gentle tap with an iron rod. The piece at one blow splits off and leaves a bright face. Considerable skill and judgment are needed to perform this critical work, but it is by no means such a mystery as it has been represented to be.

The cutting operation is conducted with heavier handles over the cutting box just described. One diamond is rubbed against another, both cemented on the ends of handles, over the box, and the abrading goes on rapidly. Here a peculiar skill is needed to give the right stroke. Without it true cutting will not be effected. The left hand stone is the one which receives the final cutting; the right hand stone gets its first rough shaping only. The box has a movable receptacle below to receive the dust. A fine wire gauze screen is above it, to catch any cement which may fall.

A machine has been introduced for performing this work which is in constant operation in the Tiffany shop. It is essentially a planing machine. It contains a fixed adjustable abutment and a reciprocating abutment forming a species of slide rest. These correspond to the right and left handles of the hand cutter. The diamond receiving its final cutting is secured by cement in a cup with spindle, which spindle is inserted into a hole in the left hand carriage or reciprocating slide rest. The right hand abutment receives a second cup, with the cutting diamond held in it by cement. Quadrant adjustments and feed screws are provided for shifting the fixed abutment in any desired direction. By turning the hand wheel back and forth through a small arc of a circle, the carriage with the diamond to be cut is made to reciprocate back and forth. By the feed screws the other diamond is brought into contact with it and the cutting begins. A face is rapidly worn upon the stone. The operator feels as well as sees the progress of the work.

As one face is done the cup is removed, the cement is softened by heat, and the stone is turned so as to present another face or corner to be operated on. In this way the gem is soon brought into its approximate shape. The machine is the invention of Charles M. Field, of Boston, Mass., and is only the third in use. It does not entirely supplant hand cutting, as much trimming and shaping of the girdle or outline of the stone is still done by hand. Although designed to be driven by power, this is not found practicable, because the cutting, as already explained, is partly a matter of feeling as well as of sight.

Having been roughly shaped by cutting, and perhaps also by cleaving, the diamond has next to be set in alloy for polishing. A brass cup with a copper wire handle, called a "dopp," is used for this purpose. An alloy of lead and pewter is used to fill it and is built up in acorn shape. When of the consistency of putty, like plumber's solder when a joint is being wiped, the diamond is inserted in the apex. With a stick, or with the fingers, the hot metal is wiped away, so as to give the right exposure.

After cooling it goes to the polisher. The wire stem of the "dopp" is fastened in the end of a wooden clamp. The operative in the upper central figure is seen holding one and examining the diamond in the "dopp." The clamp is next placed on the table steadied by a couple of pins secured thereto. A horizontal disk of iron cut or scratched in approximately radial grooves is mounted in the center of the table, and rotates at a speed of 20,000 to 25,000 revolutions per minute. The speed is so high and the motion so steady that the disks seem motionless. As the clamp is placed on the table, the diamond at its end rests upon the disk. The latter is charged with olive oil and diamond dust from the cutting boxes. After a few seconds the polisher removes the clamp and examines the stone. By pushing the cup he bends the wire one way or the other, so as to get a proper bearing. One or two trials are made. When all is right some lead weights are placed upon the clamp and it is left to itself. The polishing, which is really cutting to a considerable extent, now goes on, and lasts for a variable time, according to the work to be done.

The polisher becomes very expert in seeing what is going on by inspecting the diamond, as well as in detecting by the feel of the clamp how the diamond is resting on the disk. Even the bending of the wire of the dopp requires considerable skill.

The modern system of diamond cutting is said to have originated in 1456, with Louis Bergnen, who established a regular guild of diamond cutters at Bruges in 1470. Since then the art gradually centered itself in Amsterdam, and now only is beginning to spread to other cities.

MR. A. STANLEY WILLIAMS, of Burgess Hill, Sussex, has discovered three delicate but distinct markings in the equatorial region of Saturn. The first and third of these are round bright spots, somewhat brighter than the white equatorial zone in which they occur. The second is a smaller dark marking on the equatorial edge of the shaded belt which forms the southern boundary of the white zone. Mr. Williams has obtained abundant proof of the reality of these markings, but points out that it requires patience and practice to see them readily.

