished product, and during the past few years this department and the officers of the United States mint at Denver have worked in harmony, to the end that accuracy might be attained by both. The results have proven highly satisfactory, and while the two reports differ somewhat in detail, they are approximately the same.

An earnest effort was made to compile production from the mines, but was found impracticable. Some of the large mines refused to furnish "detail statement of their business," and the medium and smaller producers would so far overestimate their production that the totals were found to verge upon the ridiculous. One very striking feature in this attempt was the great difference of production furnished this department and supplied by same authority to the county assessors.

A close study of the foregoing table will demonstrate not only the phenomenal growth of the production of precious metals, but it should be borne in mind that the advance in the pursuits of agriculture, horticulture and manufacturing in

all lines have kept pace with mining. Colorado has not only earned the title of the "Silver State," but for the past four years has led all other sister states in gold production, and may now justly be termed the great gold and silver state.

PRECIOUS METAL PRODUCTION BY COUNTIES FOR THE YEAR 1899.

Name of County.	Gold Value.	Silver Value.	Lead Value.	Copper Value.	Total Value.
Arapahoe	$ 268 71	$ 1 19	.....	.....	$ 269 90
Archuleta	103 35	25 62	.....	.....	128 97
Boulder	547,888 35	45,501 84	1,253 52	13,879 50	608,493 21
Chaffee	216,662 94	87,784 58	53,330 41	122,695 21	480,473 14
Clear Creek	546,824 85	895,427 82	322,566 82	51,591 31	1,816,410 80
Conejos	6,263 01	13,695 65	.....	.....	19,958 66
Costilla	806 13	75 07	.....	.....	881 20
Custer	1,654 17	3,577 18	37,409 16	162 54	42,203 05
Delta	206 70	5 96	.....	.....	212 66
Dolores	66,846 78	153,151 59	91,466 57	7,838 03	319,302 97
Douglas	82 68	14 30	.....	.....	96 98
Eagle	46,094 10	26,449 35	53,100 47	1,034 76	126,678 68
Huerfano	124 02	2 98	.....	.....	127 00
Fremont	9,404 85	2,367 70	511 50	1,179 52	13,463 57
Gilpin	1,996,060 56	202,960 46	58,660 35	182,689 84	2,440,371 21
Grand	124 02	7 75	.....	.....	131 77
Garfield	723 45	10 13	.....	.....	733 58
Gunnison	70,112 64	79,231 27	62,550 32	8,133 35	220,027 58
Hinsdale	38,342 85	92,886 41	472,584 18	8,747 94	612,561 38
Jefferson	1,364 22	209 13	34 42	44 73	1,652 50
Lake	2,196,497 55	4,307,704 30	2,172,362 78	1,137,576 94	9,814,141 57
La Plata	25,672 14	1,883 92	141 97	37 16	27,735 19
Larimer	2,067 00	80 43	.....	435 67	2,583 10
Las Animas	206 70	1 79	.....	.....	208 49
Mineral	91,671 45	2,262,192 42	253,769 14	3,561 27	2,611,194 28
Montrose	723 45	27,477 70	.....	13,208 56	41,409 71
Mesa	124 02	2,454 70	.....	818 87	3,397 59
Montezuma	15,419 82	135 25	.....	.....	15,555 07
Ouray	1,694,940 00	1,397,862 39	337,770 45	53,741 67	3,484,314 51
Park	153,040 68	42,979 22	24,175 95	1,391 72	221,587 57
Pitkin	52,233 09	2,477,758 23	1,137,989 59	3,407 71	3,671,388 62
Rio Grande	19,202 43	1,619 38	73 08	59 17	20,954 06
Routt	11,554 53	757 26	152 20	.....	12,463 99

PRECIOUS METAL PRODUCTION BY COUNTIES FOR THE YEAR 1899 —CONCLUDED.

Name of County.	Gold Value.	Silver Value.	Lead Value.	Copper Value.	Total Value.
Saguache	3,885 96	8,523 51	19,716 95	6,219 68	38,346 10
San Juan	996,273 33	710,108 40	715,721 98	210,908 10	2,632,011 79
San Miguel	1,376,704 68	719,961 74	175,174 07	28,218 60	2,300,058 58
Summit	260,566 02	157,810 74	180,249 67	11,540 01	610,166 44
Teller	16,058,564 34	49,033 74		48 43	16,107,646 51
Total	$26,508,675 57	$13,771,731 10	$6,170,765 53	$1,869,169 78	$48,320,341 98

APPOINTMENTS.

December 1, 1898—C. N. Crowder, inspector for unexpired term of L. N. White, resigned.

April 11, 1899—D. L. Griffin, inspector for term of two years, beginning June 1, 1899.

May 20, 1899—P. H. Clifford, inspector for term of two years, beginning June 1, 1899.

May 20, 1899—J. C. Langley, clerk and assistant curator for term of two years, beginning June 1, 1899.

May 20, 1899—Iva C. Brawner, stenographer, for term of two years, beginning June 1, 1899.

STATEMENT OF DISBURSEMENTS OF THE BUREAU OF MINES APPROPRIATION.

Appropriation, 1899-1900		$24,000 00
Commissioner of Mines, salary	$ 5,000 00	
Commissioner of Mines, expense account	1,766 67	
Inspector C. N. Crowder, salary	750 00	
Inspector C. N. Crowder, expense account	200 04	
Inspector D. L. Griffin, salary	2,250 00	
Inspector D. L. Griffin, expense account	1,208 75	
Inspector F. H. Nye, salary	750 00	
Inspector F. H. Nye, expense account	293 25	
Inspector P. H. Clifford, salary	2,250 00	
Inspector P. H. Clifford, expense account	1,375 90	
Clerk and assistant curator, salary	2,800 00	
Stenographer, salary	2,000 00	
Printing, incidental and operating expenses	2,000 00	
Balance	1,155 39	
	$24,000 00	$24,000 00