slightly acute angle. A large tube three fourths inch in diameter is best. The amalgam is broken into pieces small enough to be dropped into the closed end where it is then heated, the fumes condensing in the long open end of the tube. The gold can be annealed by heating the tube to redness after all mercury is driven off.

A retort for treating a few ounces at a time can be made cheaply of 3/8-inch pipe, pipe connections, and a large grease cup. The lower and open end of the 3/8-inch pipe is inclosed in a larger pipe. Cooling water is poured through the space between the two pipes from an open connection in the top of the outer one. The charge of amalgam is placed in the grease-cup cover which is then screwed into place; graphite lubricant is placed on the threads to make a tight joint. Heat is applied to the grease cup, and the quicksilver is condensed in the lower end of the pipe. The method of using and the general arrangement of the device are similar to those of the next retort described.

The typical quicksilver retort for placer mines (fig. 15, C and D) is a cast-iron pot with a tight-fitting cover in which a hole is tapped to accommodate the condenser pipe. The capacities of such retorts range from a few to 200 pounds of amalgam, or about a quarter pint to 2 gallons. They are listed in chemical-supply catalogs at prices ranging from $4 to $30, not including the condensers. The condenser commonly used with this type of retort is an iron pipe 3 or 4 feet long leading from the hole in the retort cover at a downward angle of 20 to 30°; it is encased for most of its length in a considerably larger pipe through which cooling water is circulated. When heat is applied to the charged retort the mercury vapor enters the condenser pipe where it cools and condenses; it trickles down the pipe into a vessel placed under the open end of the pipe. In the treatment of a large amount of amalgam the temperature of the pipe might be raised to a point where some of the vapor would escape; therefore, a cooling device is necessary.

The retort may be heated over a large bunsen burner, by a gasoline blow torch, in a forge, or in one of several types of furnaces built for the purpose. Very high temperatures are unnecessary, and a wood fire is considered better than a coal fire. The flame should cover as much of the retort as possible.

A rigid, strong stand for the retort and condenser (fig. 15,A) should be constructed if the apparatus is to be used regularly.

The retort should be coated on the inside with chalk, or painted with a thin paste of chalk, clay, mill slimes, or a mixture of fire clay and graphite and thoroughly dried before putting in the charge. This prevents the gold from sticking to the iron, which sometimes causes trouble. A lining of paper serves the same purpose but tends to form an objectionable deposit in the condenser pipe.

The retort should not be filled over two thirds full of amalgam (a third or half full when retorting liquid mercury), otherwise there is danger of some of the contents boiling over into the condenser tube. The amalgam is broken into pieces and piled loosely. Then the cover is put on and clamped tightly with the wedge or thumbscrew provided, first making sure that the attached condenser pipe is clean and free of obstructions. The ground joint between the cover and body of the retort is seldom tight enough to prevent leakage and should be luted with clay or some sealing compound. One satisfactory cement is made readily by moistening a mixture of ground asbestos and litharge (red lead) with glycerin.

A low heat is applied at first, then after 10 or 15 minutes the temperature is increased just enough to start the mercury vaporizing and condensing. Too rapid heating harms the retort, and only enough heat should be used to maintain a steady trickle of quicksilver from the condenser. When no more mercury appears the temperature should be increased for a few minutes to red heat to drive the last of the quicksilver out of the retort; then the fire should be withdrawn from the retort and the latter allowed to cool. Some mercury vapor always remains in the retort, and the operator should take care not to breathe these fumes upon taking off the cover.