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(Illustrated articles are marked with an asterisk.)

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SCIENTIFIC AMERICAN SUPPLEMENT

No. 811.

For the Week Ending July 18, 1891.

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THE COMMISSIONERSHIP OF PATENTS.

The Hon. Charles E. Mitchell, who for the last two years has served as Commissioner of Patents, has resigned the office, and the Hon. William E. Simonds, of Connecticut, has been appointed to the position.

The retirement of Mr. Mitchell may almost be regarded as a calamity to the Patent Office. His administration has been highly successful, has given great satisfaction, and from beginning to end has been conducted with consummate ability. His rulings and decisions, always promptly given, have been distinguished for their judicial clearness and reliability. Fair and impartial hearing and consideration of both sides of the presented case has been his habit. Subject to a just regard for the public interests, he has administered the office for the benefit of inventors, for whose encouragement it was created. The progress of the Patent Office under Mr. Mitchell's guidance has been very marked. He has instituted many changes and reforms of most beneficial character. His superior administrative skill has enabled him to advance and improve the efficiency of the bureau; and in this flourishing condition he takes his leave, much to the regret of subordinates, practitioners, and all with whom he has had official relations.

William E. Simonds, the newly appointed Commissioner of Patents, is forty-nine years old and a practicing lawyer of Hartford, Conn. He also fills the lectureship on patent law at the Yale Law School, and is the author of several books on subjects pertaining to patent law. He was a member of the LIst Congress and had been a member of the Connecticut Legislature for several years. He was elected Speaker of the House in 1885. He is a man of sterling integrity, of judicial mind, abundantly qualified for the Commissionership. The Patent Office under his management will not be likely to move backward. We wish for his administration the utmost success.

It is perhaps fitting that the Patent Commissioner should hail from Connecticut. In area it is a small State, but its people have large heads, if we may judge from the records of the Patent Office. In proportion to population, the sons of Connecticut take twice as many patents as any other State.

THE CALDERA NAVAL FIGHT.

The present war in Chile is being watched and studied with keen interest by our army and navy officers and many others, and, although the reports from that country are now meager and the truth is badly snarled up with rumors, yet when reliable information is received the result will be that many useful lessons will be learned and that many improvements will be suggested in war material and its handling.

The recent action in Caldera Bay is attracting much attention, and, now that we have the report of so reliable an officer as Admiral McCann, we can study the action a little closer. The admiral's report is dated Valparaiso, Chile, April 29, 1891, and according to it the Blanco Encalada, a war ship in the service of the insurgents, was lying at anchor in the harbor of Caldera, when she was attacked about 4 A.M., of April 23, by two torpedo cruisers, the Almirante Lynch and the Almirante Condell, in the service of the Chilean government. The Encalada was sunk by the explosion of one or more torpedoes fired by the torpedo cruisers, and about one hundred and fifty men lost their lives.

The first point that strikes one, in reviewing this affair, is the statement that "the morning of the attack was perfectly clear, the light in the lighthouse burning brightly, and the ship's lights perfectly visible, so that the torpedo boats had no trouble in making the attack." The question arises, Why did not the Encalada sight the Lynch and Condell in time to make preparations to give them a warm reception, and why did she not make such preparations?

"The commanding officer admits that he alone was to blame for the catastrophe." What an admission, and what manner of man this commanding officer must be! We have an old lesson forcibly illustrated right here—that a ship may be well found in every particular, having the most modern appliances and most perfect machinery, and yet, if that very important equipment, the captain, is inefficient or unequal to his trust, the ship is a hopeless failure and her loss is to be expected. As we must have skilled mechanics to run complex machines, so must we have skilled and reliable officers to handle our war ships.

