Exercise 5

Problem 5.1

In [36]:

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

file = pd.read_csv('Ads.csv')
```

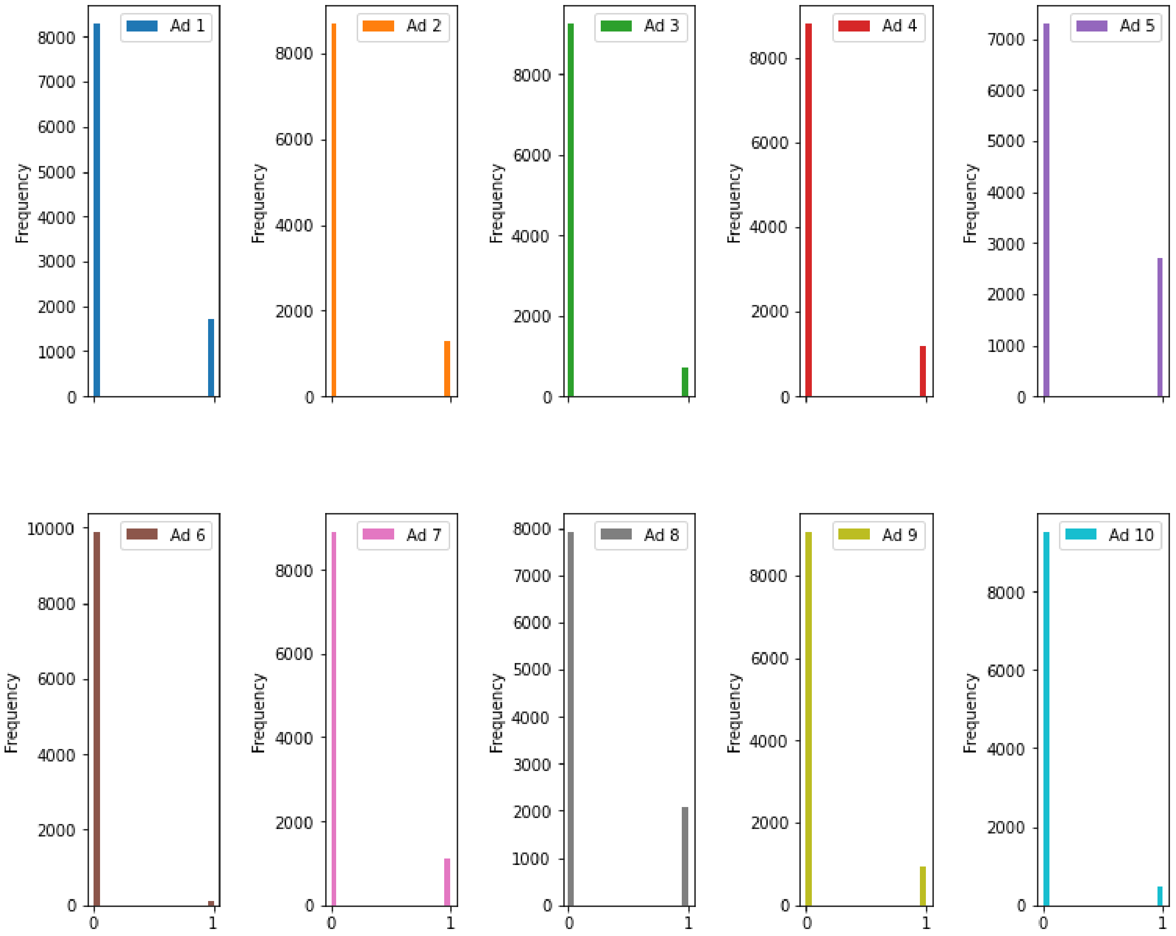
In [37]:

```
fig, ax = file.plot.hist(subplots=True, layout=(2,5), figsize=(12, 10), bins=20)

plt.subplots_adjust(left=0.1,
                    bottom=0.1,
                    right=0.9,
                    top=0.9,
                    wspace=0.8,
                    hspace=0.3)
plt.show()

#The frequency of data is shown using a histogram.
#In a histogram, the higher the bar, the more common it is in the observed data [1].
#It is evident, even without any statistical study, that "Ad 6" is most clicked and "Ad 5"
#[1] https://towardsdatascience.com/distribution-visualization-101-with-python-a12d481afec7
```

5 -1



✓

Problem 5.2

In [38]:

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import random

dataset = pd.read_csv('Ads.csv')

N = 10000
d = 10

ads_selected = []
numbers_of_rewards_1 = [0] * d
numbers_of_rewards_0 = [0] * d

total_reward = 0

for n in range(0, N):
    ad = 0
    max_random = 0

    for i in range(0, d):
        random_beta = random.betavariate(numbers_of_rewards_1[i] + 1, numbers_of_rewards_0[
        if random_beta > max_random:
            max_random = random_beta
            ad = i

    ads_selected.append(ad)
    reward = dataset.values[n, ad]

    if reward == 1:
        numbers_of_rewards_1[ad] = numbers_of_rewards_1[ad] + 1
    else:
        numbers_of_rewards_0[ad] = numbers_of_rewards_0[ad] + 1
    total_reward = total_reward + reward

print("Total reward : ", total_reward)
```

```
Total reward :  2608
```

no reference?

Problem 5.3

In [39]:

```
import numpy as np
import pandas as pd
from scipy.stats import beta, bernoulli
import random
import math

RANDOM_SEED = 123
np.random.seed(RANDOM_SEED)
init_notebook_mode(connected=True)
```

In [40]:

```
#assume that the actual CTR values for both Ads for simulation purposes are known.
ACTUAL_CTR = [.45, .65]
print('Actual CTR for Ad #0 is:', ACTUAL_CTR[0])
print('Actual CTR for Ad #1 is:', ACTUAL_CTR[1])
```

```
Actual CTR for Ad #0 is: 0.45
Actual CTR for Ad #1 is: 0.65
```

In [41]:

```
#For each alrorithm we will perform 1000 trials
n = 1000

regret = 0
ctr = {0: [], 1: []} #lists for collecting the calculated CTR
index_list = [] #list for collecting the number of randomly choosen Ad

#set the initial values for impressions and clicks
impressions = [0,0]
clicks = [0,0]

for i in range(n):

    random_index = np.random.randint(0,2,1)[0] #randomly choose the value between [0,1]
    index_list.append(random_index) #add the value to list

    impressions[random_index] += 1 #add 1 impression value for the choosen Ad
    did_click = bernoulli.rvs(ACTUAL_CTR[random_index]) #simulate if the person clicked on

    if did_click:
        clicks[random_index] += did_click #if person clicked add 1 click value for the choo

    #calculate the CTR values and add them to list
    if impressions[0] == 0:
        ctr_0 = 0
    else:
        ctr_0 = clicks[0]/impressions[0]

    if impressions[1] == 0:
        ctr_1 = 0
    else:
        ctr_1 = clicks[1]/impressions[1]

    ctr[0].append(ctr_0)
    ctr[1].append(ctr_1)

    #calculate the regret
    regret += max(ACTUAL_CTR) - ACTUAL_CTR[random_index] #here max(ACTUAL_CTR) is the true
    #and ACTUAL_CTR[random_index] is the CTR of the ad chosen in the random_index trial.

print(regret)
```

✓

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```
98.40000000000086
```