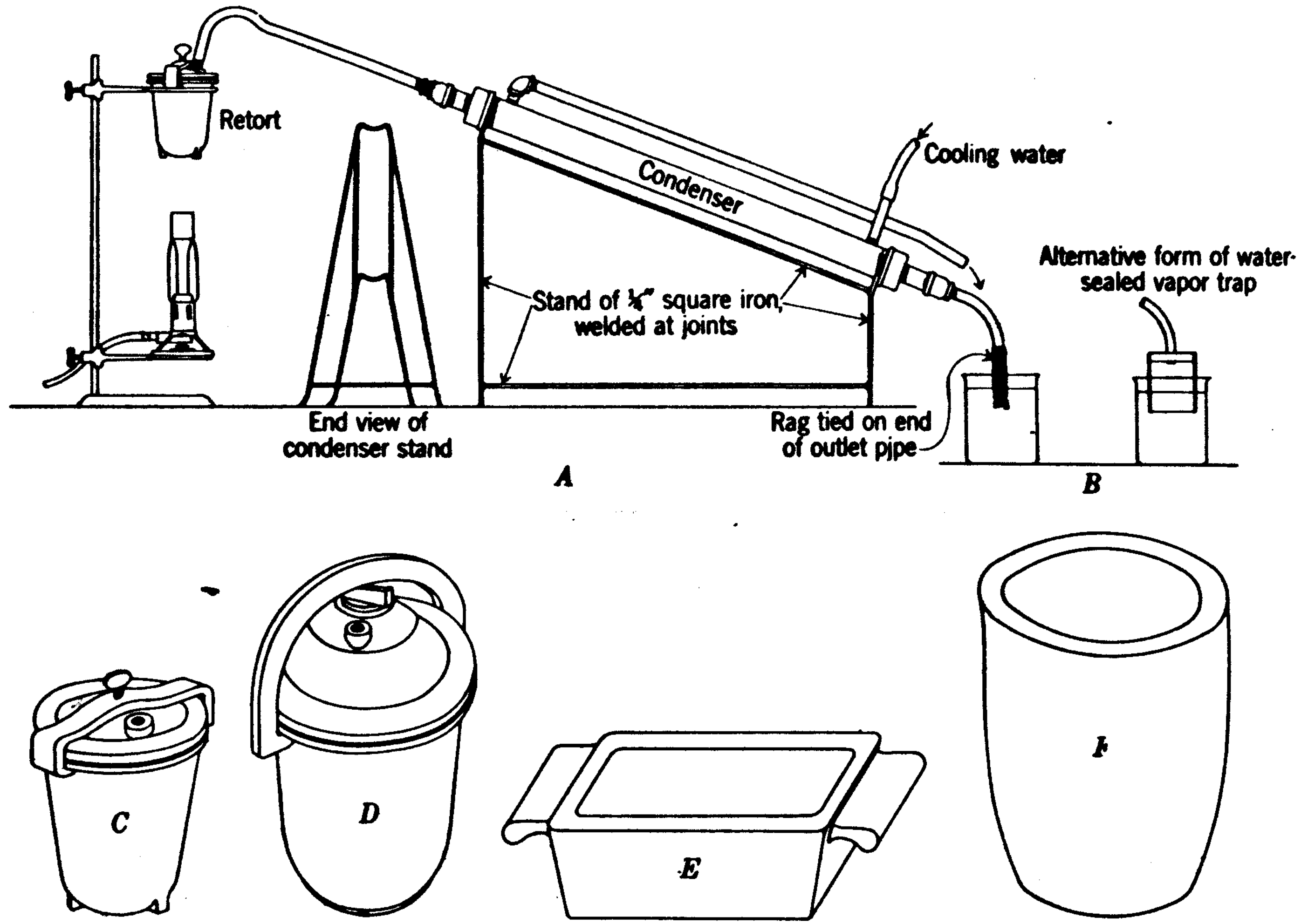

Figure 15.—Apparatus for retorting amalgam and quicksilver: *A*, Amalgam retort; *B*, Nevada-type retort; *C*, set-up of small retort; *D*, water-sealed vapor trap; *E*, graphite crucible; *F*, bullion mould.

The likelihood of dangerous amounts of mercury vapor passing through a long cold pipe without condensing is very small. However, if much amalgam is to be retorted, or if the operation is of daily or frequent occurrence, it usually is desirable to provide some form of water seal at the end of the condenser tube to prevent the escape of such fumes. Many miners have followed the dangerous practice of submerging the end of the condenser pipe in the bucket of water used to receive the condensed mercury. This should not be done, as a slight cooling of the retort would cause water to be sucked into the pipe, and if the water reached the retort an explosion would follow. Such an experience has taught more than one "oldtimer" the danger of this practice.

If the volume of the receptacle is very small compared with that of the condenser pipe and if the discharge pipe is barely submerged the danger is avoided, as any large rise of water in the pipe would lower the water surface enough to break the suction. At some properties the end of the condenser pipe is in a large sheet-iron cylinder, a few inches in diameter, open at the lower end, which may be placed 2 or 3 inches into the water in a receptacle of only slightly larger diameter, thus making a good water seal yet avoiding the danger of explosions. A laboratory adaptation of this device is shown in figure 15,B.