"The usual precautions adopted in time of war were entirely neglected," and it might be added that many of the precautions usually adopted in well regulated ships in time of peace were also neglected. Had a proper lookout been kept, had a signal station been established on the point, there is no doubt but that the Encalada would have known of the approach of her enemies in sufficient time to have cleared ship and gotten ready for action. Had the guns been loaded and had the cable been ready to slip, she might have inflicted such an amount of damage to the Lynch and Condell, and might have so maneuvered, as to render the attack less disastrous, or at least punished her assailants more severely.

Another point to be noted is the number of torpedoes fired. One account says three were discharged before an effective hit was made, another says seven. Whichever number is correct, it shows, considering the circumstances, that even the best form of torpedo is an unreliable weapon, but if a hit is made, the effect is appalling.

The Lynch and Condell are recently built torpedo cruisers of the latest design, and the torpedoes used are the most modern development of the Whitehead auto-mobile torpedoes.

The Encalada was an iron armored, twin screw, central battery ship, 219 feet in length, 45 feet and 9 inches in beam, 19 feet and 8 inches in draught, and of 3,500 tons displacement. She carried six 12 ton, muzzle loading Armstrong rifles, four lighter pieces, and seven machine guns. In the SCIENTIFIC AMERICAN of June 6 will be found a full description of the Lynch and the Condell. B.

THE DISPOSITION OF MINING DEBRIS IN CALIFORNIA.

Among the reports submitted to the last Congress was one from the Secretary of War on the treatment of mining debris in California. The report contained the conclusions of the Board of Engineer officers which was prepared in compliance with an act of Congress, approved October 1st, 1888, which directed that three officers from the Engineer Corps of the United States army be constituted a commission for the purpose of making a thorough examination of the mining debris question in California, and determining whether some plan cannot be devised whereby the present conflict between the mining and farming sections may be adjusted, and the mining industry rehabilitated.

For several years past hydraulic mining has been suppressed in California. In the early stages of placer mining the possible effect upon river channels and adjacent lands of dumping debris in the cañons does not seem to have received any attention. No great flood was recorded until 1861-62, when very serious damage was done by the overflow of certain rivers, notably the Yuba, and other floods occurred in 1875. After a number of decisions by the lower courts the United States Circuit Court rendered a decision which puts a stop to hydraulic mining in the State.

It was estimated that $100,000,000 was invested in this branch of mining previous to the restriction, the effect of which has been that many costly works connected with this industry have been allowed to go to decay, mining camps have been deserted and large districts depopulated, while the yield of gold in the State has been considerably reduced, as shown by the following table.

Product of gold in California from January 1, 1880, to December 31, 1890,:

1880	$17,745,745
1881	17,166,676
1882	15,520,325
1883	13,841,297
1884	12,896,594
1885	12,338,014
1886	13,208,034
1887	11,836,957
1888	10,076,091
1889	10,329,044
1890	9,986,851

In the prosecution of hydraulic mining all the material in the bank is moved, whereas in drift mining only the gravel and sand adjacent to the bed rock is taken out. It follows as a consequence of hydraulic mining that some depository for the debris must be found, and until the decision of the United States Circuit Court was rendered, this debris was dumped into the gulches and beds of streams adjacent to the mines, to be removed further down with the winter freshets.

The effect of filling up the river beds in this way was very disastrous to farmers and other persons owning land which was overflowed, and resulted in the formation of the Anti Debris Association, which organization has conducted the litigation resulting in the inhibition upon hydraulic mining. In one of the cases in this extended litigation the following facts among others were brought out. The plaintiff was the owner of a lot in the city of Marysville covered by a brick building and of two farms on the borders of the Feather River. Portions of these two farms were covered by debris brought down by the floods of 1862 to a depth that made them valueless as agricultural land. The winter floods of succeeding years added to the depth of the deposits and the lands are now grown up to willow and cottonwood thickets. The beds of the Yuba and Feather Rivers gradually rose from successive deposits of debris, until in 1868 the people of Marysville found it necessary to build levees to protect the city from overflow. The city is situated upon a high bank of the Yuba River and about one mile from its junction with the Feather.

Up to 1862 the Yuba was navigable all the year for ships and boats drawing from 9 to 10 feet of water, and during the winter season deep water ships from around Cape Horn navigated it to the foot of E Street. The site of the city was above extreme high water, and it was never overflowed until after the commencement of modern hydraulic mining. The river beds continued to rise after the building of the levees, and during the flood of 1875, which was much less in volume than in 1862, the levees broke, and for the first time in its history Marysville was inundated. A report to the legislature during the session of 1880 states that during the year 1879, 40,564,000 cubic yards of material were put into the Feather River by the hydraulic mining process and 9,700,000 cubic yards of this debris, about 24 per cent, passed out in suspension. Most of the material so carried in suspension was deposited in the lower Sacramento and in the bays in which the Sacramento discharges.

The above statements clearly indicate the nature of the damage done to streams by dumping mining debris where it will be washed into them, and the consequent injury to property by the overflowing of streams in which large quantities of mining debris have been deposited. The labors of the commission of United States engineers, were directed to ascertaining the amount of damage which had been done to various streams by dumping mining debris into them, and the formulation of a plan by which the injurious effects of this course might be obviated, and hydraulic mining resumed without injury to any other interest.

There are large bodies of workable gravel yet remaining, that could be worked at a fair profit, and, in the opinion of many persons who have given thought to the subject, dams could be erected for the impounding of the mining debris, and thus prevent the filling up of the stream.

The conclusions of the engineers on this method of remedying the evil are given at length. They say: "The board is of the opinion that some partial protection could be afforded the rivers and lands below by restraining a portion of the coarser part of the material mined by structures built in the cañons, ravines, and valleys at points where examinations have indicated the most favorable locations. These works should be permanent stone dams or barriers built across the beds of cañons and carried to such heights as the local conditions may demand. The results obtained by dams now in existence show the feasibility of impounding portions of the coarser material behind properly constructed barriers. As the stability of the dam depends in a great measure upon the apron, the greatest care should be taken in its construction. An economical construction could be obtained by building a low structure first, and raising the succeeding ones upon the impounded material. The faces of these dams would then constitute a series of falls, which would have the effect of breaking the force of the water upon the apron. That considerable coarse material can be stored is shown by the dams already constructed in some of the tributary streams. In Slate Creek material is impounded by two crib dams. The upper one, immediately below the Poverty Hill mine, banks up debris over 27,000 feet on a grade of 50 feet per mile." A number of other cases are cited where mining debris is stored by means of dams.

In concluding their report, the engineers refer to the injuries to the rivers of the Sacramento Valley by the deposition of vast quantities of mining debris in the beds, and reaffirm their faith in the possibility of impounding the debris without injury, and locations are pointed out where this may be done.

The question as to whether the damage from mining debris may be prevented by the erection of dams across streams into which such debris has been washed, was passed upon by the courts in the litigation which resulted in the decision by the United States Circuit Court which renders hydraulic mining in California illegal. In the action brought by the Attorney-General of the State for a perpetual injunction restraining a certain mining company from dumping debris where it would be washed into the river, the lower court granted the injunction prayed for, but affixed a condition in the decree that when efficient means should have been provided to impound the heavier portion of the debris, the defendant should be entitled to have the injunction dissolved. The people appealed from the condition affixed to the injunction, and the Supreme Court affirmed the injunction without any conditions. Judge Sawyer, in that portion of his decision relating to the erection of dams as a remedy for the evils, said: "Whether a dam can be constructed to stand the pressure to which it will necessarily be subject under these circumstances, and whether it will be of any material use in preventing the flow of the debris, and the filling of the river below, are questions upon which I am not fully advised; but from the evidence in the case, and of my observation of the premises, I am strongly impressed with the belief that sufficient of the debris will still pass over the dam in suspension with the water to maintain and even increase the present fill of the river.

"Besides, it is a very serious question in my mind whether any person or community can or ought to be required to submit to the continuous peril of living under or below such a dam as this must necessarily be if it be made high enough to impound the coarser material—and this merely for the convenience of another person in the pursuit of his or their private business. It may be likened at least to living in the direct pathway of an impending avalanche."