The simplest method is that recommended by Louis[46]; it consists merely of tying a piece of cloth such as canvas or burlap around the end of the condenser pipe and letting it dip in the water 2 or 3 inches below, forming a damp filter which will condense any escaping vapor yet not be tight enough to permit water to be sucked into the retort. This device is shown in figure 15,A.

Large gold mines use cylindrical retorts, usually set horizontally in specially built furnaces. Such installations probably would be needed in placer mining only by large dredging companies. The operation is similar to that of a pot retort, except that the amalgam usually is placed in several small iron trays, rather than on the floor of the retort proper, and charged through a door or removable cover at one end of the retort, while the condenser is attached at the opposite end.

SEPARATION OF PLATINUM-GROUP METALS FROM GOLD

In several localities in the Western States sluice concentrates from placer mining are likely to contain platinum or its associated metals in sufficient quantities to be of economic interest. The separation of these minerals from gold is difficult. Their specific gravity is too near that of gold to permit a separation by panning. Coarse platinum particles can be picked out of the gold by hand, but most placer platinum is exceedingly fine. Although platinum does not amalgamate, quicksilver can be made to coat and hold platinum particles by treatment with chemicals; thus it is possible to separate successively the gold and platinum from the concentrates.

One dredging company in California which recovers platinum metals uses the following clean-up procedure:[47]

> In cleaning up, the riffles are removed from the sluices, starting at the head end, carefully washing them off and washing the sluice down with water from a hose. This washes away the light sands and concentrates the amalgam and heavy sands, which are carefully scooped up into buckets and carried to a "long tom" for further treatment. In the long tom most of the mercury and amalgam and some

46 Louis, Henry, A Handbook of Gold Milling: London, 1894, p. 386.

47 Patman, C. G., Method and Costs of Dredging Auriferous Gravels at Lancha Plana, Amador County, Calif.: Inf. Circ. 6659, Bureau of Mines, 1932, pp. 12-13.

$$Q = 8CA\sqrt{h}$$

where

Q = cubic feet per second,
A = area of nozzle (square feet),
h = effective head at nozzle (feet),
C = coefficient of discharge ranging from 0.8 to 0.94 (usually taken as 0.9, which makes allowance for friction).

To convert cubic feet to gallons multiply by 7.48.

TABLE 7.- Flow of water through giants[1]

Giant no.	Diameter of nozzle, inches	Effective head, feet: 100		200		300		400	
		Cubic feet per second	Miner's inches	Cubic feet per second	Miner's inches	Cubic feet per second	Miner's inches	Cubic feet per second	Miner's inches
0	1 1/8	0.6	22	0.8	31	....	....	....	....
0	1 3/8	.8	33	1.2	47	....	....	....	....
1	2	1.6	63	2.2	89	2.7	109	3.1	125
1	3	3.0	120	4.3	173	5.3	213	6.4	257
2	3	3.3	133	4.7	187	5.7	227	6.6	267
2	4	5.6	227	8.3	333	10.3	410	11.9	477
3	3	3.7	148	5.0	200	6.5	245	7.1	283
3	4	6.0	240	8.6	343	10.6	423	12.2	488
4	4	6.3	253	8.9	357	10.9	437	12.6	504
4	6	13.3	535	19.2	770	23.7	950	27.5	1,100
5	5	9.8	395	15.9	560	16.7	670	19.7	790
5	6	13.5	540	19.3	770	23.8	950	27.7	1,110
6	6	13.8	550	19.6	780	24.1	960	27.9	1,120
6	7	18.7	750	26.7	1,070	33.2	1,330	37.7	1,510
7	6	14.2	570	20.0	800	24.5	980	28.3	1,130
7	7	19.0	760	26.9	1,080	33.3	1,330	38.0	1,520
8	7	19.2	770	27.2	1,090	33.8	1,350	38.3	1,530
8	8	15.2	1,010	35.3	1,410	43.7	1,750	48.7	1,950
9	9	32.0	1,280	45.0	1,800	55.3	2,210	63.7	2,550
9	10	39.3	1,570	55.3	2,210	68.2	2,730	78.7	3,140

[1]Adapted from table in catalog of Joshua Hendy Iron Works, San Francisco, Calif.

Derricks and Winches

The same general types of derricks and winches are used as in ground-sluicing, which has been described in a previous paper.[18]

I.C.6787.

[18] Gardner, E. D., and Johnson, C. H., Placer Mining in the Western United States: Part I. - General Information, Hand-Shoveling, and Ground-Sluicing: Inf. Circ. 6787 Bureau of Mines, 1934, 73 pp.