The report goes very thoroughly into all details affecting this question, and is signed by Lieut.-Col. W. H. H. Berry and Major W. H. Heuer and Major Thomas H. Handbury, of the Corps of U. S. Engineers.

Opals.

At a recent meeting of the California Academy of Sciences, the following paper was read by Melville Attwood, M.E.:

The precious, or noble, opal is one of the most beautiful gems in nature. When held between the eye and the light, it appears of a pale milky reddish blue, but when seen by reflected light, it displays all the colors of the rainbow.

Opals are always cut *en cabochon*, on both sides, and the true beauties of the gem only display themselves when the stone is moved about, as then a fine opal really appears to have an actual life within itself.

Fine stones of a large size are rarely found. They seldom exceed an inch in diameter. When held in the hand to impart warmth to the gem, it is much more brilliant.

Some varieties of opal (the common) are found with galena and blende in metalliferous veins. They also occupy the interior of fossils in sandstone. Its formation is due to the solubility of amorphous silica in water, especially in hot water, or water containing carbonic acid, the silica being dissolved out by spring waters from decomposed silicates, and deposited under favorable circumstances in a state more or less approaching to purity.

At a former meeting I presented the Academy with opals in the matrix from the State of Washington. Since that I have cut another microscopic section of the Washington rock, which I now donate to the Academy. The section shows the rock to be basalt, consisting of a mixture of fine grains of labrador, feldspar, etc., with a small quantity of magnetic iron.

Through the kindness of Adolph Sutro, Esq., I am now enabled to give the Academy specimens of opals in the matrix from Mexico, Australia, and Hungary.

The inclosing rocks of those from Mexico and Australia are so altered, or decomposed, that I could not cut a satisfactory section from them. They are, however, without doubt, trachytes. The two specimens from Hungary are very interesting, being the same rock, but the one much altered or decomposed and the other fresh or unaltered. From the latter I managed to cut a section sufficiently thin to prove it to be a trachyte, with small crystals of leucite in it.

The result of my examination of the inclosed rocks of the different precious opal deposits, and from all the information I can obtain by papers written on the subject, is that the precious opals occur, or are found, mostly in dikes of intrusive volcanic rocks, and in those parts of the dike near the surface, and where the rocks are greatly altered or decomposed.

Naval Torpedoes.

A permanent board of torpedo experts has been recently established by the Navy Department to take charge of experiments, tests of firing and launching tubes, installation on board, stowage, and torpedo supplies. It consists of Commander G. A. Converse, senior member; Lieut. F. J. Drake, and Lieut. T. C. McLean. The headquarters of the board will be at New York, with experiments conducted also at Providence and Newport, and practical steps have been taken to obtain a supply of torpedoes for our war vessels at an early day. Messrs. E. W. Bliss & Co., of Brooklyn, N. Y., having arranged with the proprietors of the Whitehead torpedo for its manufacture in this country, the Navy Department has contracted with that firm to make one hundred of these torpedoes at $2,000 each, and parts to be added by the Carpenter Steel Company will considerably increase the cost. Thirty torpedoes of the type invented by Capt. J. A. Howell, of our navy, have also been ordered, at a cost of $2,200 each, and it is expected that the first of these will be ready for trial in August.

The competitive tests of these two torpedoes will be looked for with much interest, particularly as public attention has been so strongly directed to the performance of the Whitehead torpedo by its work in the recent sinking of the Chilean warship the Blanco Encalada, as described in the SCIENTIFIC AMERICAN of June 6. In the Howell torpedo there are four sections. The first contains the firing pin and its mechanisms; the second, just behind it, the explosive charge and detonator; then comes the third, containing the flywheel and screw gears; finally, the stern, which holds the driving mechanism. The characteristic feature of this torpedo is the heavy flywheel which propels it, and which is spun up by a steam turbine motor, which forms a permanent attachment of the launching tube. The torpedo having once been placed in the tube, the steam motor clutches the flywheel, and when steam is applied it spins up the latter, and all the succeeding movements until the torpedo reaches its target and is exploded are performed automatically.